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Semblanzas Ictiológicas
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División Zoología Vertebrados
Museo de La Plata
FCNyM, UNLP

2013

Imagen de tapa

Pedro Carriquiriborde en Long Beach, California, USA, 2012

El tiempo acaso no exista. Es posible que no pase y sólo pasemos nosotros.

Tulio Carella

Semblanzas Ictiológicas

A través de esta serie intentaremos conocer diferentes facetas personales de los integrantes de nuestra “comunidad”.

El cuestionario, además de su principal objetivo, con sus respuestas quizás nos ayude a encontrar entre nosotros puntos en común que vayan más allá de nuestros temas de trabajo.

Esperamos que esta iniciativa pueda ser otro nexo entre los ictiólogos de la región, ya que consideramos que el resultado general trascendería nuestras fronteras.

Hugo L. López

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Lugar y fecha de nacimiento: La Plata 25/12/1971
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Lugar de trabajo: Centro de Investigaciones del Medio Ambiente, Facultad de Ciencias Exactas, UNLP
Especialidad o línea de trabajo: Ecotoxicología, Toxicología acuática, Toxicología de Peces.

Cuestionario

-**Un libro**: El Navegante de Morris West
-**Una película**: Un lugar en el mundo, Adolfo Aristarain
-**Un tema musical**: Bad, U2
-**Un artista**: Joan Miró
-**Un deporte**: Yachting
-**Un color**: Rojo
-**Una comida**: Cazuela de Mariscos
-**Un animal**: Yaguareté, *Panthera onca*
-**Una palabra**: honestidad
-**Un número**: 8
-**Una imagen**: Caída del Muro de Berlín
-**Un lugar**: Praia Mole, Brasil
-**Una estación del año**: Primavera
-**Un nombre**: Albert Einsten
-**Un hombre**: Nelson Mandela
-**Una mujer**: mi madre
-**Un personaje de ficción**: Charles Chaplin

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Global metabolic response in the bile of pejerrey (*Odontesthes bonariensis*, Pisces) sublethally exposed to the pyrethroid cypermethrin

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ABSTRACT

The metabolic profile of *Odontesthes bonariensis* and its global response to the insecticide cypermethrin were studied using HPLC–MS-based metabolomics. Three experiments using either juveniles or adults of *O. bonariensis* were performed by exposing fish (6, 24, or 96 h) to sublethal concentrations of cypermethrin (5 or 10 μg/L). Metabolic profiling was performed on either whole bile or aqueous and organic extracts. Chromatography was performed using a C18 column and an ACN/H_2O mobile phase. Electrospray ionization (ESI) and atmospheric pressure chemical ionization (APCI) interfaces were used in positive and negative modes. Full scan MS data were processed using the XCMS software, log-transformed, and analyzed using either regression analysis or principal component analysis (PCA). The highest amount of information (1163 peaks) was yielded by analyzing the whole bile with the ESI(−) interface. Complementary information, useful for metabolite confirmation, was obtained from the aqueous and organic extracts and using the ESI(+) and APCI interfaces. The bile metabolic profile of *O. bonariensis* was characterized by some abundant metabolite ions corresponding with taurine conjugated bile acids, which were useful as reference peaks. A characteristic global metabolic response to cypermethrin was identified in the bile of *O. bonariensis*. A ten-fold or higher variation in abundance was observed in the whole bile of exposed fish for a small group of peaks (32), and these peaks corresponded to an even smaller number of metabolites (nineteen). Both regression analysis and PCA were useful in identifying those peaks, better explaining differences between exposed and control groups, but slight differences were suggested by each of those methods. Using unsupervised PCA scores, we were able to distinguish organisms from each treatment on the basis of the metabolic changes induced by the cypermethrin, this variability being explained mainly by only one principal component (PC3, 17.7 percent total variance). Two cypermethrin metabolites were identified as major contributors within the augmented peaks: the known glucuronide of 4′-hydroxy-cypermethrin and the sulfate of 4′-hydroxycypermethrin, not previously reported in fish bile. The HPLC-MS-based metabolomic approach demonstrated to be a powerful ecotoxicological tool for identifying biological responses to pollutants, discovering new metabolic pathways and proposing specific biomarkers using non model organisms.

1. Introduction

Cypermethrin is a pyrethroid insecticide that has been widely used in household, agricultural, forestry, and veterinary applications due to its efficacy and low toxicity to mammals. As a consequence of its cost effective control of insects, in recent years this insecticide has become one of the major biotech (BT) soybean pesticides in the South American Pampas region (Carriquiriborde et al., 2007). BT soybean is a crop that currently covers more than 90 million ha around the world, mostly in developing countries, with Brazil and Argentina in the second and third places, respectively, for plantation area in the world (James, 2009). Previous studies have demonstrated that soybean cypermethrin is able to reach water courses draining agricultural basins, with concentrations of concern for the protection of aquatic biota (Marino and Ronco, 2005).

Pyrethroids are highly toxic to some aquatic organisms, such as arthropods and fish (Haya, 1989). In particular, *Odontesthes bonariensis* is very sensitive to cypermethrin's acute lethal effects,

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Physiological modulation of iron metabolism in rainbow trout (*Oncorhynchus mykiss*) fed low and high iron diets

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Summary

Iron (Fe) is an essential element, but Fe metabolism is poorly described in fish and the role of ferrireductase and transferrin in iron regulation by teleosts is unknown. The aim of the present study was to provide an overview of the strategy for Fe handling in rainbow trout, *Oncorhynchus mykiss*. Fish were fed Fe-deficient, normal and high-Fe diets (33, 175, 1975 mg Fe kg^{-1} food, respectively) for 8 weeks. Diets were chosen so that no changes in growth, food conversion ratio, haematology, or significant oxidative stress (TBARS) were observed. Elevation of dietary Fe caused Fe accumulation particularly in the stomach, intestine, liver and blood. The increase in total serum Fe from 10 to 49 μmol l^{-1} over 8 weeks was associated with elevated total Fe binding capacity and decreased unsaturated Fe binding capacity, so that in fish fed a high-Fe diet transferrin saturation increased from 15% at the start of the experiment to 37%. Fish on the high-Fe diet increased Fe accumulation in the liver, which was correlated with elevation of hepatic ferrireductase activity and serum transferrin saturation. Conversely, fish on the low-Fe diet did not show tissue Fe depletion compared with normal diet controls and did not change Fe binding to serum transferrin. Instead, these fish doubled intestinal ferrireductase activity which may have contributed to the maintenance of tissue Fe status. The absence of clear treatment-dependent changes in branchial Fe accumulation and ferrireductase activity indicated that the gills do not have a major role in Fe metabolism. Some transient changes in Cu, Zn and Mn status of tissues occurred.

Key words: rainbow trout, *Oncorhynchus mykiss*, dietary iron, transferrin, ferrireductase, intestine.

Introduction

Iron is an essential element that has a number of fundamental roles in cellular biochemistry and metabolism. These include oxygen binding to heme proteins and the formation of active centres in enzymes involved in the mitochondrial electron transport chain (De Silva et al., 1996; Aisen et al., 2001). Iron can also vary its redox state and can be rapidly oxidised from Fe^{2+} to Fe^{3+} (ferrous to ferric iron) in the presence of oxygen. This reaction generates the superoxide anion, which through a series of redox reactions leads to the generation of toxic hydroxyl radicals (the Haber-Weiss reactions; De Silva et al., 1996; Aisen et al., 2001). Thus iron can be both toxic and beneficial to organisms, and iron status in the body must be carefully regulated to provide sufficient iron for biological functions, whilst avoiding excess Fe^{2+} which can lead to oxidative stress.

Fish acquire iron predominantly from the diet, and with negligible iron uptake at the gills compared with the gut (Andersen, 1997; Bury et al., 2001), teleost fish have a dietary iron requirement of ~30–200 mg kg^{-1} dry mass (d.m.) of food (for reviews, see Davis and Gatlin, 1991; Watanabe et al., 1997). There are only a few reports of dietary iron deficiency in fish, and these have focused on defining the nutritional requirements to avoid anaemia and growth retardation in aquaculture (Kawatsu, 1972; Sakamoto and Yone, 1978; Davis and Gatlin, 1991; Watanabe et al., 1997). A precise iron requirement for most fish species, including rainbow trout, remains to be determined. However, normal dietary levels of ~100–250 mg Fe kg^{-1} d.m. food have been suggested for salmonids (Desjardins et al., 1987; Andersen et al., 1996). A few studies have used large excesses of dietary iron to explore the role of iron in oxidative stress in fish, as indicated by lipid peroxidation products in the liver (e.g. 6.3 g Fe kg^{-1} d.m. of food, African catfish; Baker et al., 1997). Despite this information on the nutritional requirement and toxic effects of iron, few attempts have been made to explore physiological regulation and mechanisms of iron metabolism in fish. However, two early studies using injected ^{59}Fe suggest the liver is the main storage pool for iron in fish (in tench, *Tinca tinca* L.; Van Dijk et al., 1975; rainbow trout, *Oncorhynchus mykiss*; Walker and Fromm, 1976).

Iron forms insoluble ferric (hydro)oxides at neutral pH (Aisen et al., 2001) and molecular evidence suggests that the

Pedro Carriquiriborde (derecha); viaje de campaña de Introducción a la Taxonomía, Parque Nacional El Palmar, Entre Ríos, 1994

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De izquierda a derecha: Vance Trudeau, Pedro Carriquiriborde y Gustavo Somoza, Congreso de SETAC-NA Long Beacha, California, USA, 2012

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