Global Efforts in Plastisphere-related AMR Research – A Systematic AI-facilitated Review

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BACKGROUND

Aims

- Answer if **biofilms** on macro- and microplastics in the environment have higher levels of **antimicrobial resistance genes** (ARGs).
- Consolidate knowledge systematically and map the research landscape detailing **sources** (e.g., fresh and wastewater), **study** and **plastic types**.

Common Hypotheses

ARG enrichment pathways (**de novo formation, sharing** and **spread**):

- **Increased biofilm formation** with favorable surface characteristics and enhanced proximity of bacteria for ARG sharing within
- **Dispersal differences** of plastic-associated and free bacteria
- **Co-location** of plastic biofilms and **contamination** (e.g., antibiotics, feces)
- **Oxidative stress** induced by chemicals adsorbed or additives leading to mutations and increased permeability for ARG exchange. [1] [2]

METHODS

Registration and Protocol

The study protocol is registered with **Open Science Framework** (https://osf.io/23wnh).

Search Syntax

("**antimicrobial resistance***" OR "antibiotic resistance*" OR "antimicrobial-resistant" OR "antibiotic-resistant" OR "drug resistance*" OR "multidrug resistance*" OR amr OR "resistance gene*" OR arg OR ARGs OR "resistant bacterium" OR "resistant bacteria" OR resistome*) AND (**plastic** OR plastics OR microplastic* OR nanoplastic* OR plastisphere)

Inclusion and Exclusion

We screened for **peer-reviewed** full text articles in English about plastic-associated AMR reporting on plastics in combination with AMR as **core concepts**, published between 01 January **2015** and 10 February **2025**.

Supervised Screening

For AI-facilitated screening we used **ASReview** with the pre-trained Sentence Bidirectional Encoder Representations from Transformers (SBERT) model in combination with neural networks setting. [3]

Data Extraction

Unstructured to structured data extraction and cleaning using **Large Language Models** (LLMs) via API with manual supervision checking full text references. We aim to automate 1) DOI to PDF download 2) article section finding, and 3) information extraction via optimized prompts:

Analysis

Comparison of study findings on ARG copy numbers and transfer rates. Collecting study **meta-data** and additional data collection from **satellites** and **socioeconomic** surveys. Subsequent, feature importance AI modelling with **extreme gradient boosting** using XGBoost and Shapely. [4]

RESULTS

Screening

The search yielded 4880 articles of which **323 articles** have been included (work in progress).

Research Approaches

Review studies (17%) most are non-systematic.
Observational studies (39%) taking unmanipulated environmental samples.
Experimental studies (44%) simulating conditions in the lab/mesocosms or substrate incubations.

Source Types

Aquatic, especially Wastewater Treatment Plant (WWTP) related plastisphere research makes up the largest proportion of all studies.

ARGs

Sulfonamide, tetracycline, and **erythromycin** resistances are dominant in observational studies.

Plastic Types

Mostly found **Polypropylene** (PP), polyvinyl chloride (PVC), polyethylene terephthalate (PET), and polystyrene (PS).

Enrichment

Opposite results in different studies.

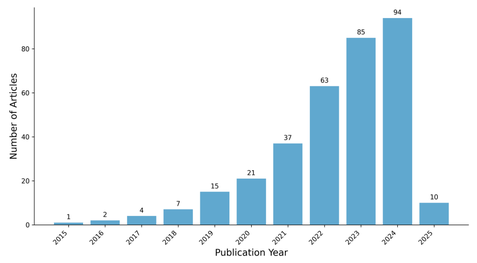

Figure 1: *Number of Relevant Research Articles Published Over Time.*

Figure 2: *Global Sampling locations of Observational studies included.*

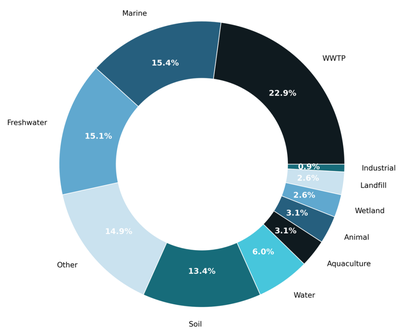

Figure 3: *Researched Environmental Sources of Plastisphere AMR.*

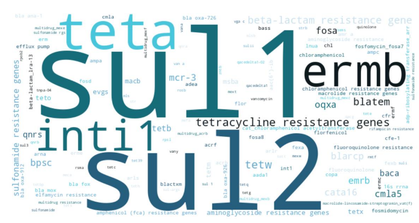

Figure 4: *ARGs Reported in Observational studies.*

CONCLUSIONS

Advantages

AI-assisted systematic review **pipeline** enables scalable and transparent overview and regular **updating** and **re-evaluation** of expanding evidence base.

Challenges

Despite AI advances, an open-source pipeline construction remains **technically challenging**; at present **manual extraction outperforms** in speed and quality in single-instance reviews.

Future work

Finalizing screening, **refining** of full-text data extraction, **quantification** of possible ARG enrichment.

REFERENCES

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FURTHER INFORMATION

Let's Connect

Group

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