Estuarine, Coastal and Shelf Science 198 (2017) 53–62

Contents lists available at ScienceDirect

Estuarine, Coastal and Shelf Science

journal homepage: www.elsevier.com/locate/ecss

Recruitment success and growth variability of mugilids in a West African estuary impacted by climate change

S. Trape [a], J.-D. Durand [a, 1], L. Vigliola [b], J. Panfili [a, *, 1]

[a] UMR MARBEC, IRD-IFREMER-CNRS-UM, Université de Montpellier, cc093, Place E. Bataillon, 34095 Montpellier Cedex 5, France
[b] IRD, UMR Entropie, Laboratoire Excellence LABEX Corail, Centre de Nouméa, BP A5, 98848 Nouméa Cedex, New Caledonia

A R T I C L E I N F O

Article history:
Received 14 April 2017
Received in revised form
20 August 2017
Accepted 21 August 2017
Available online 24 August 2017

Keywords:
Inverse estuary
Hypersaline conditions
Mugilidae
Juveniles
Habitat quality
West Africa

A B S T R A C T

With the persistence of a drought since the late 1960s, some West African estuaries became permanently reversed in term of salinity gradient and hypersaline waters are present in their upstream part (salinity >60). To understand the mechanisms regulating fish recruitment intensity in these estuaries and evaluate the consequences of freshwater shortages on juvenile habitat quality, a growth study was conducted in the Saloum hypersaline estuary (Senegal). The Mugilidae fish family, highly representative of estuarine environments, was targeted and several species sampled (*Chelon dumerili*, *Mugil bananensis* and *M.* cf. *curema* sp. M). Juveniles were sampled monthly all the year round in three areas of the estuary exhibiting strongly contrasted habitat conditions. Otolith sections were used to estimate the ages, reconstruct growth trajectories, estimate the duration of the oceanic larval phase, and evaluate juvenile growth variability along the salinity gradient. Analyses revealed that the temporal recruitment variability of *C. dumerili*, with 2 annual cohorts, was not mainly induced by growth-selection mechanisms, but probably more by predation pressures. Juveniles exhibited significantly faster growth rates in the lower salinity suggesting that benthic food availability was a strong factor controlling habitat quality of early juveniles. Salinity had also a clear impact when reducing the growth in hypersaline conditions and/or selecting slower growing individuals. Moderate freshwater inputs positively affected the nursery function of the estuary for mugilids by enhancing the productivity of the first trophic levels. In a long term, the global change could have an impact of the mugilid fishery and its management.

© 2017 Elsevier Ltd. All rights reserved.

1. Introduction

Year-class strength in marine fish populations strongly depends on the success of larval replenishment and the survival of juveniles. Because both larvae and juveniles experience massive mortality rates, typically above 90%, the identification of factors and mechanisms responsible of the survival of early life stages has become a central research theme over the last thirty years (Almany et al., 2007; Whitfield, 2016b; Whitfield and Pattrick, 2015). Several theoretical (e.g. Houde, 1987) and field studies (e.g. Rice et al., 1993; Suthers, 1998) have emphasised the key role played by growth on the survival of these early life stages. During this 'critical period' of the life cycle, a fast growth can allow individuals to increase their survival rates by shortening this phase (the 'stage duration' mechanism, Houde, 1987) and reducing predation and/or starvation risks by attaining a larger size at a given age (the 'bigger-is-better' mechanism, Miller et al., 1988; Suthers, 1998). Concomitantly, there is a general consensus among ecologists that fish population abundance is positively correlated to the availability of adequate habitats that promote growth and survival of juvenile fishes (Gibson, 1994; Ross, 2003). It is then evident that modification of environmental conditions and all events linked to global changes in coastal areas will have a very large effect on the survival and recruitment of the juvenile fishes and their populations (James et al., 2013; Whitfield, 2016b; Whitfield and Pattrick, 2015). As a result, the identification and evaluation of juvenile habitat quality using abundance and/or growth indexes is a central theme in fisheries science (e.g. Mellin et al., 2009).

Mugilidae (mullets) is a fish family widely distributed worldwide, consisting of species distributed in rivers, estuaries and coastal waters where they play an important ecological role and

* Corresponding author.
E-mail address: jacques.panfili@ird.fr (J. Panfili).
[1] Present address: IRD, UMR MARBEC, SEDES IJL, Dept. Ecology & Evolutionary Biology, University of Science, VNUHCM, 227 Nguyen Van Cu Street, District 5, Ho Chi Minh City, Viet Nam.

http://dx.doi.org/10.1016/j.ecss.2017.08.037
0272-7714/© 2017 Elsevier Ltd. All rights reserved.

usually support fisheries (Crosetti and Blaber, 2016). With a few exceptions, mullets are thought to remain in estuaries and coastal lagoons during most of their life cycle and leave seasonally these areas to spawn at sea. After hatching, metamorphosis and a short period of growth, 10–40 mm juveniles start to recruit into inshore coastal waters, primarily into brackish habitats of lagoons and estuaries (González-Castro and Minos, 2016; Whitfield et al., 2012). Despite the ecological and economical importance of the Mugilidae family, little is known about how year-class success is shaped by processes affecting growth and survival of larvae and early juveniles during their marine and estuarine phase (but see Marin et al., 2003). Moreover, although young-of-the-year mullets occupy a wide variety of estuarine habitats which are increasingly impacted by human activities and climate change (Crosetti and Blaber, 2016), there is no information on habitat quality for early juvenile mullets. Despite this, such data are crucial for both sound fishery management and for a better understanding of consequences of estuarine habitat alteration and loss on population dynamics of Mugilid species. Mugilidae often dominate estuarine fish landings and represent a major food and economic resource for local populations (Crosetti, 2016).

In West Africa, the Mugilidae family includes 8 species belonging to 4 genera (Durand and Whitfield, 2016). This area experienced an unprecedented drought episode since the late sixties with a decrease in average rainfall of about 30% (L'Hote et al., 2002; Tabutin and Schoumaker, 2004). As a result of freshwater shortage, the Saloum estuary in Senegal, the second coastal Biosphere Reserve of West-Africa in terms of area, has a permanently reversed salinity gradient, with values usually greater than 60 upstream and which can reach more than 130 at the end of the dry season (Simier et al., 2004). The environment and ground waters have then been severely impacted by the salinity increase (Faye et al., 2005). One question is then how does this strong environmental change induce and/or modify the recruitment pattern of the dominating mugilids species? And do all species react in the same way? A previous study on spatio-temporal recruitment patterns of mugilids in the Saloum estuary (Trape et al., 2009b) revealed that three species - *Chelon dumerili*, *Mugil bananensis* and *M.* cf. *curema* sp. M - numerically dominated the juvenile assemblage (see the Material and methods section for species description and nomenclature). The intensity of recruitment and the minimal size at recruitment were highly variable according to species, with *C. dumerili* being far the most abundant one (89%). Recruitment of *C. dumerili* occurred as two distinct periods with different levels of abundance, a first cohort very abundant in the cold dry season and a second cohort less abundant at the beginning of the hot wet season, whereas *M. bananensis* and *M.* cf. *curema* sp. M recruited mainly during the hot wet season. Questions remained on why such differences between sympatric closely related species and why these differences occur in a context of strong environmental pressures linked with global climatic changes?

In order to answer these questions, the present study used the preliminary results of Trape et al. (2009b) to determine whether the seasonal recruitment was due to seasonal growth variability during the larval oceanic phase on juvenile cohort strength or to differences in habitat quality during juvenile stage in estuarine conditions. More specifically, the objectives of this study were (i) to test the growth-selection hypothesis to explain differences in recruitment magnitude between cohorts, (ii) to investigate the effects of the spatiotemporal variability estuarine environmental parameters on the growth of early mugilids juveniles, and (iii) to estimate the ages at recruitment and estuarine growth rates for the main mugilids living in inverse estuary. More specifically, using otoliths for calculating age and growth rates, this work presents the first information on the early life history of West African mugilids allowing a better understanding of consequences of environmental changes on adaptive responses of estuarine fish species.

2. Materials and methods

2.1. Species nomenclature

In this paper, genus nomenclature accords with recent taxonomical revisions of Durand et al. (2012a) and Xia et al. (2016). Nomenclature at the species level follows Durand and Borsa (2015) who argued to consider as valid species, all evolutionary lineages observed in the *Mugil curema* phylogenetic tree (Durand et al., 2012b) and Fig. 2B in Durand and Borsa (2015). In this tree, all West African specimens identified morphometrically as *M. curema* belong to an evolutionary lineage different to all other American *M. curema* specimens; as the type locality of *M. curema* is Bahia, Brazil, Durand and Borsa (2015) named *Mugil* sp. M the West African lineage. However, we are aware that such nomenclature may be difficult to understand and so we added "cf. *curema*" in the species named proposed by Durand and Borsa (2015) to underline the phylogenetic proximity of *Mugil* sp. M with *M. curema*.

2.2. Study area

The Saloum estuary is located in Senegal, between 13°30′-14°30′N and 15°50′-16°50′W, on approximately 800 km^2 of open water (Fig. 1). This large estuarine system comprises three main channels, from north to south: the Saloum, the Diomboss and the Bandiala. The Saloum and the Diomboss are wide downstream (1.2 and 4.8 km at the mouth, respectively) and deep (generally 10–15 m) whereas the Bandiala is narrower (800 m at the mouth) and shallower (generally 5–8 m). The channels are bordered by sandy/muddy tidal flats covered by discontinuous mangrove in the downstream part of the estuary. The mangrove, luxuriant in the Bandiala, patchy in the Diomboss and in the lower part of the Saloum, totally disappears in the upstream Saloum after the Foundiougne village (Simier et al., 2004). The region has a Sahelo-Sudanian climate characterized by a dry winter season from November to June, and a wet summer season from July to October. Since no river of significant size currently flows into the estuary, freshwater supply comes nearly exclusively from rainfall. As a consequence, the mean salinity shows a minimum at the end of the rainy season and progressively increases until the end of the dry season (Panfili et al., 2004b). In the Diomboss and the Bandiala, mean salinities are relatively homogeneous due to the frequent renewal of waters coming from the sea tides (Diouf, 1996). In contrast, the Saloum displays a marked and permanent salinity gradient between the downstream and upstream areas (Panfili et al., 2006). Three main ecological areas of the estuary were defined by Trape et al. (2009b): (i) the Bandiala (sites 1–3) which is characterized by relatively low salinities (mean 38.6 ± 4.5) and a luxuriant mangrove, (ii) the lower Saloum (site 4–5) which is characterized by moderates salinities (mean 42.1 ± 2.6) and a patchy mangrove, and (iii) the upper Saloum (site 7–8) which is characterized by high salinities (mean 77.2 ± 11.2) and no mangrove.

2.3. Sampling

Early juvenile mullets were obtained from monthly collections (Trape et al., 2009b) which were conducted from April to October 2007, using a 10 × 2 m beach (bag) seine (5 mm mesh), at each site

Download English Version:

https://daneshyari.com/en/article/5765295

Download Persian Version:

https://daneshyari.com/article/5765295

Daneshyari.com