An Integrated Model Supporting Histological and Biometric Responses as Predictive Biomarkers of Fish Health Status

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An Integrated Model Supporting Histological and Biometric Responses as Predictive Biomarkers of Fish Health Status

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Abstract. In this work, an experimental system of histological (branchial lesions) biomarkers and biometric data in catfish (Sciades herzbergii) was modeled. The fish were sampled along known pollution areas (S1) and from environmental protect areas (S2) in São Marcos’ Bay, Brazil. Gills were fixed in 10% formalin and usual histological techniques were used in the first gill arch right. The lesions were observed by light microscopy. There were no histopathological changes in animals captured at reference site (S1). However, in the catfish collected in the potentially contaminated area (S2) was observed several branchial lesions, such as lifting of the lamellar epithelium, fusion of some secondary lamellae, hypertrophy of epithelial cells and lamellar aneurysm. The analysis using the biometric data showed significant differences, being highest in fish analyzed in the reference area. This approach revealed spatial differences related with biometric patterns and morphological modifications of catfish.

Keywords: biomarker, histopathology, catfish, gonadosomatic index

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INTRODUCTION

A challenge in biomonitoring, as part of integrated environmental management, is to link harmful effects of contaminants in sentinel animals [1]. In this context, some biomarkers in fish have been used frequently in programs for evaluating the impact on aquatic ecosystems, because they have well-founded methodology and easy development, generating answers in a short time, they have low cost of analysis and are highly sensitive [2].

In São Luís-MA, region that possesses the Harbor/Seaport that more moves loads in Brazil, studies with use of stress oxidative biomarkers in fish of São Marcos’ Bay have been accomplished in the port area, being indicated the need for continuity of such monitoring [3]. Biomarkers are defined as cellular changes, biochemical, molecular or physiological, which are measured in cells, body fluids, tissues or organs within an organism and are indicative of exposure and/or doses of xenobiotics that lead to biological effects [4].

The gill lesions are used as sensitive biomarkers to environmental impacts on fish [5]. Histopathological examination and biometric data has been recognized by many researchers as a valuable tool for assessment of environmental impacts on fish populations [6].

The detection of early warning signals through gills changes of fish is ecologically relevant, economic and faster, and it has the potential to be used as a type of biomarker in the assessment of stress. In this work, an experimental system of histological (branchial lesions) biomarkers and biometric data in catfish (Sciades herzbergii) was mathematically modeled in order to evaluate the effects of pollutants in São Marcos’s Bay.

MATERIAL AND METHODS

Two samples were collected in the seasonal period from August 2010 to April 2011 in two distinct sites in São Marcos’ Bay. The first site (S1) is located near the Crabs Island (2°49'48" S, 44°28'34" W) and was used as a reference area for being environmental protection area. The second site (S2), located near the Itaqui port (2°34'17" S and 44°22'40" W), was used as a potentially impacted area.

The total length (LT), fork length (LF), total weight (WT) and gonad weight (WG) were recorded. After measured and weighed, the specimens of fish were opened for macroscopic observation and classification of the...
gonads, considering the following scale of gonadal stages of development given by Vazoller [7]: EG1 (immature), EG2 (in maturation our repose), EG3 (mature) and EG4 (exhausted). Gonadosomatic index (GSI) was calculated as follows: (gonad weight × 100) / total weight.

In laboratory the gills were fixed in 10% formalin and kept in 70% alcohol until histological processing usual. For this, the first right gill arch was dehydrated in ascending series of alcohols, cleared in xylene, impregnated and embedded in paraffin. The tissue sections were stained with haematoxilin-eosin (HE), 4 sections of each tissue from each fish were examined by light microscope.

The analysis of environmental parameters was made by comparing seasonal (dry season and rainy season) in the potentially contaminated area and used as a reference in the São Marcos’ Bay. The results of the biometric data of the fish were expressed as mean ± standard deviation for males and females, and compared using the Student t-test. The level of significance was 0.05.

RESULTS

The results of statistical analysis of biometric data for Sciades herzbergii in the two sites (S1 and S2) in São Marcos’ Bay can be seen in Figure 1 and 2. The data indicate that length and weight of fish caught in the potentially contaminated site (S1) were significantly lower (P<0.05) than those of reference site. Biometric data showed two different patterns for both areas. These data indicate that there is a relationship between weight and length in fish from the reference area. However, the fish from port area show no relationship between these parameters. These results indicate a greater reproductive activity in the reference area, since higher values of total weight and gonads weight expressed appropriate maturation of the gonads. Mayon et al. have showed a decrease in these biometrics data of fish from contaminated site [8].

![Figure 1](image1.png)

**FIGURE 1.** Biometric data of *Sciades herzbergii* collected in potentially contaminated area (S1) and reference (S2) area of the São Marcos’ Bay from August 2010 to April 2011.

The histopathological analysis in *Sciades herzbergii* collected in Crabs Island (reference area) showed no morphological changes in gills of the catfish. However, individuals caught in the potentially contaminated area showed several histopathological changes and the branchial weights were very lower (Fig. 2). The most important change found in the gills of *S. herzbergii* was lamellar narrowing (70%), epithelial lifting of the primary lamella (22%), fusion of secondary lamella (4%) and lamellar aneurysm (4%). Histopathological seasonal variation was not detected in potentially contaminated site (P< 0.05), but the main alterations found in the dry season were fusion of secondary lamellae and lamellar aneurysm. This alteration is very severe and the damage caused to the tissue is irreversible. Kim et al. [9] has emphasized that histopathological changes in fish tissues has been important effect biomarkers of exposure to toxic substances, which reflect priority changes in biochemical and physiological functions. The histopathological examination performed in the gill epithelium of catfish could differentiate clearly the region of Crabs Island (reference) from the port site (potentially contaminated).
The great number of severe branchial lesions indicates that the fish of the port site are stressed by the pollutants. Branchial lesions like epithelial lifting, hypertrophy of the epithelial cells, fusion of some secondary lamellae are examples of defense mechanisms, since, in general, these result in the increase of the distance between the external environment and the blood and thus serves as a barrier to the entrance of contaminants [10].

Those results reinforce the importance of using different methods of bio-monitoring of the estuarine ecosystems [11]. The method based on integrated analysis of branchial lesions and biometric data proved to be sensitive for the monitoring of the environmental impacts with relatively low cost and speed.

REFERENCES