IMPLICATIONS OF BIOLOGICAL FACTORS ON ACCUMULATION OF PBDEs IN TWO ANTARCTIC NOTOTHENIOID FISH

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Introduction

The perciform suborder Notothenioidei is the dominant group of the Antarctic ichthyofauna in terms of diversity, abundance and biomass, containing 97% of endemic species (1). Notothenioid fish have developed a variety of feeding behaviors on a wide range of preys such as krill, fish and a diversity of planktonic organisms (1). The Antarctic Nototheniids, *Nototheniarossii* (NOR) and *Trematomusnewnesi* (TRN) are typical representatives of the western Antarctic Peninsula ichthyofauna. Both species have similar ecological habits in the fjords, living commonly in shallow inshore waters on rocky bottoms with macroalgae beds, to offshore shelf waters. Research focused on the analysis of persistent organic pollutants (POPs) in Antarctic fish, shows that this global theme is gaining concern in recent years (2). However, it is still unclear which biological variables are associated with levels of PBDEs in Antarctic fish. Biological factors, like body size, body condition, tissue type, and lipids content are related to PBDEs accumulation in otherfish species (3).In the present study, we analyzed NOR and TRN specimens with the aim of determine whether there are biological factors associated with PBDEs accumulation capability. It was expected that both exploratory methods will provide information on which biological factor is key when choosing notothenioid fish species as sentinels for POPs pollution in Antarctic marine environments.

Materials and Methodology

This work continues the research line of a recent publication by our group (2), where NOR and TRN are the species considered. Fish capture and measurements, chemicals and sample preparation, POPs analysis, and quality assurance were full reported in our previous study; therefore see ref. (2)fordetailed methods.PCA was used as statistical tool to identify PBDEs distribution patterns among the tissue types and to examine possible relationships between PBDE levels and biological factors of both species. Factor loadings >0.45 were considered significant and used for interpreting PCA patterns. The non-parametric Spearman's Rho correlations were used to explore intraspecific associations among fish morphometryand PBDEs levels in each specific tissue. Condition factor index (KI), wasused as indicators of health and condition of fish(4).

Results and discussion

Multivariate analysis:PCA results identified two components that explained 63% of the variability of the data set. The PC 1 accounted for 44% of the variation and was positively associated with BDE congener levels and fish total length. The second component accounted for 19% of the variation and was positively associated with fish total weight and KI (Fig. 1). Gills had the highest PBDE levels and clustered together (cluster A), suggesting a plausible role of the respiratory function to the accumulation of PBDEs in the two species. Gills are in continuously contact with the external medium and were thus, the main uptake route of pollutants from the water column (4). The observed results were expected considering the benthonic habits of NOR and TRN, thus, both species might be exposed to PBDEs adsorbed to suspended particles, as well as seabed (2). Additionally, it was considered the fact that biomagnification processes are directly related to fish size. In general,the largest fish are piscivorous which involves a gradual increase in contaminant intake through diet, andtherefore it was expected that the highest levels of PBDEs were found in larger specimens of NOR and TRN. Muscle and gonads samples of heaviest specimens with a healthier body condition seem to be weakly grouped (dashed line, Fig.1) and associated with low PBDE levels.

Intraspecific correlations: Significant positive correlations were found among the total weight of NOR and the levelBDE-47 in gonads (Fig. 2). Comparable results were found between the total length of NOR and liver levels of BDE-100. KI values were negatively associated with the levels of BDE-28 congener in NOR gills (Fig. 2). Concerning TRN, significant negative correlations were found among KI and levels of BDE-99 and BDE-28 in gonads (Fig. 2). For remaining biological factors of NOR and TRN (lipid content, total weight, and total length), no other association was found. The influence of fish size on PBDEs accumulation capacity was previously reported (3). The increased concentration of PBDEs with size could be due to differences in food habits, pollutants uptake and detoxification rates. For example, during the juvenile stage, NOR have a broad diet with lower-energetic value food items (algae). A dietary shift occurs in NOR during their adult stage, when smaller fish and krill constitute their main prey (1). In this sense, the computed positive associations could be explained by the feeding behavior of large fish which involves a higher intake of PBDEs through diet.

The intraspecific correlational approach also showed negative relationships among KI and BDE-28 in gill tissue of NOR. This association could be linked with key functions of this organ. Gills have a wide diffusion surface for gaseous exchange, osmotic regulation, and nitrogenous waste excretion. KI provides simple and rapid indications on overall fish health status and may change in response to environmental stress (4). Therefore, it is expected that the healthiest specimens are those with lower levels of pollution in an organ constantly exposed to the environment. The negative associations found in gonad tissue of TRN between KI and levels of BDE-99 and BDE-28 may be expected to occur as a result of gonad disruption to maturation processes in response to exposure to toxins(5).

Integrating results of both exploratory approaches helped to identify the following association patterns:gill tissue is a representative organ for monitoring PBDEs, and biological factors such as sizeand KI must be considered when choosing notothenioid species as sentinels for PBDEs pollution in Antarctic marine environments.

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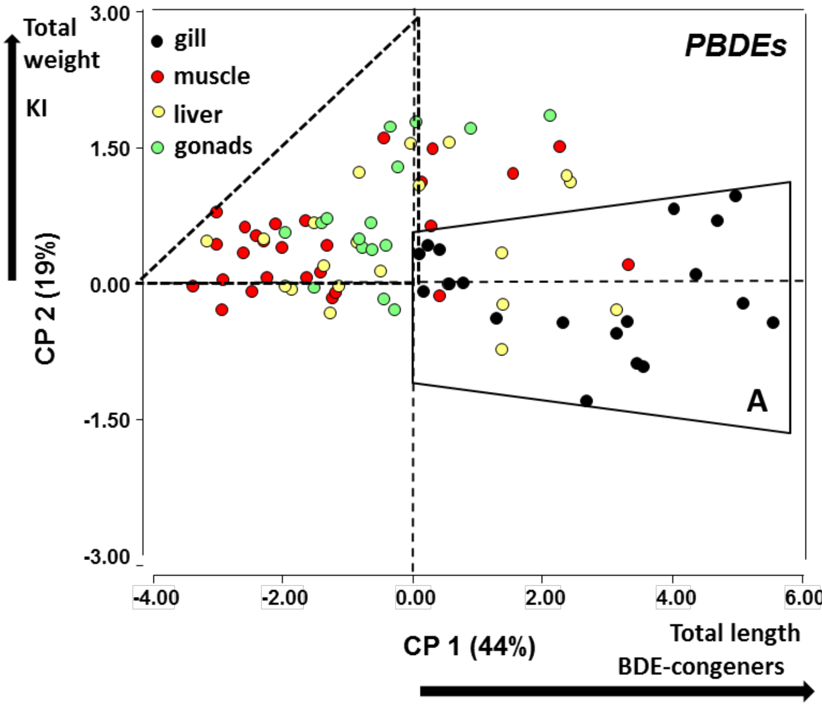

Figure 1.Position of NOR and TRN data in the plane defined by the first twoaxes obtained from a PCA carried out with levels of 7 PBDE congeners, size, KI and lipid content.

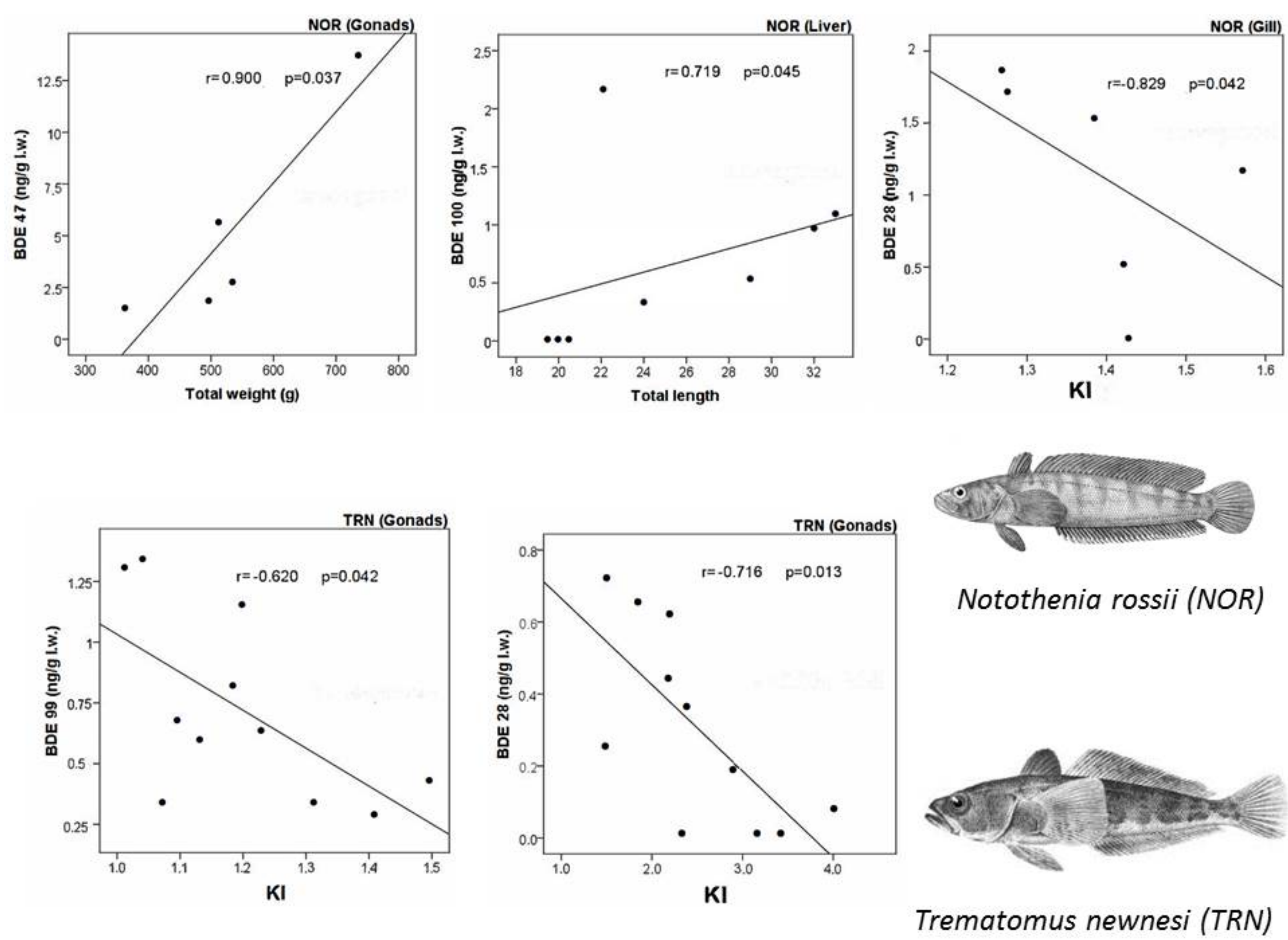

Figure 2. Relationships between PBDE levels in tissues and morphometry of NOR and TRN.