

THE STUDY OF INSHORE FISHES IN PORTUGAL – A BRIEF HISTORY AND PROSPECTS FOR THE FUTURE

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INTRODUCTION

Professor Luiz Saldanha was one of those people whose contribution to science extends well beyond the papers he wrote. Indeed, his way of thinking marine biology inspired a whole generation of researchers and contributed to open new research areas and to establish new approaches to old ones. We felt that an attempt to summarise the recent evolution of the study of inshore fishes in Portugal would be a proper contribution to honour Professor Saldanha. Indeed, the study of inshore fishes was one of the many fields whose growth benefited from his scientific activity and is one of the main areas of work of our research group.

We will also try to outline the research topics and problems that, in our view, should be given priority in the near future. In presenting this historical essay, we are aware of the risk of having overlooked any topic or research group relevant in this field. If that proves to be the case, we would like to stress that it was only a mere reflection of the lack of adequate bibliographic databases in Portuguese Institutions.

We hope that the present review will encourage the exchange of ideas between the research groups that study inshore fishes in Portugal. We further hope that it will contribute to the elaboration of new research programmes capable of bringing together the efforts of different disciplines and Institutions.

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RESEARCH ON INSHORE FISHES IN PORTUGAL BEFORE 1950

The Portuguese shore has been the subject of considerable interest from marine biogeographers since the last quarter of the 19th century. An important biogeographic area in the northeastern Atlantic – the Lusitanian province – was named after the Portuguese shore, although the status and boundaries of this area have varied somewhat in the work of different authors (*e. g.* EKMAN, 1953; BRIGGS, 1974; ALMAÇA, 1985).

In what concerns inshore fishes (those that spend most or whole of their lives in coastal shallow waters), this was a period marked by the elaboration of collections (often of a regional scope), inventories, faunal lists and even descriptions of new species (*e. g.* CAPELLO, 1867c, 1868, 1871a, b, c; GUIMARÃES, 1882, 1884; SAMPAIO, 1904) and new occurrences (*e. g.* CAPELLO, 1867a; FERREIRA, 1937, 1938, 1939). Among the most important works, those by CAPELLO (1867a, b, c, 1873, 1880), OSÓRIO (1888, 1895, 1896, 1905), VIEIRA (1893, 1898), BRAGANÇA (1899, 1904), SEABRA (1911), NOBRE (1935) and ABOIM (1941) for the mainland, and those by LOWE (1843-60, 1850), JOHNSON (1863, 1890), CAPELLO (1871a, b, c), GUIMARÃES (1882, 1884), NOBRE (1924), FERREIRA (1938, 1939) and NORONHA & SARMENTO (1948) for the Madeira and the Azores deserve special mention. Many of these researchers did not limit their interest to fishes but studied a wide range of marine organisms. The research work of King Carlos de Bragança (reviewed by GONÇALVES, 1941) is particularly noteworthy with many new species being described.

In this period, there were few techniques available to scientific collections of inshore fishes, especially those of the rocky shores. Many findings were the result of the activity of fishermen and many specimens were even brought from fish markets. The contribution of local naturalists and the re-examination of material found in museums also played an important role. Some oceanographic missions, namely those by BRAGANÇA (1902) were decisive to the establishment of marine biology as a scientific discipline in Portugal.

The work by ALBUQUERQUE (1954-56) constitutes a particularly important landmark in the study of marine fishes in Portugal. Indeed, it was the first attempt to organise a complete ichthyofaunal list, with identification keys of modern type, that synthesise the knowledge available at that time, and was for more than 30 years the basic reference in the area.

PROFESSOR SALDANHA AND THE ADVENT OF THE MODERN STUDY OF MARINE FISHES

During the 50's and 60's research in the area progressed rather slowly. It was in this context that the work of Professor Saldanha emerged as a major breakthrough in Portugal, not only to the study of inshore fishes but to marine biology and oceanography in general.

Professor Saldanha's scientific research covered a wide range of interests that extended from topics so diverse as algae and invertebrate subtidal communities (*e. g.* SALDANHA 1974, 1979; SALDANHA *et al.*, 1990), to the study of the deep sea fish fauna (*e. g.* SALDANHA, 1982, 1988; SALDANHA & MERRETT, 1982; SALDANHA *et al.*, 1995), the hydrothermal vent communities (*e. g.* SALDANHA 1994; SALDANHA & BISCOITO, 1996, 1997; SALDANHA *et al.*, 1996), and the compilation of ichthyofaunal lists (QUÉRO *et al.*, 1990; SALDANHA, 1995). His enthusiasm for scuba diving has opened an entire new research ground for biologists interested on marine organisms. In fact, a wide range of species that could not be collected by traditional techniques became accessible, and this was especially true for fishes of the rocky shores. In a few years, many species have been added to the known marine ichthyofauna of Portugal (*e. g.* ALMEIDA & GOMES, 1978; GOMES & ALMEIDA, 1979; ALMEIDA *et al.*, 1980; GONÇALVES *et al.*, 1993). One of Professor Saldanha's main goals was directed to the conservation of coastal marine communities through the creation of Marine Protected Areas in Portugal. In fact, already in 1965 he has presented together with some colleagues of the Portuguese Centre of Underwater Activities (CPAS) a proposal for the creation of Marine Reserves at Sesimbra and Sines. At the time, this proposal was strongly supported by the political entities, and after that on several other occasions, but the truth is that we had to wait until his disappearance to see the implementation of Marine Protected Areas in mainland Portugal. In the Azores and Madeira archipelagos, the local entities were more supportive of his proposals and a number of Marine Reserves are already established or proposed.

Much research has, since then, been centred on the exploration of the ichthyofauna of the habitats that scuba diving had made available. In particular, the description of new records (CALVÁRIO *et al.*, 1980; COSTA, 1980; SALDANHA, 1981; ALMEIDA, 1982, 1986; ALMEIDA & HARMELIN-VIVIEN, 1983; AZEVEDO *et al.*, 1990; GONÇALVES *et al.*, 1993), the clarification of taxonomic problems (ALMEIDA & IBAÑEZ, 1981; ALMEIDA, 1985, SALDANHA *et al.*, 1986; ASSIS, 1993; ALMEIDA & ARRUDA, 1998), and the production of faunal lists for many biocenosis (NUNES, 1974; RÉ, 1978; ARRUDA *et al.*, 1992; PATZNER *et al.*, 1992; ANDRADE & ALBUQUERQUE, 1995; ALMEIDA, 1996; ARRUDA, 1997; SANTOS *et al.*, 1997), were predominant.

Professor Saldanha was also able to communicate his enthusiasm and dedication to a whole generation of students, and helped to congregate the collective effort that made possible the establishment of the Guia Marine Laboratory. Finally he has contributed decisively to the implementation of the study of marine biology in Portuguese Universities.

After the pioneer work that Professor Saldanha led personally at the Faculty of Sciences of Lisbon University (FCUL), a growing number of research groups became established following a substantial expansion of the network of Portuguese Universities involved in marine biology studies.

Among the groups that are actively involved in the study of inshore fishes, the following deserve special mention:

- 1) Faculty of Sciences of Porto University (FCUP) and Abel Salazar Institute of Biomedical Sciences (ICBAS), together in the Centre of Marine and Environmental Research (CIMAR);
- 2) Science Faculty of Lisbon University (FCUL), which includes Guia Marine Laboratory (LMG), Institute of Oceanography (IO) and Zoology and Anthropology Department (DZA);
- 3) Fisheries and Sea Research Institute (IPIMAR);
- 4) National Institute of Engineering and Industrial Technology (INETI) through the Environmental Technologies Institute (ITA);
- 5) Institute for Nature Conservation (ICN);
- 6) Institute of Applied Psychology (ISPA) through the Eco-Ethology Research Unit (UIE);
- 7) Algarve University (UALG) through the Marine Science Centre (CCMAR);
- 8) Funchal Municipal Museum (MMF) at Madeira;
- 9) Department of Oceanography and Fisheries (DOP) of the Azores University (UAÇ).

In what concerns inshore fishes, research began to cover a wide variety of topics including:

- 1) **Biology and reproduction of commercial fish species** (*e. g.* IPIMAR: FIGUEIREDO & SANTOS, 1989; MURTA & BORGES, 1994; DOP: KRUG, 1990; ISIDRO, 1990; CCMAR: ERZINI *et al.*, 1997; ANDRADE, 1998; CIMAR: P. J. SANTOS, 1989; ANTUNES & TESCH, 1997);
- 2) **Ichthyoplankton** (*e. g.* LMG: RÉ & GONÇALVES, 1993; RÉ 1996; IPIMAR: MENESES & RÉ, 1991; AFONSO, 1995);

- 3) **Estuarine and coastal lagoon fishes and aquaculture** (*e. g.* IO: COSTA, 1988; COSTA *et al.*, 1994; CCMAR: DINIS & REIS, 1995; CANÁRIO *et al.*, 1998; IPIMAR: MONTEIRO *et al.*, 1990; POUSÃO-FERREIRA *et al.*, 1997; LMG: RÉ, 1987; CANCELA da FONSECA *et al.*, 1989; ICN: SOBRAL, 1992, 1993; ITA: CUNHA & PENEDA, 1985; ANTUNES *et al.*, 1988; CIMAR: CARVALHO *et al.*, 1997; OLIVA-TELES *et al.*, 1997);
- 4) **Behaviour and biology of non-commercial species** (*e. g.* UIE: ALMADA *et al.*, 1995; GONÇALVES & ALMADA, 1998; DOP: PATZNER & SANTOS, 1993; SANTOS *et al.*, 1996; LMG: ALMEIDA, 1996; ALMEIDA & ARRUDA, 1998; DZA: ARRUDA, 1990; ARRUDA *et al.*, 1992; ICN: HENRIQUES & ALMADA, 1997, 1998; MMF: MAÚL, 1962);
- 5) **Parasitology** (*e. g.* CIMAR: EIRAS & DAVIES, 1991; AZEVEDO *et al.*, 1997);
- 6) **Genetics** (*e. g.* CCMAR: CASTILHO & MacANDREW, 1998; SANTOS & POWER, 1998);
- 7) **Endocrinology** (*e. g.* CCMAR: POWER *et al.*, 1996; INGLETON *et al.* 1998);
- 8) **Conservation** (*e. g.* LMG: SALDANHA, 1992; ALMEIDA, 1994; DOP: MARTINS & SANTOS, 1991; SANTOS *et al.*, 1995).

This list was not intended to be exhaustive but only an illustration of the diversity of research areas currently in progress. The authors know that a great deal of other papers has been published. Indeed, we are aware of the risk of having omitted relevant research areas or researchers in the field that may have been overlooked by our review effort. With that possibility in mind, we would like to emphasise that we tried to cover the diversity of topics that have been or are being studied, and the most prominent groups in the field. The references provided are only a sample of what has been done, in order to illustrate the richness of topics that have emerged in recent years.

Has shown above, Professor Saldanha undoubtedly contributed in a very substantial way to the establishment of the modern study of inshore fishes in Portugal. His contribution was not confined to the areas in which he worked personally. His influence was also noted through his academic activity, not only in teaching in the Faculty of Sciences of Lisbon University, but also through the enthusiastic support he gave to many Ph. D. students that he supervised, of which the first author of this paper had the privilege of having been one of the many examples. The intellectual influence of Professor Saldanha was also felt through his participation in numerous scientific commissions and policy-making entities.

PROSPECTS FOR FUTURE RESEARCH

One way to honour Professor Saldanha is certainly the attempt to evaluate critically the current situation in the field, in order to delineate possible guidelines for future research.

Due to its specificity and complexity, we will not attempt to address the issues currently involved in the biological study of commercial species and their fisheries.

In what concerns the remaining research areas of inshore fishes, we believe that the time has come where the researchers involved in those studies should come together and attempt to evaluate what has been done and to define priorities and strategic goals for the near future. The paragraphs that follow are a preliminary contribution from the authors for the debate that we advocate.

Faunal and community studies

Although we now know a great deal more about our inshore marine ichthyofauna than we did 30 years ago, many sections of the shore are still virtually unexplored with modern techniques. In addition, quantitative studies of the abundance of each species and their patterns of variation both temporally and over different microhabitats, are rare (but see: SANTOS, 1992; NASH *et al.*, 1994; SANTOS *et al.*, 1994; ALMEIDA, 1996), except for a few estuarine sites that have been more frequently studied (*e. g.* COSTA, 1980; CUNHA *et al.*, 1983; ALMEIDA, 1988; COSTA *et al.*, 1994).

Such data are of great relevance for at least two reasons: i) the Portuguese shore includes many range terminations and occupies an exceptional position in the north eastern Atlantic due to its transitional character (BRIGGS, 1974); ii) a better understanding of the biogeography of the so-called Lusitanian Province requires a more detailed characterisation of our fish fauna.

The Atlantic islands of Azores and Madeira are also of great biogeographic relevance. Their fauna is being studied by authoritative local Institutions (Funchal Municipal Museum at Madeira and Department of Oceanography and Fisheries of the Azores University; *e. g.* ABREU *et al.*, 1995; SANTOS *et al.*, 1995, 1997; see also LLORIS *et al.*, 1991; WIRTZ, 1994).

In a time where major faunal changes are more and more probable, the Portuguese shore will be one of Europe's best places to investigate and predict the course of ecological perturbations, due to its transitional nature. In this context, every contribution to the characterisation of our fish fauna is relevant. Of special importance will be studies based on standardised procedures consistently applied in diverse

locations along the Portuguese shore. Since most or all research Institutions do not possess the resources to undertake this type of work alone, close co-operation along this line is the obvious way to advance our knowledge. This survey type work is also essential to provide conservation and management organisations with reference information against which the impacts of environmental damages and protection measures can be accessed. With the recent implementation of Marine Protected Areas in Portugal, there is a unique opportunity to elaborate a baseline database of the situation prior to the establishment of protective measures, against which the future developments could be compared.

The need for long-term studies

The kind of survey outlined above will only be fully useful if the same procedures could be applied consistently for many years. This is the only way to distinguish real trends from short and medium term fluctuations, so common in fish populations. Again, most research institutions, especially those linked to the Universities, do not have the resources to maintain such monitoring efforts, unless adequate support is provided. This type of work will be very difficult to undertake with the typical short term funding usually allocated to scientific studies.

Causality of community structure

Although this is not a problem specific of the Portuguese shore, there is a marked scarcity of data on the factors that govern the structure of fish assemblages in temperate habitats. While the literature on coral reefs has grown rapidly in recent years (*e. g.* KOCK, 1982; ALEVISON *et al.*, 1985; SALE, 1988; SALE & DOUGLAS, 1984; for a revision see SALE, 1991), equivalent studies in temperate shores are still few (but see *e. g.*: STEPHENS & ZERBA, 1981; YOSHIYAMA, 1981; STEPHENS *et al.*, 1984; BODKIN, 1986; YOSHIYAMA *et al.*, 1986; HARMELIN, 1987).

What is the resilience of temperate inshore fish communities? What is the relative importance of pre- and post-recruitment processes in determining population abundance? What are the relative roles of deterministic factors like competition and predation and those that have a more stochastic nature? These are examples of basic biological questions that need to be studied if we want to understand and manage properly the temperate inshore fish communities.

The need to integrate ecology and physiology

The few studies that have been done on the breeding seasons of inshore fishes in Portugal, have shown that the timing of reproduction differs both from what occurs in the Mediterranean and in northwest Europe (ALMADA *et al.*, 1990, 1994, 1996; FARIA & ALMADA, 1995; GONÇALVES, 1997). In some cases, the discrepancies are of the order of six months and some species that in higher latitudes are spring/summer

breeders, are winter/spring breeders in Portugal. This finding clearly shows that the Portuguese shore provides excellent opportunities as a “natural laboratory” to investigate the environmental factors that control reproduction in temperate inshore fishes. In this area, much will be gained from co-operation of researchers interested in ecology with those interested in physiology.

This challenge is not limited to the control of reproduction. Indeed, differences in reproductive patterns are likely to be linked to peculiar features of growth, larval survival, age and size at first reproduction and other life history traits. Again, studies involving different geographical locations, namely those involving several European countries, will be potentially very fruitful.

Larval biology and the mechanisms of recruitment

Although substantial work has been done on the biology of larval inshore fishes, namely by Portuguese authors (*e. g.* RÉ, 1981, 1987, 1990; RÉ *et al.*, 1990), much remains to be done. This becomes clear if we remember that even many common species have not been studied in what concerns embryonic and larval development (but see RÉ, 1980; RÉ & GOMES, 1982; R. S. SANTOS, 1989; GIL *et al.*, 1997). Data on the duration of planktonic life and spatial distribution patterns of larvae are still more limited (see RÉ, 1986, 1990). In addition, a basic fundamental question concerning inshore fish larval biology remains unexplored. We are referring to the understanding of the mechanisms that ensure that inshore fish larvae return to the shore, or remain near it, and the mechanisms that enable young fishes to find adequate microhabitats and levels on the shore. The answer to this problem is critical if we want to understand the processes of recruitment of inshore fishes.

Genetic characterisation of populations

The genetic characterisation of inshore fish populations is virtually unexplored in Portuguese waters, with a few recent exceptions (*e. g.* CASTILHO & McANDREW, 1998). This information is however necessary if we want to determine effective population size, patterns of gene flow and define the different stocks and their geographical distribution.

The topics listed in the preceding paragraphs, are certainly biased by the personal views of the authors. In spite of this, they exemplify areas that require more and innovative effort from the scientific community. They also illustrate how much remains to be done to study inshore fishes in Portugal.

All the topics mentioned call for co-operation: co-operation of similar institutions in different geographical areas; co-operation of researchers from diverse

disciplines; co-operation between governmental and academic entities to make possible long-term, sustained and consistent surveys of the inshore fish communities. In our view, the legacy of Professor Saldanha to the study of inshore fishes in Portugal could be much reinforced if these co-operation efforts would become a reality.

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