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Patterns of distribution of deepwater demersal fishes of the North Atlantic mid-ocean ridge, continental slopes, islands and seamounts

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ABSTRACT

Basin-scale spatial and depth-related distribution patterns of deepwater demersal fishes were analysed using bottom trawl datasets from the North Atlantic continental margin, slopes of oceanic islands and seamounts, and the mid-Atlantic Ridge. Depth-stratified presence-absence data for 593 species were compiled from fisheries-independent trawl studies with full species lists. The datasets comprised trawls conducted on the upper continental slope (200 m) to abyssal depths, and 750 m wide depth strata were used. Number of species and families declined with depth in all areas. Species number was highest in the western North Atlantic, significantly lower on the mid-Atlantic Ridge and eastern North Atlantic. Observed species numbers are also low in southern areas (Bahamas, NW Africa, southerly seamounts), but the sampling effort in these waters has been much less than in northern sites. Fish assemblages vary by depth, latitude and longitude, and the study corroborates earlier suggestions that assemblages are broadly distributed in relation to regional circulation and watermass features. The mid-Atlantic Ridge assemblages between Iceland and the Azores are most similar to those on eastern North Atlantic slopes and rises, rather dissimilar to all others, including western Atlantic, Greenland, northwest Africa and Azorean seamount and island assemblages. Across the North Atlantic differences between subareas are strongest at slope depths, much less pronounced at the less speciose rise and abyssal depths. Demersal fish biomass estimates suggest that the American slope (New England) has low biomass compared with Newfoundland and European areas, and that the supposedly oligotrophic mid-Atlantic Ridge has a level of biomass similar to or higher than the European margin.

1. Introduction

Present distribution patterns of deepwater demersal fish reflect evolutionary adaptations to deep-sea life, as well as the more recent responses to the changing configuration, bathymetry and oceanographic features of the oceans (Andryiashev, 1953; Marshall, 1979; Merrett and Haedrich, 1997). Previous basin-scale studies in the North Atlantic suggested limited similarity in species composition between different distant locations, e.g. on either side of the ocean rims, and rather restricted distributions of individual species (Merrett and Haedrich, 1997 and papers cited therein). However, Koslow (1993), using the extensive datasets compiled in the atlas by Haedrich and Merrett (1988, 1990), showed a pattern of distribution of species assemblages related to major watermasses or regional circulatory features, presumably reflecting also differences in food-web structure and productivity (e.g. Merrett, 1992).

These papers, including Koslow (1993), only used data from the North Atlantic continental slopes, while distribution data from the mid-Atlantic Ridge (MAR), isolated oceanic seamounts, and slopes of oceanic islands were not considered. These bathymetric features are either major shallows of the deep ocean, i.e. ridges, or widespread isolated shallows. They are potentially very significant habitats for demersal deepwater species and may facilitate basin-wide dispersion. However, their significance for the basin-wide patterns of distribution has not been assessed. In particular, it is not known whether the mid-ocean ridges have unique assemblages, or rather assemblages similar to either of the adjacent continental slope areas.

Our objectives were to (1) reanalyse basin-wide patterns with new and extended datasets, (2) analyse faunal variation among subareas and (3) specifically compare faunas on the mid-Atlantic

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Ridge and seamounts with slope areas. Adding new datasets we were interested in re-examining the ocean-wide patterns found by Koslow (1993). In addition we compiled swept-area estimates of demersal fish catch from selected trawl surveys and compared depth-related variation in biomass between slopes and the mid-Atlantic Ridge.

2. Material and methods

2.1. Species composition data

Regardless of location, all previous studies have demonstrated strong variation in species composition with depth from the upper slope to the abyss, so we carried out a depth-stratified analysis using the depth strata defined by Haedrich and Merrett (1988). Previous studies from the MAR have shown a latitudinal variation in the species composition (Hareide and Garnes, 2001; Kukuev, 2004; King et al., 2006; Bergstad et al., 2008; Fossen et al., 2008) and a rather abrupt change in species composition associated with the Sub-Polar Frontal Zone at 48–52°N. Accordingly, in order to identify how the two rather distinct faunas compared with other areas we split the datasets from the MAR into northern and southern sub-sets.

We defined benthic and benthopelagic species as demersal. The list of families in Haedrich and Merrett (1988) was used as a guide to which species should be included in our analyses. We thus excluded meso- and bathypelagic species even if they occurred in the catch of bottom gears. Taxonomic status of individual species was verified using the Integrated Taxonomic Information System (ITIS, http://www.itis.gov).

The datasets, all from bottom trawls, used in the analyses and their origins are listed in Table 1. Data used by Haedrich and Merrett (1988) and later by Koslow (1993) were supplemented by other datasets. The additional datasets comprised data from the mid-Atlantic Ridge (MAR), Greenland, and several seamounts not associated with the MAR, but also some further slope data not used in the previous analyses. The design, dimensions and operations and hence the catchabilities of the trawls varied between studies and standardisation of abundance data that would have facilitated quantitative comparisons proved difficult. Therefore it was decided to use only presence-absence data for the analyses of species composition and distribution patterns. In several cases species lists were compiled from subarea-specific checklists or unpublished sources using data from a range of

Table 1
Subareas, locations and data sources for the analyses of demersal fish distribution patterns.

Subarea code	Location	Data source	No. of tows
ENA	Bay of Biscay	P. Lorance, pers. comm., IFREMER, France, 1999	10
	Cantabrian shelf	Instituto Español de Oceanografía (IEO), http://www.ecomarg.net/biodiversidad_en.html	Unknown, only species list
	Faroe bank	Magnussen (2002)	303
	Galicia shelf	Instituto Español de Oceanografía (IEO), http://www.ecomarg.net/biodiversidad_en.html	Not given, only species list
	Hatton bank	M. Stehmann, pers. comm. ISH, Germany (Gordon, 1999)	28
	Ireland slope	P. Lorance, pers. comm., IFREMER, France. 1999	11
	Le Danois bank	Instituto Español de Oceanografía (IEO), http://www.ecomarg.net/biodiversidad_en.html	Not given, only species list
	Lousy bank	M. Stehmann, pers. comm. ISH, Germany (Gordon, 1999)	60
	Porcupine seabight	Merrett et al. (1991a,b), Priede et al. (2010)	187
	Rockall trough	Gordon and Duncan (1985), Gordon, 1986, Gordon et al. (1996)	54
	Scotland slope	P. Lorance, pers. comm., IFREMER, France, 1999	13
SENA	Morocco	Merrett and Domanski (1985)	29
	W. Africa	Merrett and Marshall (1981)	64
WNA	Greater New England	Musick et al. (1992, 1996), Moore et al. (2003), Hartel et al. (2008) Museum of Comparative Zoology (MCZ), Harvard Univ., USA National Museum of Natural History (NMNH), Wash. DC, USA	Exact number not given. Species list extr. from checklist
	Newfoundland	Snelgrove and Haedrich (1985)	32
WSI	Bear seamount	Museum of Comparative Zoology (MCZ), Harvard Univ., USA Moore et al. (2003)	As for New England As for New England
BHSI	Bahamas	Sulak (1982)	199
AZSI	HRC seamount	G.M. Menezes, pers. comm., DOP, Univ. Azores, Portugal	51
	NW of Sedlo	G.M. Menezes, pers. comm., DOP, Univ. Azores, Portugal	1
	S. of Sedlo	G.M. Menezes, pers. comm., DOP, Univ. Azores, Portugal	3
	DMA seamount	G.M. Menezes, pers. comm., DOP, Univ. Azores, Portugal	19
	Sedlo seamount	G.M. Menezes, pers. comm., DOP, Univ. Azores, Portugal	142
	SW of Flores	G.M. Menezes, pers. comm., DOP, Univ. Azores, Portugal	2
	SW of Faial	G.M. Menezes, pers. comm., DOP, Univ. Azores, Portugal	7
MTSI	Great meteor seamount	Uiblein et al. (1999)	15
NMAR	Reykjanes ridge	Magnusson et al. (2000)	4635 (all areas around Iceland)
	MAR-ECO North	Bergstad et al. (2008)	11
SMAR	MAR South	Hareide and Garnes (2001)	113 (seamounts only)
	MAR-ECO South	Bergstad et al. (2008)	6
SEGR	SE Greenland	Möller et al. (2010)	Not given.
	Denmark Strait	Haedrich and Krefft (1978)	27
SWGR	SW Greenland	Möller et al. (2010) and Jørgensen et al. (2005)	263