OPEN ACCESS

ISSN1927-6648

International Journal of Marine Science

ISSN 1927-6648

12002

Published by BioPublisher

http://bio.sophiapublisher.com

2013

Volume 3

Publisher

Sophia Publishing Group

Edited by

Editorial Team of International Journal of Marine Science

Email: edit@ijms.sophiapublisher.com

Website: http://ijms.sophiapublisher.com

Address:

11388 Stevenston Hwy,

PO Box 96016,

Richmond, V7A 5J5, British Columbia

Canada

International Journal of Marine Science (ISSN 1927-6648) is an open access, peer reviewed journal published online by BioPublisher.

The journal publishes all the latest and outstanding research articles, letters and reviews in all areas of marine science, the range of topics containing the advancement of scientific and engineering knowledge regarding the sea; from chemical and physical to biological oceanography, from estuaries and coastal waters to the open ocean; as well as including fisheries, socio-economic science, co-management, ecosystems and other topical advisory subjects.

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International Journal of Marine Science 2013, Vol.3, No.28, 219-224
http://ijms.sophiapublisher.com

Research Article Open Access

Fish Distribution in Fauna Data in Lagoon of Aveiro (North Portugal): a Comparative Analysis between 1758 and the Present — An Interdisciplinary Case Study

M.R. Bastos[1], Vidal A.[2], Azeiteiro U.M.[3], Dias J.A.[4]

1 Open University of Portugal & Cepese - Centre of Research of Population, Economy and Society, Oporto, Portugal
2 Cepese - Centre of Research of Population, Economy and Society, Oporto, Portugal
3 Open University of Portugal & CFE – Centre for Functional Ecology, University of Coimbra, Coimbra, Portugal
4 CIMA- Centre of Marine and Environmental Research, University of Algarve, Faro, Portugal
Corresponding author email: rbastos@uab.pt

International Journal of Marine Science, 2013, Vol.3, No.28 doi: 10.5376/ijms.2013.03.0028
Received: 16 Apr., 2013
Accepted: 17 May, 2013
Published: 02 Jun., 2013

Preferred citation for this article:
Bastos *et al*., 2013, Fish Distribution in Fauna Data in Lagoon of Aveiro (North Portugal): a Comparative Analysis between 1758 and the Present — An Interdisciplinary Case Study, International Journal of Marine Science, Vol.3, No.28 219−224 (doi: 10.5376/ijms.2013.03.0028)

Abstract The present study aims to identify fish species mentioned in the Parish Descriptions of 1758 to the lagoon of Aveiro, comparing them with those existing at present. By crossing and interpretation of the resulting data of these two analyses (1758 and timeliness), we can identify which species that remain and those who no longer have individuals in the habitats listed in historical source. Explanatory hypotheses are presented to the absence or presence of fish species. Special attention is also being paid to anadromous and catadromous fish which are extremely vulnerable to anthropic impacts meantime introduced in lagoon and river ecosystems.

Keywords Aveiro's Lagoon; Historical Data; Ichthyofauna; Anthropic impacts

Introduction

The lagoon of Aveiro, improperly called “Ria de Aveiro” (because “rias” are flooded river valleys, whose paradigm can be found in Northern Spain Galician Rias), is located in the NW of Portugal, between the city of Coimbra and Porto, more properly between Espinho and Mira (Figure 1). The lagoon was developed in NNE-SSW direction (parallel to the present Oceanic coast). Presently, the lagoon is about 40 km in length, approximately between latitudes 40°52' N and 40°31' N, having maximum width, in the central sector, about 8 km. It is separated from the sea by a sandy strand of variable width, with almost 2.5 km maximum and minimum of less than 200 m.

As a result of the need for further dialogue between various scientific disciplines, namely history, biology and geology, we developed an interdisciplinary work based on references to fishes found on historical sources from the 18th century and compared this information with the presently existing species taking into account the geomorphological modifications meanwhile observed.

Figure 1 Map of the study area

The so-called Parish Descriptions emerged as a result of the Enlightenment tradition of drawing up descriptions of the territory and, in the Portuguese case, succeeds the investigation called Marquis Inquiry (Marquis of Pombal, Minister of Portuguese King Joseph I), dated of 1656. Marquis Inquiry resulted from the desire to know the effects that the so-called Lisbon Earthquake (November 1, 1775), a natural catastrophe, about 9 magnitude on the Richter scale, that had an enormous impact reported in the whole of Europe of the 18th century. Parish Descriptions arise from a series of attempts to gather information about the country, through a questionnaire, beginning early in the 18th century. They continue the work of Fr. Luis Cardoso, who, between 1747 and 1751, published two volumes of his Geographical Dictionary, which remained incomplete because the collected information was lost during the earthquake. The project was once more taken up in 1758, with government support, when the original questionnaire was enlarged and divided into three parts, containing questions on the parish, the mountains and the rivers. The inquiry was directed to all the bishops that, in turn, have made reaching out to at parish priests. The document and the quality of the responses are extremely varied, depending on the effort and capacity of each cleric (Atlas. Cartografia Histórica, s.d.).

More or less detailed responses, with greater or lesser accuracy that resulted from these investigations, the Parish Description of 1758 are a precious source for the knowledge of Local History and of the Portuguese territory in mid-eighteenth century (Figure 2). Being of national scope, allows us to (also) an approach to the knowledge of the coast in its various aspects and in a synchronous approach.

In this case we will highlight the answers to the questions that allude to the fish fauna.

Another important aspect is the season when the historical information was written (*e.g.* the provided information in the historical records is different according to the season in which it was written) and in this particular situation was written in the winter (Osswald, 2002).

This last assertion only serves to reiterate one of the aspects that enhance and enrich the information contained in this historical source. Of course, the case of Aveiro's Lagoon (located in the north of Portugal)

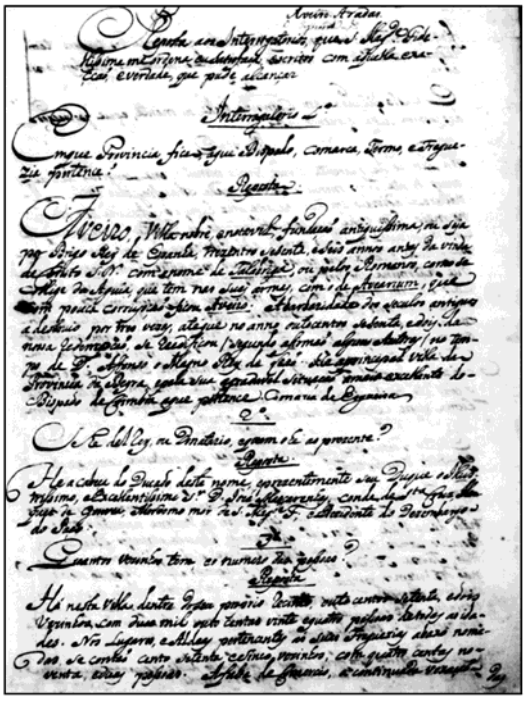

Figure 2 Excerpt of the Parish Description of Aveiro

was no exception (Sarmento and Cardoso, 2006). There are many elements included in the responses of the pastors: economic, social, geographical and fauna references.

1 Background

In 1904, Adolfo Loureiro made a description of the port of Aveiro, in which he described an historical overview of Aveiro from Roman times until the late 19th century (Loureiro, 1904). Despite the relevance of his study the first work to draw attention, in a consistent perspective, for the major changes observed in the coastal zone occupied by the lagoon of Aveiro was the one from Schwalbach Lucci (1918). On the basis of a careful geological and geomorphological analysis, the author concluded, notably the coastal developments in the region: a large bay widely exposed to oceanic waves was gradually being confined by the growth of a sandy spit which set the lagoon body.

The doctoral thesis of Amorim Girão (1922), building on the work and ideas of Lucci (1918), complemented them significantly and gave them more coherence and substance, both the geological and geomorphological analysis, with archaeological data, historical

documentation and old cartography. Among other interesting aspects, to the researcher did not escaped the relevance of the tectonic conditioning, particularly in parts of the rivers Vouga and Caima, as well as the importance of careful geological cartography as a way to deduce the paleo-geographic regional configuration.

The theme was taken up again the following year by Alberto Souto (1923) that supplemented and detailed, with new data, the previously outlined by Lucci (1918) and Girão (1922).

Many are the articles that, since then, have been produced. However, all of them are based on the referred original works, only deepening and detailing them locally (Neves, 1956; Girão, 1941; Martins, 1947), or using that knowledge as a basis for another kind of works, as coastal engineering (Cunha, 1930; Abecassis, 1955; Oliveira *et al*., 1982).

The studies that we have been referring focus mainly on issues of geographical, geological and geomorphological, neglecting the historical documentation contribution. However, it should be noted that history can and should support, as far as possible, the inductions of geomorphological, geophysical character to express ideas and phenomena which by its monumentality, strangeness or significance, were written in Historical Memory. From the point of view of historical approach, it is clear that something has been done. Among the historiography's works that we hand stand out the studies of Mattoso (Mattoso *et al*., 1989), Silva (1991), as well as Amorim (1997). In all these works, we find a careful concern in commodity framing versed in natural environment, reserving even a few unique pages to description of it. However (with the exception for the work of Mattoso referenced below), it seems clear that there is no care to made the counterpoint between human behavior and the surrounding area at the time, given the extent to which the same interacted and influenced. This perspective of the relationship between Man and Nature was, at least, analyzed by Bastos (2006), although with a chronological approach between the 9th and the 14th century (1325 – end of the reign of King Dinis). In addition to these work, there are numerous articles and small historical studies, with special emphasis on the work of Oliveira (Oliveira, 1967) about Ovar in the Middle Ages. In these there are a complete exposure of written historical sources, but with a total absence of references to the characteristics and evolution of the physical space.

In 2012, two works presented a holistic approach, on the lagoon of Aveiro evolution and occupation, as well as on the exploitation of their natural resources (Bastos and Dias, 2012; Dias *et al*., 2012).

The Parish Description used as the main (historical source for this work) has also been analyzed by several researchers (Capela, 2011). However the fish fauna have never been the focus of a specific study. It is understandable why: a work of this scope is only possible using an interdisciplinary approach that is not common in the scientific community in Portugal. The specificity of such an integrated analysis demands the abandonment of the hyper-specialization, one of the characteristics of contemporary science, requiring the researcher to leave their comfort zone and take with humility his limitations to achieve the most global possible knowledge. Such assumption, applies social sciences and humanities as well as the exact and natural sciences. Thus, only through an effort to get closer to the level of the language, concepts, methodology and paradigms usually get results as hard as challenging (Pombo, 2005).

2 Results

Of the species identified in 1758 ceased to be referred in the more recent documentation the following species: trout (*Alosa alosa*), eels (*Angulla Anguilla*) and lampreys (*Petromyson marinus*). All these species are anadromous (live in the sea and go into the rivers and lagoons to reproduce, such shads and trout) or catadromous (live in the rivers and lagoons, and go to the sea for spawning, as the eels and lampreys).

During this work we are faced with changes of various kinds: firstly we highlight the natural, through the growth of sandy spit that prevented contact between lagoon and sea and *vice-versa*, with the obvious damage for navigation, salt production, human health, etc. At the same time we have anthropogenic actions: in past centuries we can highlight the construction of mills, dams and the extraction of aggregates that hinder or prevent the transit of the ichthyofauna. At least, we also have environmental changes resulting from the deployment of heavy chemical industry (Figure 1) whose contaminated waste water were

dumped into the pond. This sparked a negative impact, especially in gastropods and crustaceans. It seems to be obvious that environmental modifications (natural and anthropogenic) caused such ichthyofauna's changes. Indeed the trophic chain is now in danger. The sustainability of the lagoon environment can become impossible.

We must appeal to the good sense and strike a balance between the human current *modus vivendi* and the preservation of endangered species.

If the environmental awareness is something quite recent that only in the second half of the 20th century began to be an object of study, the result of a profound change that humanity operated in the ecosystems through the rampant use of new technologies, find the middle ground, the fair procedure between profit and preservation of species has been one of the greatest challenges that came up to our 21st century and which will continue to be for decades a key theme for the various quarters of civil society.

Hence the importance of interdisciplinary dialogue that should not be a mere casual meeting among academics, but it should be a continuum, a permanent dialogue discussion and improvement.

3 Discussion

Through the analysis of this historical sources stored in the National Archive of Portugal (DGARQ-Torre do Tombo) we were able to detect important physical and human components. From a physical point of view, the collected information contains two major coordinates: the sea and the river.

Since ancient times the lagoon of Aveiro was occupied and exploited by Man (Bastos, 2006). This has contributed to the change of its configuration and modification of environmental characteristics (Figure 3).

The transformation of the coastal stretch and the strong anthropic action (especially from the mid-twentieth century) led to the destabilization of the animal ecosystem.

For example refer to part for Ovar, which states that in 1758 this lagoon passage "raise fish, abundantly European eel, mullets (*Mugil cephalus*), plaice, and less abundant snook (*Centropomus undecimalus*), lamprey, shad and croakers (*Micropogonius undulates*)." (Torre do Tombo on line PT-TT-Mprq/26/45).

Even in the second half of the 18th century, as testify

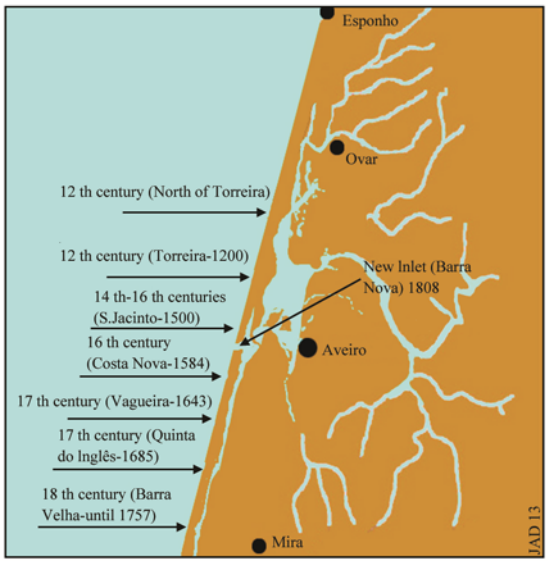

Figure 3 The evolution of Aveiro's lagoon

the Parish Description of Aveiro, the people could enjoy plenty species such as eels. With the entrance in the 20th century and with the implementation of industries in the area significant changes were observed.

From the 30's, with the proliferation of heavy chemical industry in Estarreja (City of Aveiro region), the negative impact of contamination of the lagoon's fauna and flora are reflections of serious environmental effect of imbalance of human action and dramatic contours took on some of the species of yore.

One of the many indicators of this strong contamination is expressed by the accumulation of heavy metals in eels, *ex-libris* the region of Aveiro, as are highly appreciated of the gastronomic point of view and are very significant economic resources (Eira *et al*., 2009).

The relevance of the information gathered leads us to the question of the species identified in 1758 (Figure 4) which ceased to be referred to in later documentation? The analysis is evident: shads, trouts, European eel and lampreys are no longer referred to. Why are they no longer mentioned?

Firstly it is important to know if those species are present nowadays. The characterization of the ichthyofauna of Ria de Aveiro has been subject of several publications in the last years (Garnerot *et al*., 2004; Jemuce, 2008; Macaringue, 2009; Pinto, 2009).

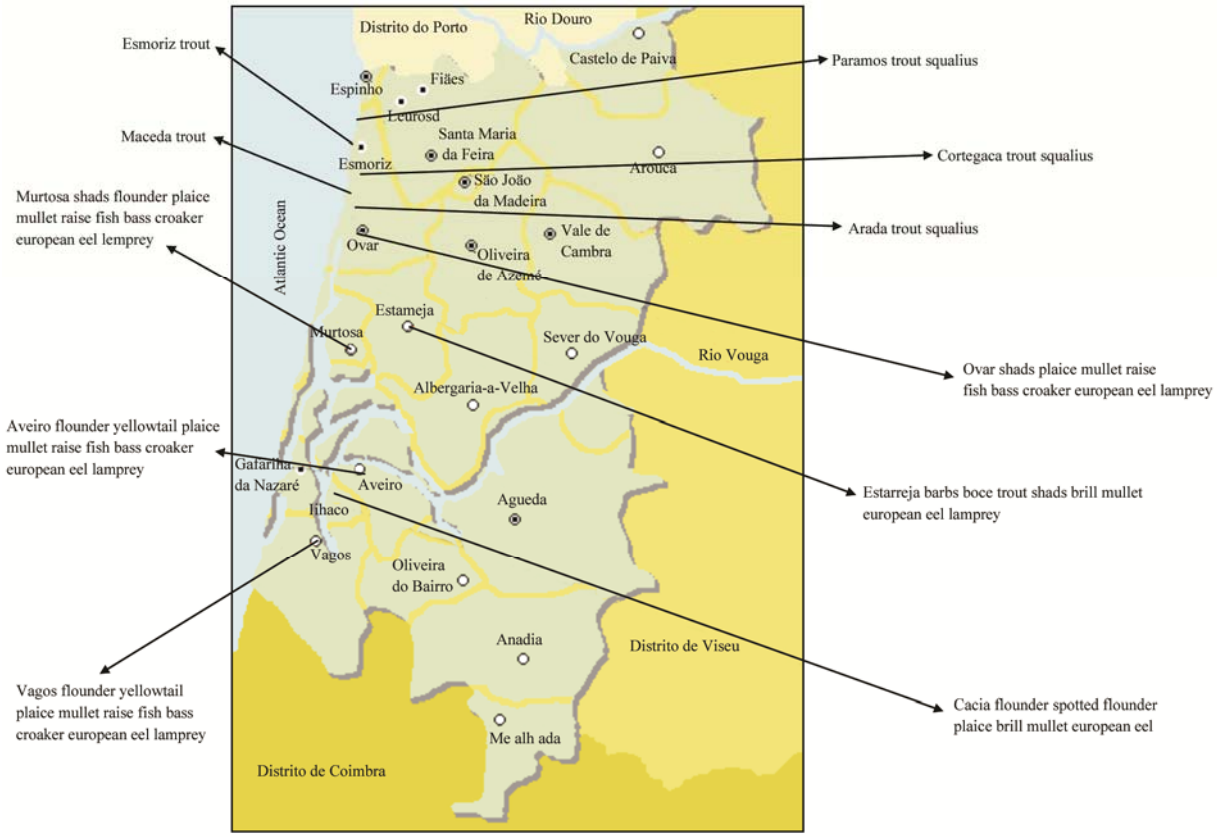

Figure 4 Species diversity for parishes

From this recent data it is observable that only the European eel is still captured regularly. The migrating species shads are captured irregularly and trouts and lampreys disappeared from the actuals records. This distributional pattern clearly put in evidence that the migrant species (anadromous and catadromous species) are the ones that first suffer the effects of anthropogenic impacts in the system.

Secondly it is known that the already referred anthropogenic impacts in the system (transformation of the coastal stretch and the strong anthropic action and contamination) impacted this ecological sensitive migrant species.

The changes in the ecosystem resulting from the above factors, led to a change of the physiology of some species (physiology and sex ratios) (Baptista *et al*., 2013; Mieiro *et al*., 2012). The trophic chain is clearly affected (Coelho *et al*., 2013) which compromises the sustainability of the system.

This is because, if the environmental awareness is something quite recent that only in the second half of the 20th century began to be object of study, the result of a profound change that humanity has operated in the ecosystems through the unbridled use of new technologies, find the middle ground, the fair procedure between profit and preservation of species has been one of the greatest challenges that came up to our 21st century and which will continue to be for decades a key theme for the various quarters of civil society.

Hence the importance of interdisciplinary dialogue that should not be a mere casual meeting among academics, but it should be a continuum, a permanent dialogue discussion and improvement.

4 Materials and Methods

The selection and collection of historical data through the information was made available online by DGARQ-Torre do Tombo, at Torre do Tombo on line PT-TT-Mprq.

We selected and processed all the data relating to the parishes that were on the banks of Aveiro's lagoon, in particular with regard to geomorphological and fish elements.

The actual fish systematics and ecology was supported by the CFE group (Martinho *et al*, 2012). In fact were

analyzed two objects of study enclosed chronologically: one of 1858 and another of 2012. We draw up a table of selected species (which we omit here for long and tedious) and then it was only compare the presence and absence of individuals and find a reason for the evidence recorded.

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