



Microplastic Counts in Zooplankton Tows From an Upwelling Region Off West Africa: A Technical Note on Sampling and Interpretation

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Abstract

Zooplankton nets are towed routinely on fisheries and oceanographic cruises in the Canary Current upwelling system off north-west Africa, and the samples they bring up contain synthetic particles and fibres alongside the animals. Counting those particles is an attractive way to obtain microplastic data from a region where dedicated surveys are few, because the ship time, the nets and often the archived samples already exist. This technical note considers what such counts can and cannot show. It reports no new measurements. It explains why a plankton net is an imperfect microplastic sampler, how the mesh and the dense blooms typical of upwelling affect what is retained, and how the offshore movement of surface water and its return at fronts are expected to shape where buoyant particles collect. It distinguishes three quantities that are often confused: particles per volume of water, particles relative to plankton biomass, and particles found inside the animals. The note then summarises the contamination controls and polymer confirmation that published quality criteria require, and suggests a minimum set of information that should accompany any count taken from a zooplankton tow so that results from different cruises and laboratories off West Africa can be compared.

Keywords: Microplastics, Zooplankton, Canary Current, Coastal upwelling, Plankton nets, Contamination control

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1. Introduction

The coast from Morocco to Senegal and Guinea borders one of the four great eastern boundary upwelling systems. Trade winds drive surface water offshore, cold nutrient-rich water rises to replace it, and the resulting production supports large stocks of sardine, sardinella and horse mackerel. Upwelling is permanent off Mauritania and seasonal to the north and south, and the system is strongly structured by capes, filaments and fronts (Aristegui et al., 2009). Zooplankton are sampled here regularly in support of fisheries assessment, usually with vertical or oblique tows of fine-meshed nets.

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Those samples have a second potential use. [Thompson *et al.* \(2004\)](#) showed, using archived material from the Continuous Plankton Recorder, that plankton samples collected for another purpose can yield a history of microplastic in the sea. Zooplankton also ingest microplastic particles in laboratory exposures ([Cole *et al.*, 2013](#)), and ingestion has been confirmed in copepods and euphausiids caught at sea ([Desforges *et al.*, 2015](#)). For a region with little dedicated monitoring, counting plastic in existing tows is an obvious step. This note sets out the conditions under which such counts are meaningful. It is a commentary on method and presents no data.

2. The Net as a Microplastic Sampler

A plankton net retains what is larger than its mesh and passes most of what is smaller. Standard zooplankton nets have meshes of roughly 200 micrometres, and the manta and neuston nets normally used for floating plastic are coarser still ([Harris *et al.*, 2000](#); [Hidalgo-Ruz *et al.*, 2012](#)). Since small particles greatly outnumber large ones, the mesh largely determines the count: [Lindeque *et al.* \(2020\)](#) compared nets of different mesh towed together and found that finer nets captured far higher concentrations. Fibres complicate matters further, because a long thin fibre may pass end-on through a mesh that its length would not. A count is therefore a property of the water and the net together, and cannot be compared with a count made using a different mesh without qualification.

Upwelling adds a difficulty of its own. Blooms of chain-forming diatoms and swarms of gelatinous animals clog fine meshes within minutes. A clogged net filters less water than its flowmeter may indicate, and it retains particles smaller than its nominal mesh, so that the volume and the size cut-off both drift during a tow. Short tows, a flowmeter mounted in the mouth, and a record of net condition on recovery are the practical safeguards. Vertical hauls through the whole water column raise a further point: they integrate over depth, whereas buoyant polymers concentrate at the surface, and a surface tow and a vertical haul at the same station measure different things.

3. What Upwelling Does to the Distribution

Buoyant particles follow the surface flow. In an upwelling cell that flow is directed offshore, which should carry floating plastic away from the coast and leave freshly upwelled water comparatively clean, while convergent fronts and the edges of filaments gather floating material together with plankton. The expected pattern is therefore patchy and tied to hydrography, not a smooth gradient from land. [Kanhai *et al.* \(2017\)](#) sampled subsurface water along a latitudinal transect of the Atlantic that crossed the upwelling system off south-western Africa and examined upwelling among the factors that might affect abundance. For West Africa the practical lesson is that each tow should be placed in its oceanographic setting, with temperature, salinity and chlorophyll recorded, and that a single station cannot represent the region.

Sources add a second layer of structure. Along this coast synthetic material enters the sea from a small number of cities and river mouths, from artisanal landing beaches, and from the industrial and artisanal fleets that work the shelf, whose ropes and netting are themselves polymer. Fragments and fibres of fishing gear should therefore be expected on the fishing grounds irrespective of distance from land, and a count that separates fibres, fragments, films and pellets, and records colour, says far more about origin than a single total. Seasonal sampling matters for the same reason: the wet season brings river discharge to the southern part of the region at a time when upwelling there is weak.

Counts can be expressed in several ways, which answer different questions. Table 1 sets them out. In highly productive water the ratio of plastic to plankton may be low even where the concentration per cubic metre is not, simply because there is so much plankton, and the reverse holds in the oligotrophic water offshore.

4. From Sample to Count

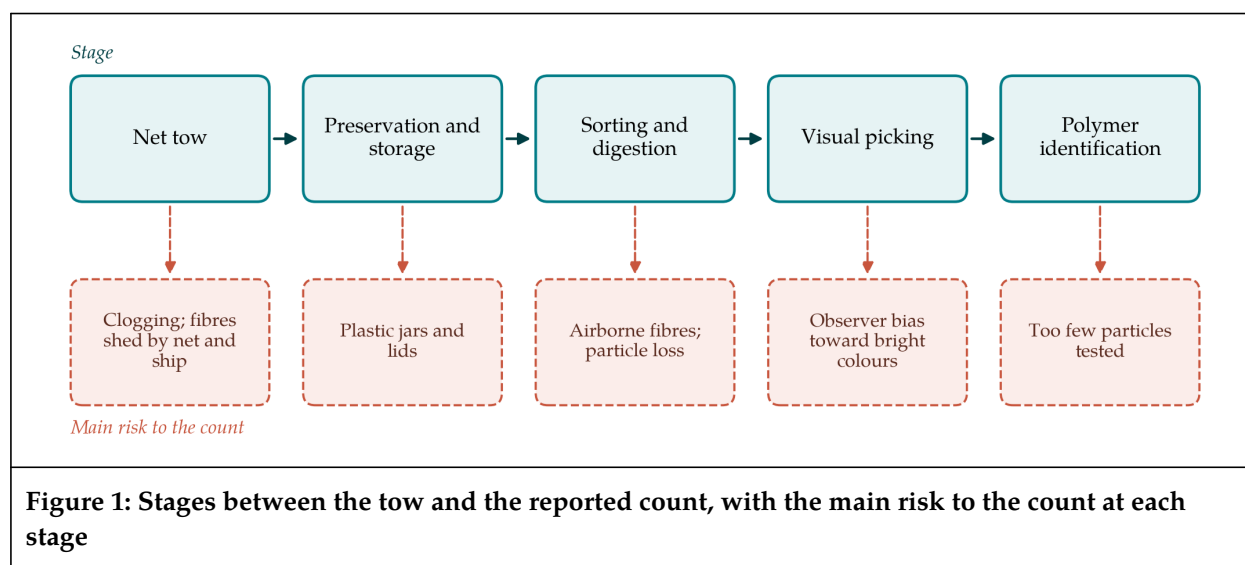
Most of the error in microplastic work arises after the net is on deck, and Figure 1 follows a sample through the stages at which a count can be inflated or reduced. Particles in the cod end are a mixture of those free in the water and those inside or stuck to animals, and the two can be separated only if animals

are picked out and rinsed before digestion. To free ingested particles the tissue must be dissolved without damaging the polymers. Strong acids destroy some plastics, and [Cole et al. \(2014\)](#) showed that enzymatic digestion removes most biological material from plankton-rich samples while leaving microplastic intact. Formalin-preserved archive samples can be examined, but the history of the jars and lids must be considered.

Table 1: Ways of expressing microplastic counts from a zooplankton tow and what each can support

Quantity	What it describes	Main caveat
Particles per cubic metre	Concentration in the water sampled	Depends on mesh, clogging and flowmeter accuracy
Particles per unit area of sea surface	Load in a surface tow	Sensitive to wind mixing during the tow
Particles relative to plankton biomass or number	Encounter rate for planktivores	Driven as much by plankton as by plastic
Particles per individual animal	Ingestion by a named taxon	Needs rinsed, individually picked animals and blanks
Proportion by shape and polymer	Likely sources	Only valid for spectroscopically confirmed particles

Contamination is the central problem for fibres. Clothing, ropes, the net itself and laboratory air all shed them, and [Woodall et al. \(2015\)](#) set out forensic-style precautions: cotton clothing of known colour, covered samples, filtered reagents, and blanks exposed alongside every sample. A critical review of studies of biota found that few met basic quality criteria, and it proposed a scoring scheme covering sampling, laboratory conditions, blanks, positive controls and polymer identification ([Hermesen et al., 2018](#)). Visual identification alone misclassifies many particles, natural fibres and fragments of shell among them, so that a defined subsample must be confirmed by infrared or Raman spectroscopy ([Hidalgo-Ruz et al., 2012](#)). On a fisheries vessel, fragments of the ship's own paint and net twine are likely contaminants, and reference scrapings should be taken for comparison.



Losses deserve the same attention as additions. Particles adhere to the net, to sieves and to the walls of digestion vessels, and the smallest are easily overlooked under a dissecting microscope. The usual check is a positive control: a known number of reference particles of several polymers and shapes is added to a plankton sample, carried through the whole procedure and counted at the end. The recovery obtained should be stated with the results, and counts should not be adjusted upward for it without saying so.

5. Minimum Information to Report

Comparability across cruises depends less on a single agreed method than on complete reporting. A count from a zooplankton tow should state the net type, mouth area and mesh; whether the tow was vertical, oblique or at the surface, and over what depth; the volume filtered and how it was measured; the wind and sea state; the hydrographic setting of the station relative to the upwelling front; the preservation and digestion used; the lower size limit actually counted; the number and results of procedural blanks, with any correction applied; and the proportion of particles confirmed by spectroscopy. Ingestion should be reported per individual of a named taxon and life stage, with the number of animals examined, and kept separate from the count of free particles. Reviews of zooplankton and microplastic have noted how often such details are missing and how much this limits synthesis (Botterell et al., 2019).

6. Conclusion

Zooplankton tows off West Africa are a ready source of microplastic observations in an under-sampled and productive part of the ocean, and archived collections may extend the record backward. Their value depends on recognising that the net was designed for animals, that upwelling circulation makes the distribution of floating particles patchy, and that blooms change what a net retains. Counts reported with mesh, volume, setting, blanks and polymer confirmation can be compared and built upon. Counts reported without them add numbers to the literature but little knowledge.

Conflict of interest

To be declared by the author(s) before publication.

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