Zooplankton and suprabenthos of the upstream part of the Seine estuary (France)

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INTRODUCTION

The **megatidal** Seine estuary is located in the northern part of France and has a long and **uninterrupted salinity gradient**.

Zooplankton and suprabenthos of the lower Seine estuary have been widely studied in the case of GIP Seine-Aval projects. Nonetheless, little is known concerning the **structure** and the **species composition** in its **oligohaline and freshwater** parts.

In the downstream part of the estuary, zooplankton and suprabenthos structures were **mainly affected by salinity** (Mouny *et al.*, 2000; Mouny & Dauvin, 2002; Dur *et al.*, 2009; Devreker *et al.,* 2010; Pezy *et al*., 2017; Dur & Souissi, 2018), but nothing is known concerning the abiotic factors that govern their structure in the upstream part.

CHARACTERISTICS OF THE STUDY SITE

The estuary is extended over more than **165 km**.

Megatidal regime (tidal range of 8 m at spring tide).

Well marked **Maximum Turbidity Zone** located between Le Havre and Caudebec according to the season.

Productive habitat **highly anthropized** (Dauvin *et al.*, 2006), hosting two harbours.

OBJETIVES

1. Describe the **specific composition and distribution of zooplankton and suprabenthos** in the oligohaline and freshwater reaches of the Seine estuary.
2. Explore the **relationship that may exist between these two compartments** (comparison of abundance trends).
3. Underline which **environmental parameters** most affect zooplankton and suprabenthos structures.

METHODOLOGY

Zooplankton was sampled with a sub-surface water **plankton net** (mesh size = 50 µm, filtering 50L of water) and suprabenthos with a **suprabenthic sledge** (mesh size = 500 µm).
Abiotic parameters were measured using a Sea-Bird® SBE 19 plus **CTD profiler**.

Counting and identification of organisms with a dissecting microscope and an optical microscope

Relationship between zooplankton and suprabenthos
➔ **Spearman rank correlation**
Environmental influence on zooplankton and suprabenthos
➔ **Redundancy analysis (RDA)**

RESULTS

Zooplankton – Suprabenthos diversity

Downstream ↑ Oligohaline → Freshwater ↓ Upstream

		Taxonomic richness		Shannon H		Pielou eveness J	
		Zooplankton	Suprabenthos	Zooplankton	Suprabenthos	Zooplankton	Suprabenthos
Tancarville	June-19	6	5	1.048	0.31	0.4055	0.12
	July-19	7	8	1.664	0.94	0.5928	0.33
	sept-20	4	9	1.733	0.82	0.8666	0.26
	May-21	5	7	1.021	0.64	0.4398	0.25
	June-21	7	9	1.157	1.03	0.4123	0.34
Caudebec	June-19	8	3	1.859	1.12	0.6196	0.7
	July-19	7	5	1.742	1.64	0.6205	0.68
	sept-20	6	7	1.454	1.77	0.5626	0.62
	May-21	6	5	0.3135	0.9	0.1213	0.55
	June-21	8	5	1.624	1.43	0.5413	0.75
Val des Leux	June-19	8	2	2.318	0.27	0.7727	0.27
	July-19	11	4	1.378	1.33	0.3983	0.69
	sept-20	7	4	0.9202	0.87	0.3278	0.42
	May-21	12	2	2.082	0.2	0.5807	0.2
	June-21	10	3	1.536	1.3	0.4623	0.82
Oissel	June-19	15	3	2.405	0.64	0.6156	0.96
	July-19	33	3	2.569	1.42	0.5092	0.89
	sept-20	19	2	3.392	0.74	0.7986	0.59
	May-21	17	1	3.233	0	0.909	0
	June-21	15	2	2.643	0.61	0.6765	0.61

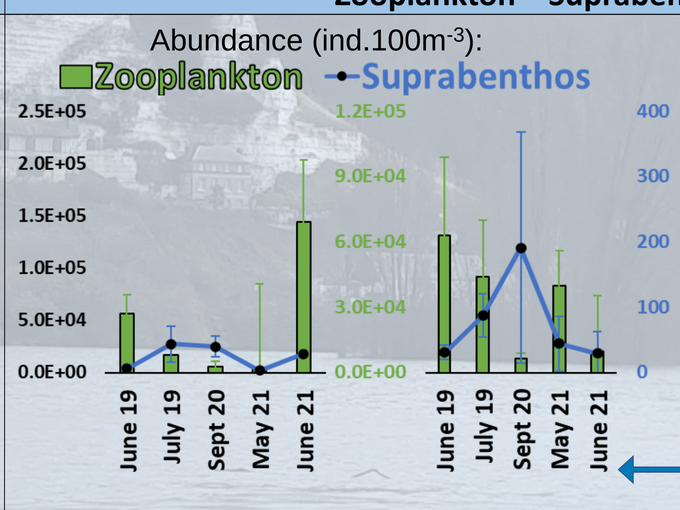
Zooplankton taxonomic richness (TR) seems to **increases from downstream to upstream**, whereas suprabenthos TR **decreases from downstream to upstream**. Nevertheless, it is not excluded that suprabenthos TR might increase further upstream, as it has been observed in other European estuaries (Mees *et al.*, 1995*).*

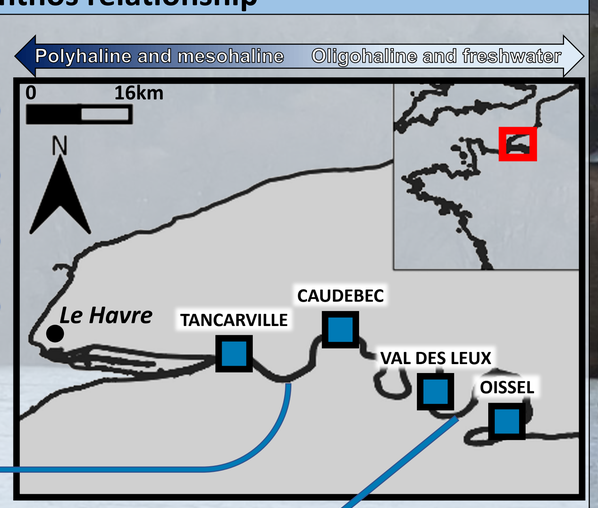
Shannon diversity index (H) is **always weak for suprabenthos**, but it reaches a **high value for zooplankton for the upstream stations**. This high diversity might be explained by a high number of taxa (generally more than 15) in this area, and by a good distribution of individuals among taxa (Pielou evenness index > 0.60).

Equitability is **higher at Oissel for both compartments**. However, suprabenthos displays only a few taxa at this location, which could explain why its equitability is so high at this station.

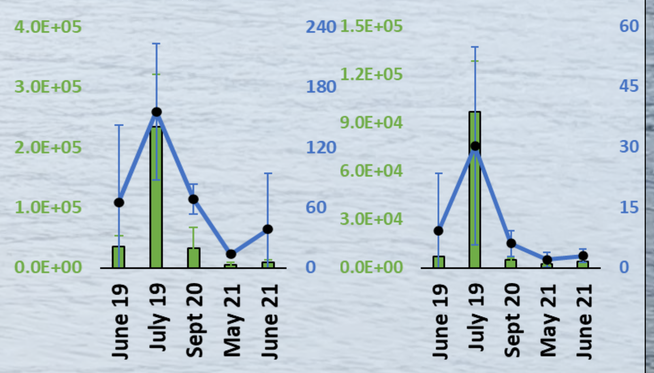
The low overall diversity of suprabenthos, and the weak diversity of zooplankton in the downstream part of the study area are probably best explained by **the ecocline nature** of this part of the estuary.

Zooplankton – Suprabenthos relationship





TANCARVILLE	CAUDEBEC	VAL DES LEUX	OISSEL
ns	ns	**	*



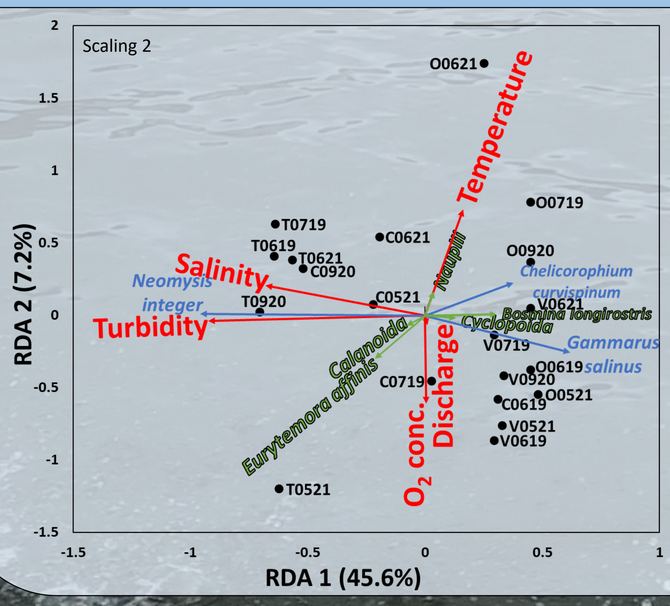
No correlation between zooplankton and suprabenthos abundances was observed either at Tancarville or at Caudebec.

The decrease in zooplankton abundance between May and September at Tancarville and Caudebec might be explained by the **predatory behavior** of suprabenthic organisms (as the Mysids *Neomysis integer, Mesopodopsis slabberi* or the decapods *Crangon crangon, Palaemon longirostris*) on zooplankton. These species are known to feed on zooplankton, especially the Calanoid *Eurytemora affinis* (Marchand, 1981; Dauvin & Desroy, 2005) which is found abundantly in this part of the estuary. Further studies are needed to confirm these hypotheses.

Zooplankton and suprabenthos abundances were **positively correlated at the two most upstream stations**:

- Val des Leux (ρ = 0.729, p<0.01)
- Oissel (ρ = 0.477, p<0.05).

Environmental influence



Salinity, turbidity and temperature strongly affect both zooplankton and suprabenhtos structure.

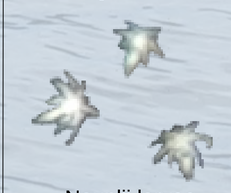
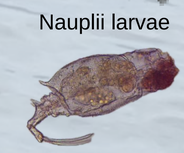
Zooplankton and suprabenthos were characterized by a strong **spatial** (RDA1) and **temporal** (RDA 2) variations.

Mesohaline and oligohaline reaches (Tancarville, Caudebec) were numerically **dominated by calanoid copepodits or *Eurytemora affinis* adults**(zooplankton) and by **mysids like *Neomysis integer*** (suprabenthos).

Freshwater reaches (Val des Leux, Oissel) were dominated by **cladocerans like *Bosmina longirostris* or cyclopoids copepodits** (zooplankton) and by **amphipods like *Gammarus salinus* or *Chelicorophium curvispinum*** (suprabenthos). However, *Gammarus salinus* was found more abundantly downstream, but it was one of the only suprabenthic species found upstream (euryhaline species), whereas *Chelicorophium curvispinum, c*yclopoids and cladocerans seemed to be more characteristic of the freshwater sections.

Good correlation between nauplius larvae and temperature was found, which was linked to the spawning activity of these organisms and thus underline the importance of the **ecological functions** supported by this part of the estuary.

Top 3 most abundant taxa

Zooplankton	Suprabenthos
 Nauplii larvae	 *Neomysis* spp.
 *Trichotria tetractis*	 *Mesopodopsis slabberi*
 *Eurytemora affinis*	 *Gammarus* spp.

Conclusion & outlooks

Zooplankton and suprabenthos of the upper Seine estuary were caracterized by an oligohaline and a freshwater communities
Salinity, turbidity and temperature strongly influenced both zooplankton and suprabenthos
Abundance pattern suggests a predatory behavior of suprabenthos on zooplankton, but further studies are needed

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