biology and life sciences forum

MDPI

Abstract

Metabolic Responses and Resilience to Environmental Challenges in the Sedentary Batrachoid *Halobatrachus didactylus* †

Juan M. Molina [1,2], Andreas Kunzmann [2], João Reis [3] and Pedro M. Guerreiro [3,*,‡]

[1] Conicet Bahia Blanca, Universidad Nacoinal del Sur, Bahia Blanca B8000, Argentina; jmmolina@criba.edu.ar
[2] Leibniz-Zentrum für Marine Tropenforschung (ZMT), 28359 Bremen, Germany; akunzmann@leibniz-zmt.de
[3] Centro de Ciências do Mar (CCMAR), Universidade do Algarve, 8005-139 Faro, Portugal; jreis@ualg.pt
* Correspondence: pmgg@ualg.pt
† Presented at the IX Iberian Congress of Ichthyology, Porto, Portugal, 20–23 June 2022.
‡ Presenting author (Poster presentation).

Abstract: The Lusitanian toadfish, *Halobatrachus didactylus* is a marine teleost found in coastal lagoons and river estuaries, often exposed to important changes in salinity, temperature and reduced oxygen. Sedentary species, with strong site fidelity and low migratory ability along the temperature gradient such as this may be especially impacted by climate change. We aimed at establishing the tolerance limits to acute temperature and oxygen changes, and evaluate respiratory and metabolic responses in chronic control, warm and hypoxic (35% O_2) conditions. Critical temperature maximum (CTmax) was determined in 12 individuals exposed to a temperature ramp of 3 °C per hour starting at 18 °C, and was found to be 34.8 ± 0.66 °C. Critical oxygen level (PO_2crit) was determined in 8 fish at 18 °C while performing intermittent respirometry and oxygen depletion was created by nitrogen injection in the tank. PO_2crit was calculated as the inflexion point between oxyregulation and oxyconformation, which was found to be around 1.2 mgO_2/L, but fish survived down to 3% O_2, recovering from 0.2 mgO_2/L but showing increased hematocrit (Hct), red blood cell (RBC) counts and blood pH. We also quantified routine aerobic scope and daily activity patterns, finding this fish to be extremely sedentary. *H. didactylus* showed one of the lowest daytime basal metabolic rates (MR) found in the literature but activity increased significantly at night (over two-fold when closed inside the metabolic chambers). The effect of temperature on metabolic rate (MR) was evaluated using a temperature ramp ranging from 8 to 32 °C (1 °C/h). Acute temperature changes resulted in a steady increase in MR up to circa 29 °C, beyond which MR become increasingly variable, especially among smaller individuals. Indeed, small fish appear to show high- and low-MR groups, and were more susceptible to heat and hypoxia than larger individuals. In chronic acclimation, the MR was increased by 3- and 4-fold (hypoxia vs. normoxia) in fish at 28 °C in relation to those at 12 °C. Standard MR were not statistically different between normoxia and hypoxia at 12 °C, but maximum MR in hypoxia was only about 2/3 of that in normoxia. Fish in high temperature lost weight (mean −3.1%) and had higher metabolism, while in low temperature, weight increased (mean +9.3%) and metabolism was low, and HIS was significantly lower in high temperature groups. Fish in hypoxic conditions showed consistently high Hct but not RBC or hemoglobin (Hb). Overall this study indicates that *H. didactylus* is highly tolerant to hypoxia and temperature variations. It remains to be seen if other populations along the Atlantic coast show similar metrics. The measured CTmax is close to the actual maximum temperature possible to experience in Ria Formosa ponds during summer, and it would not be unexpected to find this species establishing stable populations in other regions if climate change forces it out of its actual distribution.

Keywords: respirometry; metabolic rates; hypoxia; temperature; sedentary species; climate change; physiology

Citation: Molina, J.M.; Kunzmann, A.; Reis, J.; Guerreiro, P.M. Metabolic Responses and Resilience to Environmental Challenges in the Sedentary Batrachoid *Halobatrachus didactylus* . *Biol. Life Sci. Forum* **2022**, *13*, 50. https://doi.org/10.3390/blsf2022013050

Academic Editor: Alberto Teodorico Correia

Published: 2 June 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Funding: Funded by FCT-UIDB/04326/2020 & AssemblePlus 8307, EMBRC.PT ALG-01-0145-FEDER-022121.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.