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EXTENDED ABSTRACT
VI IBERIAN CONGRESS OF ICHTHYOLOGY

SIBIC2016 VI CONGRESO IBÉRICO DE ICTIOLOGÍA / MURCIA 21 - 24 JUNIO

Ecophysiology of the small-spotted catshark in free-living conditions

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Citation: Valls E, Navarro J, Barría C, Coll M, Fernández-Borras J, Rotllant G (2016) Ecophysiology of the small-spotted catshark in free-living conditions. FiSHMED Fishes in Mediterranean Environments 2016.014: 3p

Sharks are considered key species in marine ecosystems due to their role in maintaining the structure and functioning of food webs (Baum and Worm, 2009). In comparison with other marine predators few ecophysiological studies have been conducted in these species (Navarro et al. 2009; Gallagher et al., 2014). Such studies would be a huge step toward understanding how environmental seasonal changes or ontogeny/sexual variations affect the physiology of these marine predators. In the present study, the physiological state (plasma biochemistry) of the small-spotted catshark (*Scyliorhinus canicula*) was examined in free-living conditions. This is an abundant demersal shark present throughout the Mediterranean Sea and in some areas of the Atlantic Ocean (Navarro et al., 2016). The main aims of the present study were to examine the effect of season (winter and summer), sex (males and females) and maturity stage (juveniles and adults) on four plasma metabolites related to the physiological state (cholesterol, triglyceride, phospholipids and the ketone 3-ß-hydroxybutyrate).

The study was conducted at the Catalan coast during winter and summer of 2013. 108 individuals were captured in depths ranging between 250 and 350 m during two experimental trawling fishing campaigns. The body length, body mass and sex (visually external reproductive organs) were recorded. For each individual, 0.3 mL of blood from the caudal veins was extracted. Three lipid fractions: triglycerides, cholesterol and phospholipids, and one ketone body, 3hydroxybutyrate, were measured in plasma samples. Statistical differences were examined by ANOVA tests.

Our results show changes in plasma lipid fractions (triglycerides, phospholipids and cholesterol) and the ketone body (Fig. 1), indicating that the mobilisation of these reserves from the liver of the small-spotted catshark to extra hepatic tissues is related to the season, sex and maturity stage (García-Garrido et al. 1990). All plasma lipid fractions, on average, were higher in summer, probably related to increased food availability. Nevertheless, the lowest concentrations shown by adult females during summer may indicate that these major sources of energy will be used by this group to form the yolk during oocyte maturation (Ballantyne, 2014).

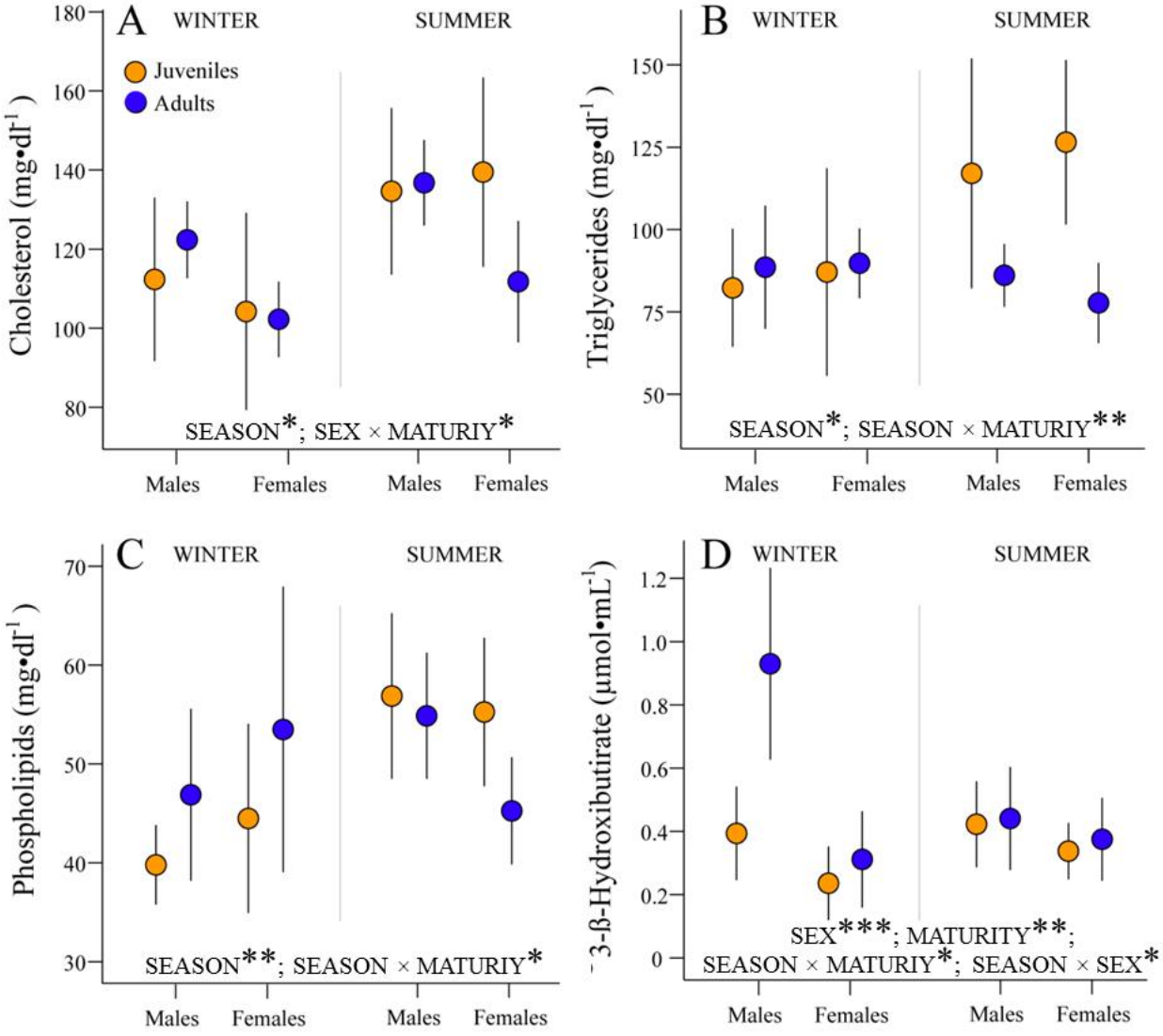

FIGURE 1. Mean and CI 95% values of cholesterol (a), triglycerides (b), phospholipids (c) and 3-ß-hydroxybutyrate (d) of small-spotted catshark (*Scyliorhinus canicula*) depending on the season, sex and maturity stage. Significant results from the ANOVA tests are shown at the bottom of each panel (*** P< 0.001; ** P< 0.01; * P< 0.05).

Hepatic lipids appear to be mobilised as oxidative fuels in the form of non-esterified fatty acids and triacylglycerol, as well as ketone bodies, via ketogenesis. Unlike mammals and most teleosts, elasmobranchs lack plasma albumin, such that non-esterified fatty acid levels are relatively low in the blood of elasmobranchs compared with teleosts. In the case of the ketone body, 3-ß-hydroxybutyrate, the pattern observed was clearly different from those of the other physiological parameters. In winter, males showed higher values than females, especially adult males that showed values more than double those presented by all the other groups. During summer, the values of 3-ß-hydroxybutyrate did not differ between sex and maturity stage. These low values may indicate that there is no lack of energy during this season since available food is enough (Gutiérrez et al., 1988). Pearson correlation tests indicated that phospholipids, triglycerides and cholesterol were positively correlated with each other.

In conclusion, the results revealed seasonal and sexual variations in plasma lipid fractions and 3-ß-hydroxybutyrate, indicating that adult females mobilize lipid reserves for the formation of egg-yolk while adult males show high values of ketone bodies during winter probably associated with an increase in physical activity (Valls et al. 2016). The approach used here, with minimal damage to the target species shows promising prospects for conducting further ecophysiological studies with elasmobranch species in the future.

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