Contamination and effects of microplastics in the Seine estuary's food web. First results from the Plastic-Seine research project (# 334343)

J. Cachot [1], C. Clérandeau [1], F. Le Bihanic 1, C. Vignet [1,3], P. Pannetier [1,3,] F. Misurale [1], Q. Pedriat [1], B. Morin [1], M. Revel [2], C. Mouneyrac [2], M. Mouloud [2], A. Châtel [2], H. Perrein-Ettajani [2], M. Bruneau [2], M.P. Halm [3], A. Gangnery [3], M.L. Bégout [3], X. Cousin [3], C. Dreanno [3], M. El Rakwe [3], J. Thery [4,] C. Bialais [4], S. Souissi [4], M. Kazour [4], R. Amara [4], M.A. Dutertre [5], R. Coulaud [5], T. Monsinjon [5], B. Xuereb [5], L. Boudahmane [6], C. Partibane [6], B. Grassl [7], S. Lecomte [8], J. Gasperi [9]

1. Université de Bordeaux, EPOC, Pessac France ; 2. Université Catholique de l'Ouest, MMS-UCO, Angers France ; 3. Ifremer France 4. Université de Lille-ULCO, LOG, Lille France 5. Université du Havre, Sebio, Le Havre France ; 6. Université de Paris Est, LEESU, Paris, France; 7. Université de Pau, IPREM, Pau, France ; 8. Université de Bordeaux, CBMN, Pessac, France ; 9. Université Gustave Eiffel, GERS-LEE, Nantes, France

Introduction:

The Seine River has an highly populated and industrial watershed (76,800 km²) and has been considered for decades as one of the most contaminated river and estuary in Europe (Cachot et al., 2006). Even though a lot of studies have reported organic or metallic contamination in this ecosystem very few reports focused on macro and microplastics (MPs).

The Plastic-Seine program (Flow and impacts of microplastics in the Seine estuary) is funded by Seine-Aval and CPIER Vallée de Seine. It involves six French laboratories associated in a joint research project to study in an integrated approach, the occurrence and levels of contamination of the Seine Estuary by microplastics in all compartments of the ecosystem including seven representative species of the food web and also possible impacts of MPs exposure on biology traits, physiology and behavior of three estuarine species, the worm *Hediste diversicolor*, the copepod *Eurytemora affinis* and the flatfish *Solea solea*.

Figure 1: Seine estuary (West of France), a 180 km long and highly contaminated macro-tidal estuary (Google Earth).

WP1: Occurrence of microplastics in abiotic compartments

See Gasperi et al., oral presentation # 333668. The fate of microplastics along salinity gradient and tidal cycles in a well-mixed estuary: a case study of the Seine estuary

WP2: Microplastic contamination in biota

Fig. 2: Sampling sites in the Seine estuary for seven representative estuarine species of the food web.

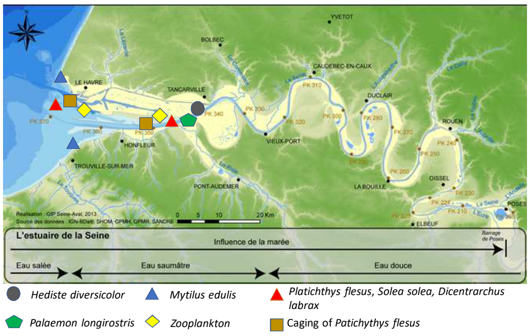
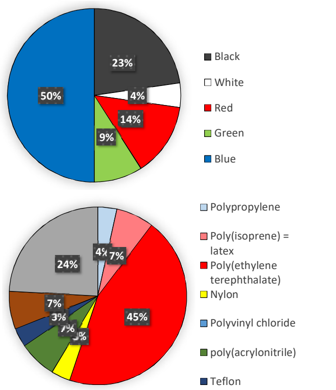


Table 1: Suspected microplastics in gut or in soft tissue of 6 species collected in 2017 and 2018 in the Seine estuary

Species	Number of individual	% of contamination	Main type	Main type	Size range (µm)	Main polymers
Hediste diversicolor	120 pools of 3	61	Fibres and fragments	Black, blue or red	100-4000	PE + PP + PS
Palaemon longirostris	107 pools of 3	44.5	Fibres	Black or blue	100-6000	PS
Mytilus edulis	36 pools of 3	100	Fibres	Black	250-500	NI
Platichthys flesus	21	70-80	Fibres	Blue or red	< 800	PA + PET + PUR
Solea solea	101	80-98	Fibres	Black or blue	100-5000	NI
Dicentrarchus labrax	77	50	Fibres and fragments	Blue or red	100-2000	PET

PUR: polyurethane, PA: polyamide, PET: polyethylene terephthalate, PP: polypropylene, PE: polyethylene, PS: polystyrene, NI: non identified

Fig. 3: Main colours and polymers (FT-IR identification) of MPs isolated from gut of juveniles of Seabass *Dicentrarchus labrax*



- **All species studied contained MPs but the occurrence varied widely between species and individuals.**
- **Fibers and fragments are the most abundant particles. Most of them are colored in blue/black or red.**
- **Several polymers were identified but PE and PET are the most abundant ones.**

WP3:Transfer and effect of MPs on three representative estuarine species : worms, copepods and soles

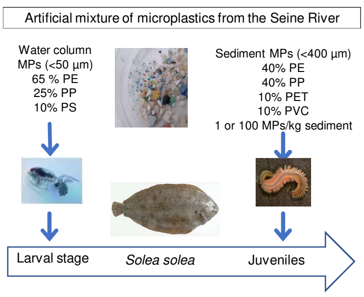


Fig. 4 : Experimental design. Exposure of copepods via the water column. Exposure of annelids via sediment. Sole larvae were fed with copepods and sole juveniles were fed with worms.

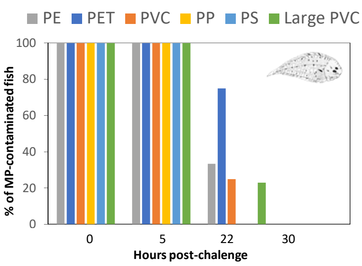


Fig. 5 : Kinetic of ingestion and egestion of different polymers of MPs by post-larvae of Sole.

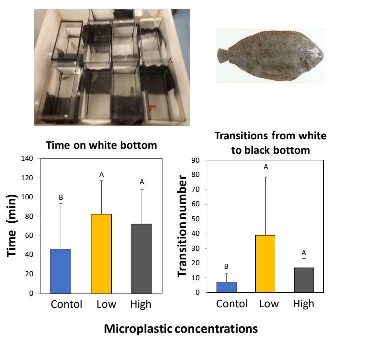


Fig. 6 : Behavior of sole juveniles following 20 days of feeding with MP-contaminated worms.

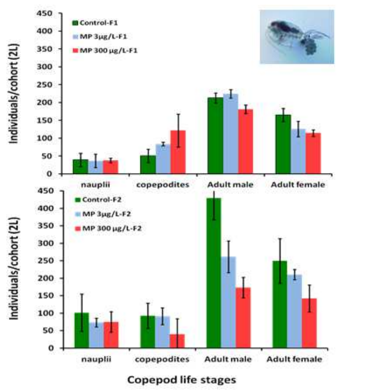


Fig. 7 : Chronic exposure to MPs of the copepod *Eurytemora affinis* over two generations using protocol of Souissi et al., (2016).

- **Efficient ingestion and egestion of MPs by worm and sole. Retention time of MPs in the gut of worms and soles is about 1-2h and 22-30h respectively.**
- **No lethal effects of MPs on worms and sole. No effects on growth and metabolism in sole but significant effects on skin color and camouflage behavior.**
- **Effects of MPs on development and survival of copepods at the 2nd and 3rd generation.**

Conclusions:

- ✓ **MPs were detected in all studied species of the food web (mussels, worms and fish) but with high variability in contamination between species and individuals.**
- ✓ **High efficiency of ingestion and egestion of MPs by worms and flatfish. Small MPs less than 10 µm can be ingested by copepods.**
- ✓ **No lethal effects on worms and soles but significant effects on skin color and behavior of soles.**
- ✓ **Effects of MPs on survival and development of copepod at the 2nd and 3rd generations.**