Deep-Sea Research I 78 (2013) 16–23

Contents lists available at SciVerse ScienceDirect

Deep-Sea Research I

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

Distribution of the biomass-dominant pelagic fish, *Bathylagus euryops* (Argentiniformes: Microstomatidae), along the northern Mid-Atlantic Ridge

C.J. Sweetman [a,*], T.T. Sutton [a], M. Vecchione [b], R.J. Latour [a]

[a] Virginia Institute of Marine Science, College of William & Mary, P.O. Box 1346, Gloucester Point, VA 23062, USA
[b] NMFS National Systematics Laboratory, National Museum of Natural History, Smithsonian Institution, Washington DC, USA

ARTICLE INFO

Article history:
Received 6 September 2012
Received in revised form
25 March 2013
Accepted 4 April 2013
Available online 21 April 2013

Keywords:
Mid-ocean ridges
Mesopelagic zone
Bathypelagic zone
Vertical migration
Ontogeny
Prey availability

ABSTRACT

The northern Mid-Atlantic Ridge (MAR), from Iceland to the Azores, ranges in depth from 800–4500 m and extends over an area of 3.7 million km^2. Despite its size, few studies have described the distribution of pelagic fishes along the MAR. Recent evidence from MAR-ECO, a Census of Marine Life field project, reported increased abundance and biomass of deep-pelagic fishes below 1000 m on the ridge, which stands in stark contrast to the traditional view that abundance and biomass decline exponentially with increasing depth in 'typical' open ocean ecosystems. Among the midwater fishes sampled during the MAR-ECO campaign, *Bathylagus euryops* (Argentiniformes: Microstomatidae) was the biomass-dominant pelagic species and ranked third in total abundance. In this paper, we characterize the distribution of *B. euryops* in relation to physical and biological variables along the MAR. Average catch of *B. euryops* over the MAR varied between 0.68 individuals/100,000 m^3 $\pm$ 0.70 individuals at the Azorean Zone and 5.82 individuals/100,000 m^3 $\pm$ 2.08 individuals at the Reykjanes Ridge. Generalized linear models applied to *B. euryops* catch data indicated that ridge section, depth zone, and prey abundance were important explanatory variables in structuring the distribution along the MAR. Analyses of vertical distribution patterns, relative to time of day and fish size, showed that larger fish were found deeper in the water column, likely due to an ontogenetic migration to depth. Mean fish size increased from 58.9 mm standard length in the epipelagic zone and continually increased to 155.7 mm standard length between 2300–3000 m. Due to the high abundance and biomass observed along the MAR, *B. euryops* appears to be an important species in the oceanic food web of the North Atlantic Ocean.

1. Introduction

The deep-pelagic realm, ranging from 200 m below the ocean's surface to just above the sea floor, is the largest habitat on Earth and holds 97% of the global ocean's volume (Tyus, 2012). Mid-ocean ridges and seamounts are massive features in the open ocean that can have important impacts on ecosystem structuring and overall productivity. The Atlantic Ocean contains one of the largest topographic features in the world, the Mid-Atlantic Ridge (MAR). Despite the enormous size of the MAR, few studies have focused on characterizing the distribution of pelagic fauna along it (Vecchione et al., 2010), which, in part, inspired the initiation of the Census of Marine Life field project "Patterns and Processes of the Ecosystems of the Northern Mid-Atlantic," MAR-ECO (Bergstad and Godø, 2003; Bergstad et al., 2008).

Open ocean ecosystems are ultimately dependent upon near-surface productivity for energy transfer to the meso- and bathypelagic zones. Food is perceived to be scarce in the deep sea as it must first pass through a suite of vertebrate, invertebrate and bacterial consumers in the mesopelagic zone before reaching the bathypelagic zone. Therefore, there is a decrease in production with increasing distance from the surface. Vertical distribution profiles in the North Atlantic have shown that deep-pelagic zooplankton and micronekton biomass decline exponentially with depth (Angel and Baker, 1982; Reinthaler et al., 2006; Arístegui et al., 2009; Robinson et al., 2010). However, recent evidence of increased abundance and biomass of deep-pelagic fishes below 1000 m on the MAR (Sutton et al., 2008) contradicts the traditional view of vertical structuring in the open ocean. These observations suggest that ecosystems over the MAR are structured differently than 'typical' open ocean ecosystems (Fock et al. 2004; Sutton et al., 2008; Fock, 2009).

Among the fishes sampled during the 2004 MAR-ECO R/V *G.O. Sars* expedition, *Bathylagus euryops* was the biomass-dominant

* Corresponding author. Tel.: +1 804 684 7589; fax: +1 804 684 7110.
E-mail address: cjsweetman@vims.edu (C.J. Sweetman).

0967-0637/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.dsr.2013.03.004

pelagic species and ranked third in total abundance (Sutton et al., 2008). Historically, *B. euryops* is known to inhabit the North Atlantic meso- and bathypelagic zones as far north as Greenland, extending south to Bermuda (Mauchline and Gordon, 1983; Cohen, 1984; Møller et al., 2010) and is not known to migrate vertically. However, Scott and Scott (1988) noted that *B. euryops* may be present in other oceans. The deep-pelagic realm, overall, has been poorly sampled due to the technological challenges and high cost of sampling (Webb et al., 2010) and as a result, knowledge of large-scale horizontal and vertical distributions is limited for most deep-sea taxa (Vecchione et al., 2010).

A central theme in ocean ecology is the relationship between biological patterns and regional physical conditions (Haedrich, 1997). In the North Atlantic Ocean, physical conditions can vary greatly across a large-scale latitudinal gradient. The open ocean is also structured in the vertical dimension, creating ecologically distinct habitats, and can be delineated by differences in solar illumination, temperature, hydrostatic pressure, and current shear (Angel, 1986; Tyus, 2012). Within these vertically structured habitats, abrupt topographical features, such as seamounts and mid-ocean ridges, can impinge on the deep-pelagic realm (Porteiro and Sutton, 2007). Major topographical features, such as the MAR, are known to influence local and regional circulation patterns (Roden, 1987) and thus can have important implications on the distribution of deep-pelagic organisms and their interactions with benthic fauna.

Along the MAR, Sutton et al. (2008) summarized the occurrence of bathypelagic fishes in the epipelagic zone, including abundant species not known to migrate vertically such as *Cyclothone microdon* and *B. euryops*. Physical factors may contribute to these previously unobserved occurrences; however, behavioral or biological factors such as vertical migration (both diel and ontogenetic) must also be considered. In this paper, we describe the distribution of *B. euryops* over the MAR relative to hydrography, prey availability, ontogeny, and diel patterns to understand better the influence each factor has on the habitat utilization of this biomass-dominant species.

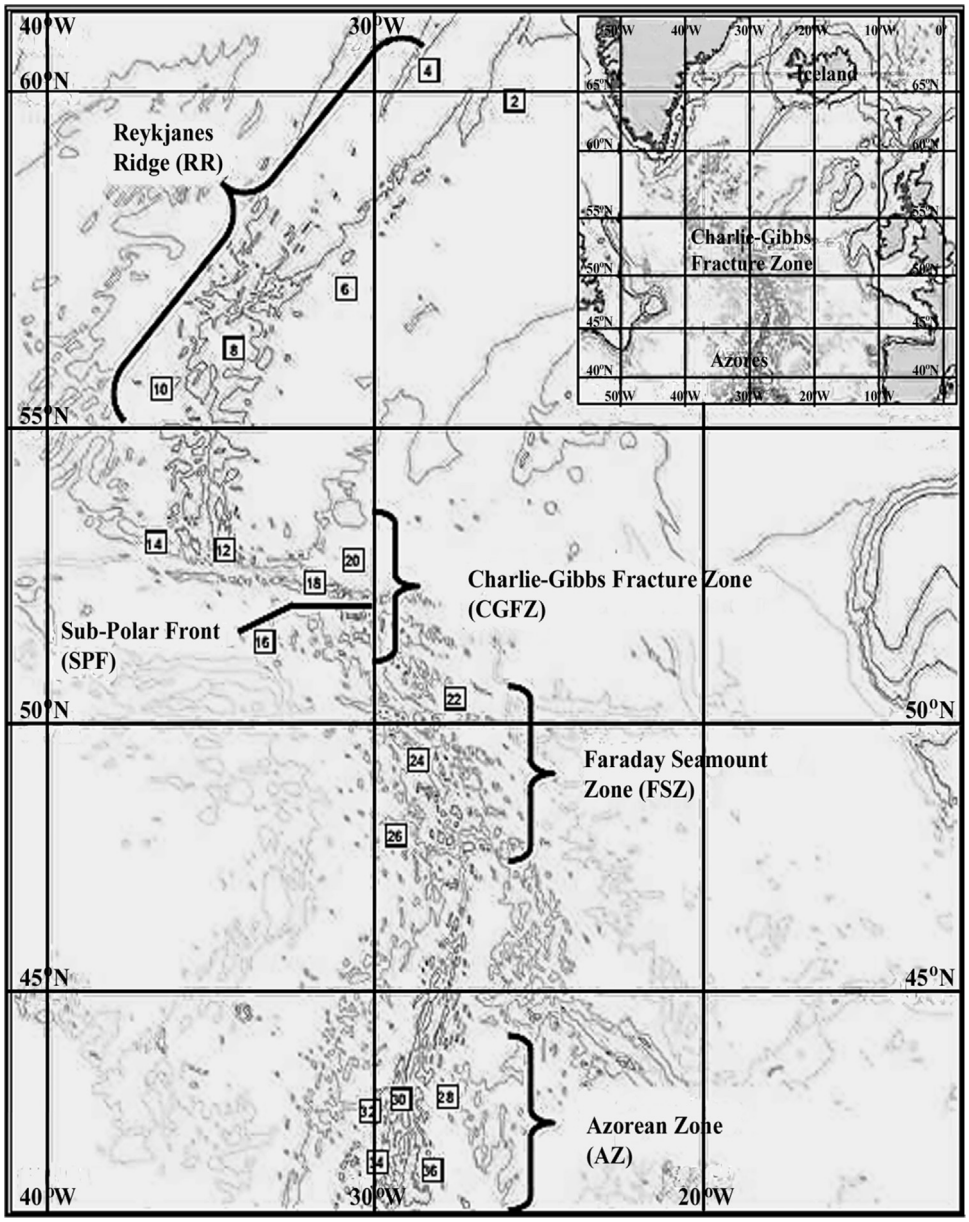

Fig. 1. Trawl sampling stations for Leg 1 of 2004 R/V *G.O. Sars* MAR-ECO expedition to the Mid-Atlantic Ridge, from Iceland to the Azores (adapted from Sutton et al., 2008).