Temporal trends and influence of biological variables on bisphenol and phthalate concentrations in Mediterranean striped dolphins (*Stenella coeruleoalba*)

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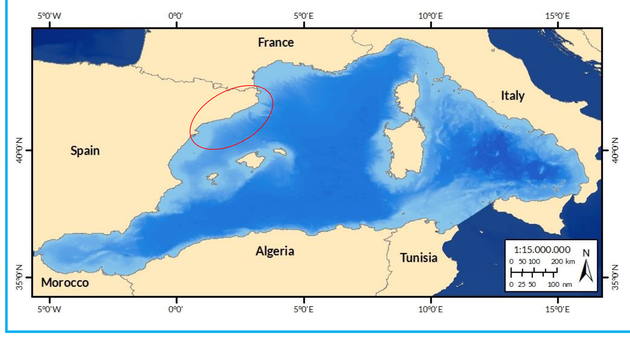
Introduction and Objectives

Bisphenols (BP) and phthalate esters (PAE) are ubiquitous chemicals used to confer properties to plastics. The input of plastic-related contaminants in the marine environment caused by the increasing plastic pollution may produce detrimental effects to long-living mammals, including cetaceans.

Here we assess the concentration of **10 BPs and 13 PAEs** in **muscle samples of 30 striped dolphins** (*Stenella coeruleoalba*) stranded along the Spanish Catalan coast (NW Mediterranean Sea) between 1990 and 2018 to determine their levels, **trends over time** and potential **relationship with biological variables**.

Materials and methods



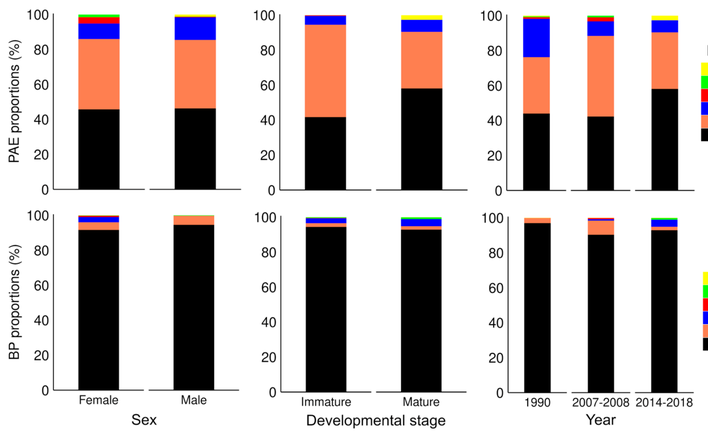
- ✓ Muscle samples were taken from 30 striped dolphins (12 males, 12 females, 6 immature individuals).
- ✓ Lyophilized samples were prepared as in Garcia-Garin *et al.* (2022): Aliquots of 200 µl and 50 µl of the extracts were analysed using an Agilent 7890 GC coupled to an Agilent 7000C Triple Quadrupole GC/MS system at the LASIRE Laboratory, University of Lille (France), in clean lab conditions, including analytical standards and blanks.
- ✓ The influence of sex and year of death (i.e., 1990, 2007-2008 and 2014-2018) were tested on samples from mature individuals (n=24) through a Kruskal Wallis and a Spearman's rho correlation test, respectively; the influence of maturation stage was tested on samples from 2014-2018 (n=15) through a Kruskal Wallis test.

Results

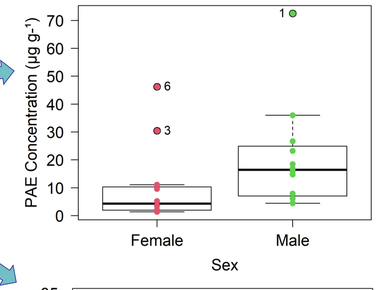
	Mean lw (µg g^{-1})	Range (µg g^{-1} lw)	FO (%)
BPA	0.29	0-4.93	10
BPE	0.67	0-6.17	90
BPF	0.01	0-0.07	67
BPFL	0.05	0-0.44	47
BPP	0.03	0-0.94	7
BPZ	16.06	0.12-94.9	100
ΣBP	17.13	0.15-96.4	
DBP	7.24	0-26.59	73
DCHP	0.19	0-3.03	13
DEHP	6.85	0-48.9	63
DEP	1.62	0-8.04	80
DMP	0.08	0-1.38	38
DNOP	0.09	0-2.1	7
ΣPAE	16.08	0.01-80.29	

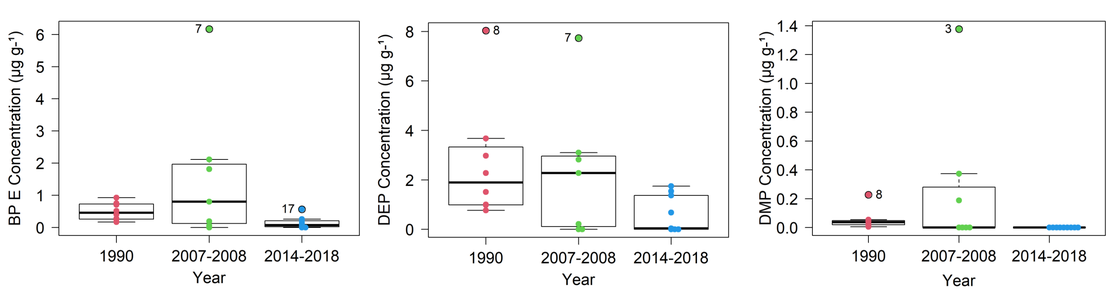
FD: frequency of detection; 0: below detection limit

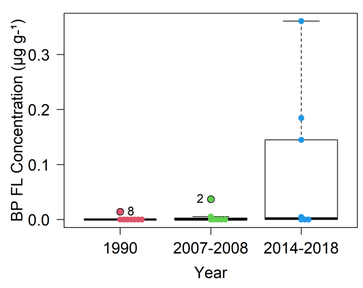
- ✓ **Six BPs and 6 PAEs** were detected, at varying concentrations, but often only in a limited number of samples, being in most samples under the LOQ.
- ✓ **BPZ** was the most frequent and concentrated BP, followed by **BPE**.
- ✓ **DEP** was the most frequent PAE, while **DBP** was the one with the highest concentration.



- ✓ Individual BP or PAE concentrations did not significantly differ between sexes, but the **overall PAE concentration was significantly higher in males** than in females.
- ✓ Maturation stage had no relevant effect: only **DMP concentrations were significantly higher in immature dolphins** than in mature ones.
- ✓ The year of sampling did not correlate with the overall compounds concentration. However, **concentrations of BPE, DEP, and DMP were lower, and concentrations of BPFL were higher, in samples from 2014-18** than in those from previous periods.







Conclusions

✓Our results provide the first assessment of 12 BP and PAE analogues in the muscle of Mediterranean striped dolphins, indicating exposure to these pollutants.

✓Sex and maturation stage showed little influence on BPs and PAEs concentrations, confirming the scarce tendency of these pollutants to bioaccumulate.

✓ Temporal trends detected for some compounds possibly reflect shifts in the production and use of these analogues between the 1990s and the late 2010s.

✓Although the detected concentrations are unlikely to cause toxic effects, the long-term exposure to these chemicals, combined with the multiple stressors that affect Mediterranean striped dolphins, may potentially produce adverse effects:
the risk that these pollutants pose to sensitive species such as cetaceans deserves further attention.

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