Progress in Oceanography 160 (2018) 83–100

Contents lists available at ScienceDirect

Progress in Oceanography

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

Variation in the diel vertical distributions of larvae and transforming stages of oceanic fishes across the tropical and equatorial Atlantic

M. Pilar Olivar[a,*], Tabit Contreras[a], P. Alexander Hulley[b,c], Mikhail Emelianov[a], Cristina López-Pérez[a], Víctor Tuset[a], Arturo Castellón[a]

[a] Institut de Ciències del Mar (CSIC), Passeig Marítim 37-49, Barcelona 08003, Spain
[b] Iziko – South African Museum, Cape Town, South Africa
[c] MA-RE Institute, University of Cape Town, South Africa

ARTICLE INFO

Keywords:
Early life-history
Ontogenetic vertical migration
Mesopelagic fishes
Lanternfishes
Lightfishes
Hatchetfishes

ABSTRACT

The vertical distributions of early developmental stages of oceanic fishes were investigated across the tropical and equatorial Atlantic, from oligotrophic waters close to the Brazilian coast to more productive waters close to the Mauritanian Upwelling Region. Stratification of the water column was observed throughout the study region. Fishes were caught with a MOCNESS-1 net with mouth area of 1 m^2 at 11 stations. Each station was sampled both during the day and at night within a single 24-h period. The investigation covered both larvae and transforming stages from the surface to 800 m depth. Distribution patterns were analysed, and weighted mean depths for the larvae and transforming stages of each species were calculated for day and night conditions. Forty-seven different species were found. The highest number of species occurred in the three stations south of Cape Verde Islands, characterized by a mixture of South Atlantic Central Water (SACW) and Eastern North Atlantic Central Water (ENACW). There was a marked drop in species richness in the three stations closer to the African upwelling, dominated by ENACW. The highest abundances occurred in the families Myctophidae, Sternoptychidae, Gonostomatidae and Phosichthyidae. Day and night vertical distributions of larvae and transforming stages showed contrasting patterns, both in the depths of the main concentration layers in the water column, and in the diel migration patterns (where these were observed). Larvae generally showed a preference for the upper mixed layer (ca. 0–50 m) and upper thermocline (ca. 50–100 m), except for sternoptychids, which were also abundant in the lower thermocline layer (100–200 m) and even extended into the mesopelagic zone (down to 500 m). Transforming stages showed a more widespread distribution, with main concentrations in the mesopelagic zone (200–800 m). Larvae showed peak concentrations in the more illuminated and zooplankton-rich upper mixed layers during the day and a wider distribution through the upper 100 m during the night. For most species, transforming stages were concentrated in the mesopelagic layers both day and night, although in some species (*Diaphus* cf. *vanhoeffeni* and *Vinciguerria nimbaria*), the transforming stages displayed vertical migration into the upper 100 m at night, in a manner similar to their adult stages.

1. Introduction

Oceanic regions are inhabited by a great diversity of fishes (Weitzman, 1997) from large pelagic fishes such as tuna, which migrate to reproduce near the continents, to others that occupy the open sea for their entire lives. Many of the latter are small meso- and bathypelagic species which inhabit the poorly illuminated, deeper zones, and many of them perform diel vertical migrations into the surface layers. The larvae of these groups constitute the main component of ichthyoplankton samples from oceanic regions (Moser and Ahlstrom, 1970, 1996; Kinzer and Schulz, 1985; de Macedo-Soares et al., 2014), although these larvae are also commonly reported above slope regions and even over continental and insular shelves (Masó et al., 1998; Funes-Rodríguez et al., 2011; Koubbi et al., 2011; Contreras-Catala et al., 2016). The present investigation focuses on the early developmental stages of species reproducing in the tropical and equatorial Atlantic, and includes only the larvae and transforming stages. An earlier paper has dealt with the juvenile and adults distributions in relation to oceanography and biogeography (Olivar et al., 2017).

There have been numerous, previous investigations on larval distribution patterns in the central Atlantic and in most of them mesopelagic species are key components: for the eastern North Atlantic

* Corresponding author.
E-mail address: polivar@icm.csic.es (M.P. Olivar).

https://doi.org/10.1016/j.pocean.2017.12.005
Received 24 May 2017; Received in revised form 19 October 2017; Accepted 15 December 2017
Available online 15 December 2017
0079-6611/

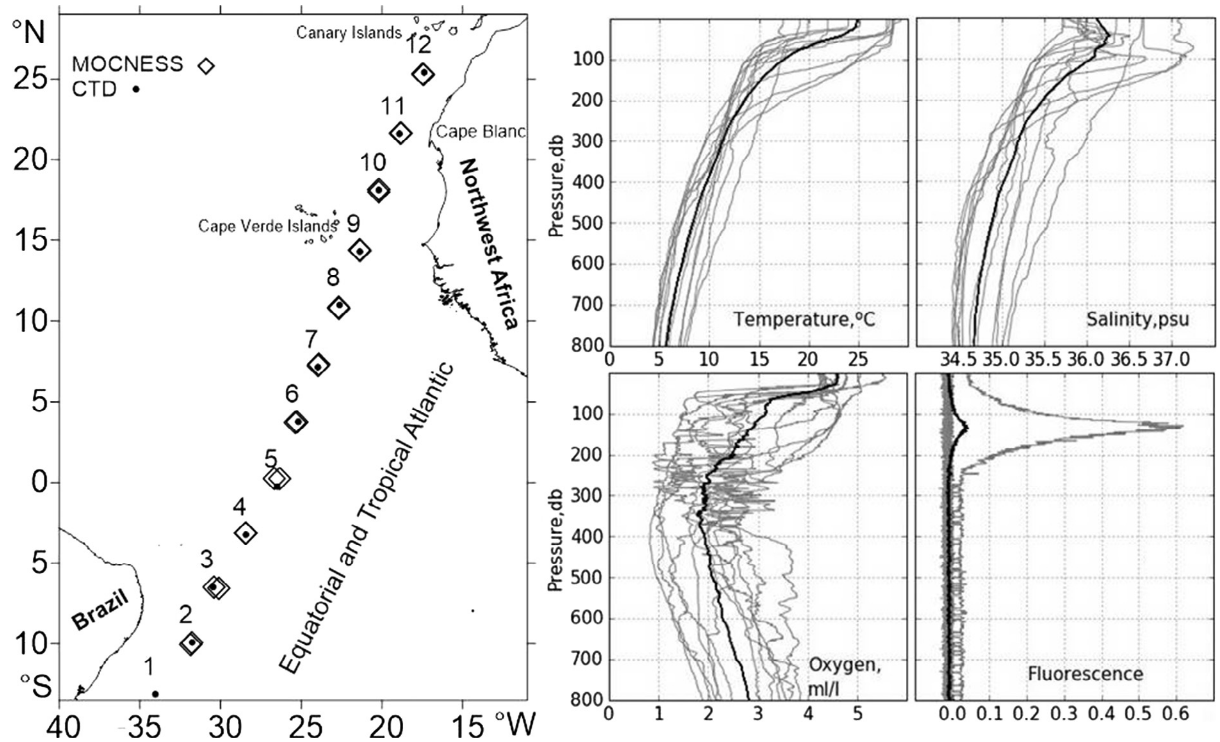

Fig. 1. Location of MOCNESS and CTD stations sampled in March-April 2015 and vertical profiles of temperature; salinity; dissolved oxygen; fluorescence. Black line: mean value profile; grey lines: individual value profiles).

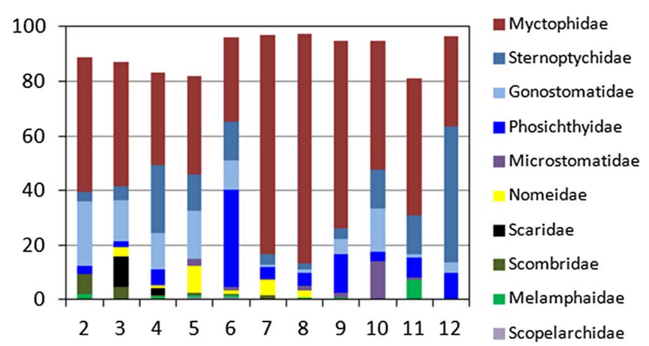

Fig. 2. Family contributions at each station (% by number) of the larvae collected with the MOCNESS net.

(Canary Current sector) (Badcock and Merrett, 1976; John et al., 2001; Rodríguez et al., 2004; Moyano et al., 2014; Olivar et al., 2016); and for the western North Atlantic (Richards, 2006 and references therein). The Sargasso Sea has received particular attention, mainly devoted to eel leptocephali (e.g. Miller and McCleave, 1994), but a few also addressing other fish larvae (Ayala et al., 2016). Although many ichthyoplankton investigations for the western South Atlantic (Brazilian sector) have targeted shelf species (Matsuura and Kitahara, 1995; de Macedo-Soares et al., 2014; Katsuragawa et al., 2014), a few others have extended to oceanic regions (de Castro et al., 2010; Bonecker et al., 2012; Namiki et al., 2017).

Notwithstanding that expatriation is a process commonly reported in myctophids, where adults of some species occur beyond its home range and are not able to reproduce there (Hulley, 1984a,b; Young et al., 1987), larval fish distributions usually mirror adult distributions, and generally tend to be broader due to the susceptibility of larval stages being transported by ocean currents (Carassou et al., 2012; Leis et al., 2013). Specific spawning strategies adapted to oceanographic structures, such as eddies or surface currents, have been advocated to explain species-specific horizontal distribution patterns through local

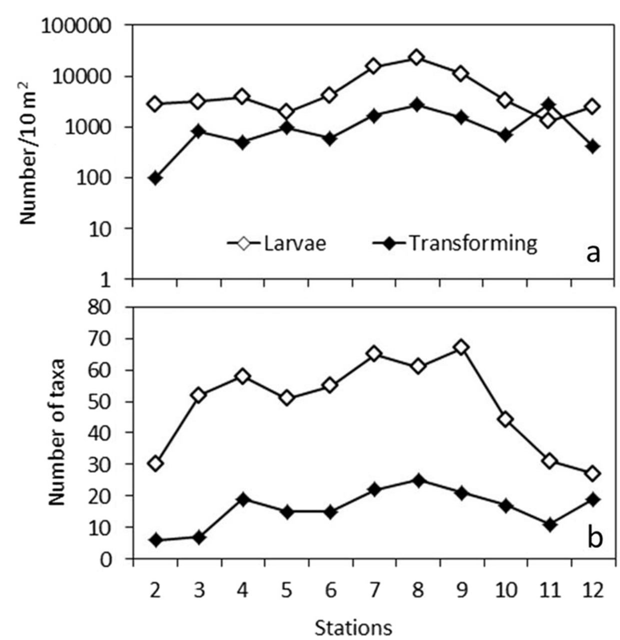

Fig. 3. Abundances (a) and numbers of species (b) per station for larval and transforming stages.

retention and/or larval transport (Hare et al., 1999; Watanabe et al., 1999; Sassa et al., 2004; Gaither et al., 2016).). Therefore, the vertical location of larvae in the water column is a key factor influencing larval transport (Leis, 1986; Moser and Smith, 1993; Hernandez et al., 2009; Garrido et al., 2009). Following the pioneer study by Ahlstrom (1959), investigations on larval vertical distributions have been performed for many geographical regions (Pacific Ocean: Loeb, 1979; Sassa et al., 2002; Suthers et al., 2006; Indian Ocean: Röpke, 1993; Muhling et al., 2007; Atlantic Ocean: John et al., 2001; Garrido et al., 2009; Moyano et al., 2014; and Mediterranean Sea: Olivar and Sabatés, 1997; Sabatés,