# INTEGRATING BIOCHEMICAL MARKERS AND TARGET POLLUTANT CONCENTRATIONS IN EUROPEAN EEL *ANGUILLA ANGUILLA* FOR ECOSYSTEM HEALTH ASSESSMENT OF A COASTAL LAGOON

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**Abstract**

Many lagoons are impacted by human activities, which lead to progressive ecosystem degradation. In order to assess the ecological risk of the Orbetello lagoon (Tuscany, Italy), several biomarkers as EROD, B(a)PMO, reductases NADH cytochrome c, NADH ferrycianide, AChE and levels of polychlorinated biphenyl (PCB) were measured in European eel (*Anguilla anguilla* L.) collected in seven sites of the lagoon. Results suggested that the lagoon is mainly impacted by agricultural run-off and nutrient-rich effluents rather than by industrial activities.

*Keywords: biomarkers, lagoon, European eel, pollution*

## Introduction

Lagoon ecosystems, like most brackish environments, are biotopes of great ecological value which could be at risk without appropriate management and risk assessment (1). In order to assess the ecological risk in a brackish environment, specimens of European eel (*Anguilla anguilla* L.) were collected from a moderately polluted brackish environment, the Orbetello Lagoon (Southern Tuscany, Italy) known for its complex seasonal physico-chemical fluctuations (1). The aim of this work was to investigate the site-specific variability of several biomarkers in eel and its sensitivity as bioindicator. Liver 7-ethoxyresorufin-O-deethylase (EROD), benzo(a)pyrene monooxygenase (B(a)PMO), NADH cytochrome c (NADH cyt c red) and NADH ferrycianide (NADH ferry red) reductases and muscle Acetylcholinesterase (AChE) were investigated and integrated with levels of polychlorinated biphenyl (PCBs) in muscle tissue to provide an idea of the overall fish and ecosystem resistance/susceptibility to chemical disturbance in the lagoon.

## Materials and methods

Sampling was conducted in June 2002 in the Orbetello Lagoon, a 2600-hectare area on the southern coast of Tuscany (Lat. 42° 30'N; Long. 11° 10'E), bordered by two sandbars. Seventy eels were collected from seven sites (Fig. 1) and their liver microsomal fraction as previously described (4) was used to determine EROD, B(a)PMO and NADH cyt c and NADH ferryred activities based on (5), (6) and (7) respectively. AChE activity was measured in crude muscle preparations according to (8). Total protein was measured based on (9). PCBs were extracted from pooled muscle tissues according to (10) and expressed as Aroclor 1260, calculated on wet weight basis (w.w.). Log-transformed data were analysed using analysis of variance (ANOVA). Post-hoc Tukey compromise tests were used to determine statistical differences in means among sites.

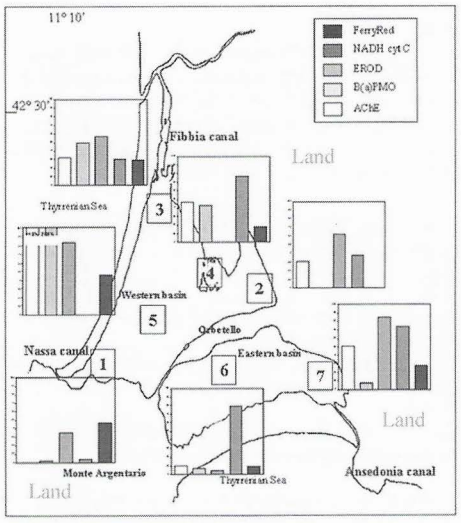


**Fig. 1. Biochemical markers in European eels from seven sites: enzyme activities are shown as percentage of variation with respect to the lowest activity recorded among seven sites.**

## Results and discussion

All the enzymes analysed in eels from the seven sites varied significantly (Fig. 1). EROD, NADH ferry red and NADH cyt c red were significantly higher at site 5 ($p<0.05$) in the middle of the western basin compared to values in other sites while B(a)PMO activities were highest at site 6 in the middle of eastern basin. The most congruent and lowest enzyme activities were found in organisms from site 1 located in the Nassa canal. AChE activities also differed among sites, although no significant differences were observed except for sites 1, 3 and 5 (located near Nassa canal, Albegna river mouth and the middle of western basin, respectively). Considering the average AChE activities recorded in eels from all sampling sites, the differences were below 50%, suggesting that there is no neurotoxic risk for this species. The highest PCB levels (Table 1) were found in eels collected from site 5 while the lowest ones were recorded in specimens from site 2, near the fertilizer plant. On the basis of the results obtained, European eel seems to be a suitable bioindicator of environmental quality for the Orbetello lagoon.

| Site | n | l.w. (%) | PCBs |
|---|---|---|---|
| 1 | 3 | 3 | 9.72 |
| 2 | 3 | 2 | 4.98 |
| 3 | 3 | 5 | 17.80 |
| 4 | 5 | 2 | 8.48 |
| 5 | 3 | 10 | 23.73 |
| 6 | 2 | 10 | 16.43 |
| 7 | 6 | 7 | 16.61 |

**Table 1. PCB levels expressed as ng $g^{-1}$ wet weight in liver of European eels collected from seven sites of Orbetello lagoon (n = number of samples; l.w. lipid weight in liver tissue).**

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