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Larval fish abundance, composition and distribution at Senghor Seamount (Cape Verde Islands)

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3 **Larval fish abundance, composition and distribution at Senghor Seamount**
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6 **(Cape Verde Islands)**
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Abstract

The Cape Verdean Senghor-Seamount rises up to 93 m below the surface, and lies within the Cape Verde Frontal Zone (CVFZ), and within the southwestward North Equatorial Current (NEC). The seamount and its oceanic surroundings were surveyed with Multiple-Opening-Closing Net (MCN) fish larval catches, Issacs-Kidd-Midwater-Trawl (IKMT) micronekton hauls, and an analysis of some Conductivity-Temperature-Depth (CTD) data (RV Poseidon cruise no. POS 320/2). The thermal and saline stratifications showed widely symmetrical uplifts near the summit. The larval fish community was diverse ($H' = 2.656$) and composed mainly of larvae of meso- to bathypelagic species (91.5%). In IKMT 44.1% of the specimens originated from demersal parents ($H' = 3.296$), and mostly, albeit not entirely, from West African coastal waters, after advection along the CVFZ to and across this potential “stepping stone”. Gross larval fish abundance (median 35.5 specimens/1m²) and composition agreed well with historical literature data from adjacent waters and seamounts north of the CVFZ, whilst south of the CVFZ and towards NW-Africa reported abundances were higher. Vertical distributions of larvae which generally live at greater depths showed a rise above the seamount, following the hydrographic uplift, accompanied by “thinning-out effects” through bathymetric disturbance. The extent to which findings at Senghor Seamount are representative for small, shallow and steep seamounts in the tropical NE-Atlantic is discussed.

Keywords: Senghor Seamount, Cape Verde archipelago, fish larvae, micronekton, hydrographic disturbance, faunistic links

Introduction

Seamounts are of potential interest for fisheries (Kukuev, 1982 and 2004), or have already been exploited with temporary commercial success regardless of the vulnerability of deep-sea ecosystems (Koslow, 1997; Koslow et al., 2000; Large et al., 2003; Morato et al., 2004; Clark and Koslow, 2007). Although located in the deep sea, they are inhabited by a demersal ichthyofauna commonly associated with shelf and slope areas (Moore et al., 2004; Kukuev, 2004). However, these demersal fish species have been generally found to be rare in larval fish assemblages over seamounts (Boehlert and Mundy, 1993). Seamounts are also of interest for ichthyogeography as their demersal fish fauna can be interpreted with respect to faunistic linkages and dispersal (“stepping stones”, see, e.g., Wilson and Kaufmann, 1987; Moore et al., 2004; Monteiro et al., 2008).

Due to the difficulties in sampling rocky submarine rises (Hareide and Garnes, 2001), quantitative assessments or even inventories of the respective species composition are scarce (Arkhipov et al., 2004; Christiansen et al., 2009; Kukuev, 2004; Moore et al., 2004; Monteiro et al., 2008; Shcherbachev et al., 1985). Knowledge is somewhat better for meso- and bathypelagic fish associated with seamounts (Parin, 1986; Moore et al., 2004; Pusch et al., 2004; Porteiro and Sutton, 2007), and for fish larvae (Belyanina, 1984; Gordina, 1991; John, 2003; Nellen, 1973; Nellen & Ruseler, 2004).

Wilson and Kaufmann (1987) provided a first comprehensive review of biological seamount studies worldwide. More recent literature was summarized by Stocks and Hart (2007). McClain (2007; see also Christiansen and Wolff, 2009) reviewed the reliability of theories on seamount ecology, and revealed an overall lack of evidence for respective conclusions, and particularly for generalizations. Even earlier, Boehlert and Mundy (1993) pointed out limitations in previous studies, and concluded that especially small seamounts tend rather to disrupt the oceanic larval fish assemblage than to provide any ecological advantage.

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3 Senghor Seamount is a steep and narrow seamount on the northeastern periphery of the Cape
4 Verde Archipelago (Fig. 1), rising from depths of ca. 3.350 m to 93 m (DHI 1987). At the
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Senghor Seamount is a steep and narrow seamount on the northeastern periphery of the Cape Verde Archipelago (Fig. 1), rising from depths of ca. 3.350 m to 93 m (DHI 1987). At the nearest point, it is approximately 550 km from the African mainland and only 110 km from the nearest Cape Verdean shelf, Sal Island. The size of the seamount, as measured across the 1000 m isobath, is approximately 13.5 * 10.7 km, and across the 200 m isobath 5.4 * 2.8 km (<http://earthref.org/SBN/>).

Senghor Seamount lies within the North Equatorial Current (NEC), which is linked to the NW-African current system (Fiekas et al., 1992; Lathulière et al., 2008; Lázaro et al., 2005), as well as the Cape Verde Frontal Zone (CVFZ, Zenk et al., 1991; Lathulière et al., 2008). In midwater up to the thermocline, the CVFZ separates nutrient-poor and oxygen-rich North Atlantic Central Water (NACW) in the north (respectively, west), from nutrient-rich and oxygen poor South Atlantic Central Water (SACW) in the south (Klein, 1992; Siedler and Onken, 1996). The area southeast of the CVFZ is a cyclonic “recirculation gyre” with a shallow nutricline (Lathulière et al., 2008), oxycline, and biogeographic peculiarities in mesopelagic fish (Backus et al., 1977; John and Zelck, 1997). Below the central waters, Mediterranean Outflow Water reaches its southernmost extension (Zenk et al., 1991). The islands coincide, partly, with a boundary between tropical eastern Atlantic and Atlantic-Mediterranean fish faunae, but also show faunistic links to the West African coast, the Gulf of Guinea, and even the tropical West Atlantic (Briggs, 1974 and Lloris et al., 1991 for adult fish; John and Zelck, 1997 for the interdependence of larval fish distribution and hydrography). Most recent inventories of the Cape Verdean fish fauna were compiled by Lloris et al. (1991), and Reiner (1996) from historical data, and by Vakily et al. (2002, for the archipelago largely based on Reiner’s book). The Cape Verde archipelago has been much less explored ichthyologically than other Atlantic islands further north.

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3 We aimed to assess the influence of bottom topography and physical environment on the
4 pelagic and larval fish communities above and near the Senghor Seamount by conducting a
5 zooplankton/micronekton survey across its summit. By comparing its faunistic inventory with
6 data from adjacent oceanic areas and seamounts, some potential seamount effects should be
7 revealed. We herewith present a quantitative data set entirely new for the Senghor Seamount,
8 and, to a lesser extent, for the Cape Verde Archipelago.
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20 **Method**

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22 A total of nine IKMT-trawls, eight Multinet tows and nine CTD casts were conducted across
23 the summit of Senghor Seamount with the RV Poseidon (Cruise Number PO320/2) from 13 to
24 17 April 2005 (Fig. 1). Micronekton was sampled with an Isaacs-Kidd Mid-water Trawl
25 (IKMT) with a 6 m² net-opening, 4 mm mesh-size and equipped with a flowmeter. It was
26 towed at approximately 1.5 m/s plus wire speed of 0.5 m/s in double-oblique paths from 0 to
27 200 m and back to the surface, but to 130 m only at the shallower summit station. The nine
28 tows had an average swept area of 128.4 m² ± 21.0 and were all performed in daylight.
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38 Depth-stratified zooplankton sampling was conducted with a Hydro-Bios Multinet (MCN) of
39 0.5 m² mouth opening and 335 µm mesh size, equipped with an external and internal
40 flowmeter. It was towed at approximately 1.0 m/s, with opened Net 1 lowered to 250 m depth,
41 and then hauled up with Nets 2 to 8 fishing up to the surface in up to 7 different strata. Only at
42 Summit Station # 6 did sampling start 10 m above ground, i.e. at 100 m. Sampling intervals
43 were always constant, with 50 m strata below 100 m depth, and 25 m strata above 100 m.
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Wire speed at retrieval was 0.5 m/s. Catch per volume data were originally calculated for each
individual stratum and converted to catch per 1 m². Abundances were subsequently integrated
(except for vertical distribution) to the entire depth range, as recommended by Ahlstrom
(1973). The actual mean sample size was large at 5.3 m² ± 1.79; with N = 52 samples. MCN
haul No. 4 was made in the early evening, all other hauls during daylight hours.

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3 Catches were immediately preserved in buffered 4 % formaldehyde solution, except for single
4 specimens separated and stored in ethanol for subsequent DNA barcoding purposes.
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8 Whenever possible, all fishes caught were identified to the species level.
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12 CTD, O₂ and chlorophyll data were obtained by a Seabird 911 in 1 m-increments, downcast
13 only, starting from below the surface to 250 m (116 m at the summit station). In T/S and T/O₂
14 plots near-to-surface salinities and oxygen-data (less frequently temperature) were spiky.
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17 Therefore S and O₂ data from the upper 20 m were discarded and respective temperatures
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22 were used only when stable.
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25 Station dots in Fig. 1 refer to CTD-positions. IKMT and MCN tows differed slightly in
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27 position from CTD. To facilitate the presentation of biological data, we ordered the
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29 geographical longitudes for each sample individually, while maintaining the integrity in date
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31 and time of the respective stations. Thus biological data are projected onto an artificial line,
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34 from west to east for stations 1 to 10. As a consequence bottom-profiles vary somewhat
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36 between the types of measurements.
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41 Due to the large differences in swept area, numbers of fish caught (Tables 1, 2 and 3; Fig. 4)
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43 and size of fish retained by mesh-size (Table 4), IKMT and MCN catches cannot be
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45 statistically compared (Whittaker, 1975).
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51 Agglomerative hierarchical cluster analysis was used to differentiate and group the eight
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53 MCN samples according to their ichthyoplankton composition (70 different taxa). Vertical
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55 stratification was not considered. Species abundances at stations were arranged in an (m x n)-
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57 matrix with m representing the abundances (individuals/m²) of the 70 taxa and n representing
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59 the 8 samples. We used the Jaccard Index to measure the similarity between all possible
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sample pairs in the matrix. The index considers only the presence or absence of taxa in the

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3 samples to assess the similarity between the samples. The samples were then plotted in a
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5 dendrogram according to their degree of similarity starting with the two samples which
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7 showed the highest similarity. The clustering of samples followed the group average method.
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9 Clustering and univariate analysis of diversity (Shannon-index) and evenness (Pielou-index)
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11 were performed with the PRIMER 5 software (Clarke and Warwick, 2001).
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17 Mean vertical distributions of fish larvae were calculated from abundances per stratum and
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19 square meter for the 12 most abundant taxa as mean-weighted depth $MWD = \sum (n_i * d_i) * N_i^{-1}$
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22 ¹, with n_i being the abundance in stratum i , d_i the mean depth of stratum i , and $N_i = \sum n_i$.
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27 For distributions and habitat classifications we refer to the respective summaries in FNAM
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29 (1986) and CLOFETA (1990). Bathymetrically, we here simplify benthic habitats shallower
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31 than 200 m as “shallow”, and those deeper than 200 m as “slope”. We compiled, and partly
32
33 recalculated, comparative data from other East Atlantic submarine rises. Since these original
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35 data resulted from extremely different types of samples and standards of quantification, for
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37 reasons of space we refer to the respective discussion in John (2003).
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42 43 **Results**

44 45 *Hydrography*

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47 Perpendicular sections of temperature and salinity across the seamount are shown in Fig. 2. A
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49 thermocline, exemplified by isotherms 22 – 16°C, was wide vertically, between 40 and 120 m
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51 depth in the southwest, and with a slight ascent towards the northeast in Transect A. At the
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53 northwestern stations of Transect B the thermocline was approximately 20 m deeper, but with
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55 very little ascent towards the southeast. Salinity increased from near-surface waters to a
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57 salinity maximum ≥ 36.5 within the thermocline, decreasing again below it to values < 36.0 .
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60 This intermediate salinity maximum revealed a slight ascent southeastwards. As reviewed by

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3 Martínez-Marrero et al. (2008) the depth of 150 m for $S = 36.0$ at Senghor Seamount is
4 indicative of the position of the CVFZ. Isolines of temperature and salinity showed an uplift
5 of some 20 to 40 m. Oxygen values in subsurface waters were generally > 3.5 ml/l.
6 Thermocline waters showed values > 2.0 ml/l. Below it, oxygen decreased to minimum values
7 of 1.3 ml/l at 250 m depth. CHL decreased from subsurface waters with 0.65 to 0.5 at about
8 50 m depth, and to values $> 0.1 < 0.2$ below 90 m depth. T/S- and T/O₂ values (not illustrated)
9 were between the definitions of NACW and SACW at subthermocline depths of all stations,
10 corresponding to the local definition of the CVFZ (Klein, 1992).
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13 Before and during the survey the ship's log recorded almost constant trade-wind conditions
14 from NE with 7 to 15 m/s. We assume therefore that the general current direction was towards
15 the southwest, as reviewed by, e.g., Lathulière et al. (2008: Fig. 1).
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22 *Fish larvae and micronekton*

23 *Faunistic composition*

24 The species compositions of IKMT- and MCN catches are presented in Tables 1 and 2. Based
25 on an identical taxonomic resolution, these tables show 25 common taxa. The gross IKMT
26 catch was very low (68 specimens, 37 species), with 0 to 14 specimens and 0 to 12 species per
27 haul (Fig. 3, left y-axis). Six IKMT samples down to 500 m depth near the Cape Verdean
28 islands Fogo and Brava yielded 779 specimens and 80 species (unpublished data from the
29 same cruise). It is therefore likely that the IKMT catches at Senghor did not sample the
30 daytime depths of adult mesopelagic fish, and that their larvae were not retained by the much
31 coarser meshes.
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34 The numbers of taxa versus specimens per haul (Fig. 3) increased steeply, and almost linearly
35 ($p < 0.005$), indicating that we sampled only minor parts of the assemblages. Even when
36 cumulated in order of ascending station numbers (Fig. 3) predictions from these curves would
37 remain far below the number of species recorded from the archipelago so far (Reiner, 1996:
38 570 species).
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3 The majority of the fish larvae caught by the MCN (total catch: 1461 larvae, 76 taxa)
4 originated from meso- and bathypelagic parents (Table 3). This part of the community was
5 composed mostly of ubiquitous as well as subtropical species, although tropical species like
6 *Bathylagus argyrogaster*, *Vinciguerria nimbaria*, *Ceratoscopelus warmingi*, and *Hygophum*
7 *macrochir* were abundant as well. Few *Ceratoscopelus maderensis* were caught. Oceanic
8 epipelagic larvae were generally rare. At downcurrent Station #2 larvae from shallow living
9 benthic parents and from slope habitats contributed 8 taxa and 10 specimens, and seamount
10 stations showed minimum lengths for Gobiidae and Macruridae (see Table 4).
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19 IKMT catches had a much larger proportion (44.1%) of benthic species. Most of them were
20 eel leptocephali, also caught upcurrent of the Senghor-Seamount. Wide-eyed flounder (*Bothus*
21 *podas*) and single specimens of other benthic species occurred upcurrent and downcurrent of
22 the seamount. The species, occurrences and lengths of larvae originating from benthic parents
23 are listed in Table 4, in order to estimate whether the larvae were native to the seamount, or
24 entrained from elsewhere. The estimation of a larvae being native or of unknown origin was
25 based on developmental stage and body length. Preflexion larvae were considered to be
26 native, postflexion until settlement-length larvae as uncertain. Gobiidae, Macruridae,
27 Scorpaenidae, and the single specimens of Notacanthiformes, Moridae and Scaridae were
28 therefore considered to be native, while *B. podas* and the neritic eels *Ariosoma balearicum*,
29 *Chlopsis bicolor*, *Chlopsis olokun*, *Dalophis sp.* were regarded as originating from the West
30 African coast.
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41 Among the mesopelagic community, larval myctophid percentages did not display any
42 evident relation to bottom depth (all percentages in Table 3 refer to total catch). The complex
43 of gonostomatid, photichthyid families and the sternoptychid subfamily Maurolicinae
44 contributed on average 17.6% to MCN stations, with a minimum value at the shallowest
45 Station #6. This complex was lumped together as “Gonostomatidae” by Grey (1964), found to
46 be a faunistic indicator (Loeb, 1979, and literature cited therein; John and Zelck, 1997), and
47 pooled by us accordingly. Linked with the higher proportion of benthic species in IKMT (plus
48 the catchability limitations mentioned above), micronektonic myctophids and gonostomatids
49 showed lower percentages in MCN than their larvae. However, MCN abundance values per
50 square meter of more abundant myctophid and gonostomatid taxa differed significantly with
51 bottom depth in that there was a numerical decrease above the seamount for deeper
52 distributed sternoptychid and some myctophid larvae (see also Fig. 5).
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Community structures

A summary of gross abundances and community structure parameters is presented in Table 3. Gross IKMT diversity H' was 3.296 and evenness (Pielou index) J' amounted to 0.920. It should be noted that in IKMT catches most specimens could be identified to species level. The lumping of two sternoptychid species and the discarding of unidentified myctophids, as done for MCN-identification, leads to a total of 35 taxa ($H' = 3.266$; $J' = 0.919$).

Diversity and evenness values were high and fairly similar for the MCN samples (Table 3), but lower than calculated from the pooled IKMT hauls. Lowest numbers of species and abundances, and smallest lengths of seamount-native Gobiidae, were encountered at summit Stations 5 and 6. However, there is no significant correlation between the statistical MCN averages (abundance and species richness) and bottom depth ($R^2 \leq 0.1319$).

Cluster analysis of MCN samples revealed 4 groups (Fig. 4), but their separation was not very strong. The downcurrent Station 2 deviated from all other stations. It was characterized by more demersal taxa (8) and specimens (10) and was most similar to seamount Station 5 which showed a low percentage of myctophids, and a relative maximum of "Gonostomatidae". The two upcurrent Stations 1 and 10 proved to be most similar in taxonomic composition of oceanic mesopelagic taxa, and the presence of few larvae of neritic parents (Tables 3 and 4). The remaining seamount stations had similar specific abundances, with the presence of some few small larvae of demersal adults. The empirical analysis of IKMT demersal species (Table 4) showed the very same groupings.

Vertical distributions

Mean weighted depths and specific abundances have been calculated for the 12 most abundant taxa, and each MCN station. Abundance values of these 12 taxa showed largest

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3 deviations for the two shallowest stations (sequential numbers 5 and 6). Among the
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5 remainder, the fewest mesopelagic taxa were found at the easternmost position (83%, no. 10,
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7 see also Table 3). For a better legibility, results on depth distribution relative to the seamount
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9 are presented for only 8 of the taxa in Fig. 5, while overlapping medium-deep distributed
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11 *Notolychnus valdiviae* (mean MWD 69.2 m), *Vinciguerria nimbaria* (54.8), *Notoscopelus*
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13 *resplendens* (51.3) and subsurface living larvae of genus *Diaphus* (37.2 m) were omitted.
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15 These four (not illustrated) taxa corresponded with the illustrated ones in that they
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17 disappeared, or became scarce, at the sequential Stations # 5 and 6 at shallow bottom depth.
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25 Discussion

26 27 28 29 *Hydrographic implications*

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31 TS-characteristics and oxygen-concentration of the lower range of our CTD-measurements
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33 were fairly close to the SACW definition for the CVFZ-area, while thermocline and surface
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35 water masses showed an admixture between NACW and SACW (Klein, 1992). Senghor
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37 Seamount itself showed $S = 36.0$ at 150 m depth, characteristic for the CVFZs position
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39 (Martínez-Marrero et al., 2008). The pycnocline showed a slight ascent towards NW Africa,
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41 caused by the North Atlantic's large scale circulation (Olbers et al., 1985), but the cross-front
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43 transect did not extend into the gyral structure southeast of the front. This, together with the
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45 stable tradewind conditions prior to and during the survey, suggests that in the upper 250 m at
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47 Senghor, the general flow was NEC towards the southwest (Fiekas et al., 1992; Lathulière et
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49 al., 2008; Lázaro et al., 2005; Siedler and Onken, 1996), in continuation with the Canary
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51 Current (same references). The downcurrent distance from shelf waters at Cape Blanc (NW
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53 Africa), and respectively CVFZ waters off Cape Timiris (Klein, op. cit, Lathulière et al., op.
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55 cit.), to Senghor-Seamount is approximately 610 km. Lathulière et al. (2008) based their
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57 "recirculation gyre", southeast of the CVFZ, on literature data obtained during strong wind
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3 conditions in the 1970s. However, this gyre (called “Mauritanian Province” on the basis of
4 oxygen and fish larval data, John and Zelck, 1997) is smaller during weak wind conditions
5 (John and Zelck, 1997; Martínez-Marrero, op. cit.), and apparently also during the survey
6 described here. Historical biogeographical data suggest a link of the Cape Verde Archipelago
7 with the Gulf of Guinea (Briggs, 1974; Lloris et al, 1991). Based on more recent hydrographic
8 literature and distributional data of equatorial fish larvae, John et al. (2000) considered that a
9 branch of the Guinea Undercurrent follows the African continental margin northwards (as
10 postulated by Hagen and Schemainda, 1984), and that the Guinea Dome causes deflections of
11 both the North Equatorial Undercurrent (NEUC) and the North Equatorial Countercurrent
12 (NECC, Hagen and Schemainda, 1984; Mittelstaedt, 1991; Siedler et al., 1992). Both currents
13 correspond with the larval depth ranges (John et al., 2000). These deflections reach the Cape
14 Verde Islands, and can cross the CVFZ by filaments north of these islands (Hagen and
15 Schemainda, 1987; Klein, 1992; Martínez-Marrero et al., 2008). The model of Lathulière et
16 al. (op. cit.) shows that linkage of the Mauritanian upwelling area with the CVFZ, albeit
17 neither a connection with the Gulf of Guinea, nor any cross-CVFZ transport. Our data set
18 includes the tropical indicator species *Bathylagus argyrogaster* and *Hygophum macrochir*.
19 Adults of both species have their northeastern boundaries at the Cape Verde Islands, but their
20 larvae become entrained beyond the boundaries of adults (John et al., 2000). The distribution
21 of tropical *Vinciguerria nimbaria* also corresponds with advection from equatorial waters in
22 this transport model. *V. nimbaria* and *H. macrochir* had extended their range northwards in
23 the 1990s as far as the Canary Islands (John et al., 2004). *Cyclothone*, *Diogenichthys*
24 *atlanticus*, *Notolychnus valdiviae*, Sternoptychidae can be considered as ubiquitous outside of
25 the Mauritanian upwelling (Bekker et al., 1982; John and Zelck, 1997), but the Mauritanian
26 gyre’s oxygen deficit limits their successful reproduction (John and Zelck, 1997).
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3 As shown by Fig. 2, the Senghor-Seamount caused an uplift in temperature and salinity (and
4 consequently density) above and around its summit. Due to the lack of CTD-casts above
5 seamount depths of 1000 to 2000 m (and lack of any data below 250 m) the vertical and
6 horizontal scale and nature of respective symmetrical structures remains unknown. The
7 disturbance could have been caused by waves, describing a cyclonic gyre (which would not
8 be a retention system, except in its very centre), or a topographically enforced meandering
9 (Roden, 1987), or a Taylor-cap (Boehlert and Genin, 1987; White and Mohn, 2004:
10 “anticyclonic”; Mullineaux and Mills, 1997: “retention system”).
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25 *Species richness and diversity*

26 Larval and micronektonic species composition were found to be highly diverse, and stations
27 turned out to be rather dissimilar overall despite an obvious undersampling of both sampling
28 gears. To allow for some comparisons of abundance and taxa richness, we tabulated extracted
29 (partly recalculated) values from earlier publications on tropical and subtropical East Atlantic
30 seamounts and rises (Table 5). The highest taxa richness was recorded by Nellen and Ruseler
31 (2004: 150 species), which is the most intense seamount study known to us, considering
32 sample number, individual sample size (1 m² sampler; also used by Lopes, 1983), spatial
33 coverage, depth range, and taxonomical resolution. The high taxa richness observed by Nellen
34 and Ruseler was furthermore caused by the high proportion of neritic species (14%) on the
35 much larger Meteor Seamount. In contrast, lowest values in Table 5 resulted from either few
36 catches with a 20 cm Bongo net (Arkhipov et al., 2004: 3 to 10 samples per area), or depth-
37 restricted vertical tows (some of the data by Gordina, 1991) and seem to underestimate
38 abundance as well as taxa richness (John, 2003).
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57 Altogether 88 taxa were collected in this study with both gear types. Twenty-five of them,
58 mostly myctophids, have not been listed for the archipelago previously (Lloris et al., 1991;
59 Reiner, 1996; Vakily et al., 2002). Literature on species composition in the few and small
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3 bottom trawls, or longline sets, conducted, consistently points to a far more diverse Cape
4 Verdean ichthyofauna than currently listed (Danke and Koch, 1987; Menezes et al., 2004;
5 Strømme et al., 1984), indicating the need of a more comprehensive future study. It is obvious
6 from the ratio of taxa richness versus number of specimens per sample that only a fraction of
7 the species actually present at Senghor Seamount could be caught in this study.
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14 The larval fish species composition listed in Table 2 is fairly similar to that of “Polygon I”
15 south of the Cape Verde Islands (Gordina, 1986: 60 species), except for the scarcity of
16 hatchetfish (Sternoptychidae) resulting from sampling only the upper 100 m, and the
17 occurrence of a few “northern” *B. glaciale* during winter. Also fairly similar were Gordina’s
18 more southeastern species inventories (Polygons II – VI), which yielded from between 30 to a
19 maximum of 51 species, but 63 off Sierra Leone (Polygon VII, maximum catch with lowest
20 similarity to Polygon I). Gordina’s respective “abundance” data are total catches, diversity
21 values were also calculated differently from ours. Our species list is also similar to those for
22 the Sierra Leone Rise (Gordina, 1991; John, 2003), both for oceanic and neritic taxa
23 according to the dominance of myctophids. Similarly, larvae of neritic parents contributed
24 only 1 to 2% to single samples, and occurred both upcurrent and downcurrent of the rise.
25 Genin and Dower (2007) considered the relatively high abundance of neritic ichthyoplankton
26 at Meteor Seamount to be “an exception rather than the rule”, and that seamount
27 ichthyoplankton is generally dominated by “cosmopolitan oceanic taxa”.
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50 The above-mentioned study from Mauritania to Sierra Leone (John and Zelck, 1997) included
51 cold water coastal species of the Mauritanian upwelling area not occurring at the Cape Verde
52 archipelago. Nellen and Ruseler’s species list for the more northern Meteor Bank (2004)
53 resembles ours for ubiquitous taxa and even some of our tropical mesopelagic species, but
54 differs again in the presence of cold water and temperate neritic species. For the study
55 presented here, the paucity of *Ceratoscopelus maderensis* (adult *C. maderensis* is confined to
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3 Mediterranean Outflow Water, terminating at the CVFZ (Zelck and Klein, 1995)) and
4
5 disappearance of *Benthosema glaciale*, replaced by the tropical congeners *C. warmingi* and *B.*
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7 *suborbitale* (see Hulley, 1981), are indicative for the faunal change associated with the CVFZ,
8
9 although the distributions of *Benthosema* species seem more likely to be related to
10
11 temperature alone (*B. glaciale* is abundant in the Mauritanian upwelling in spite of the high
12
13 proportion of SACW there (Nafpaktitis et al., 1977)). Gross abundances of 27 to 52 fish
14
15 larvae per square meter found during our study (Table 3) are common for the subtropical and
16
17 tropical East Atlantic west of, and within the CVFZ, whilst off Mauritania and off Sierra
18
19 Leone abundance values increased significantly to $> 100/\text{m}^2$ at the ascent of the oxycline and
20
21 nutrients to 50 m depth (John and Zelck, 1997; John, 2003). Neritic specimens at Meteor
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23 Seamount (Nellen and Ruseler, 2004: 9.6 % of all specimens) did not result in abundances
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25 increasing noticeably (Table 5).
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34 ***Larval dispersal, implications for a stepping stone hypothesis***

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36 Although widely distributed as adults, their small lengths suggest that the larval gobiids,
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38 macrurids, scorpaenids and the single notacanthiform *Leptocephalus giganteus*, morid and
39
40 scarid were native to the seamount. Gobies even showed the expected tendency to increase in
41
42 size downcurrent by 3 to 5 mm. *Chromis lubbocki* is a Cape Verdean endemic species, and 2
43
44 specimens at downcurrent Sta. #2 were postflexion larvae and only 6 mm long. These larvae
45
46 therefore did not originate from Africa, but were probably native to the seamount. However,
47
48 this would imply that *C. lubbocki* did breed at depths of broadly 100 m. Allen (1991) stated
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50 for *C. lubbocki* a depth range of 0 – 15 m, most congeners breed in shallow water < 50 m
51
52 (Breder and Rosen, 1966; Allen, 1991; although Allen (op. cit.) noted that some exceptional
53
54 species live at up to 135 m depth). It would imply also that one larva of 11 mm SL had
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56 remained above the seamount, or had returned to it, and that three larvae 6 – 10 mm SL had
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58 drifted up to 30 km southwestwards. If the doming of the hydrographic structure at the
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3 seamount's summit had been caused by a cyclonic surface circulation, it would have
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5 dissipated larvae, but an anticyclonic circulation within the thermocline would have retained
6
7 them near the summit. Assumptions on drift and "active homing" seem possible in light of
8
9 recent findings on directional and swimming capabilities of larvae from eight pomacentrid
10
11 species investigated (Leis et al., 2007). These authors found that larvae larger than 10 mm of
12
13 seven of these species (including one congener of *C. lubbocki*) were able to counteract current
14
15 dispersal by swimming speed, orientation, and endurance. *Chromis* larvae of 6 mm length
16
17 should have lived approximately 2 weeks in pelagic waters and been swept downcurrent, the
18
19 two remainders 10 and 11 mm long should have been near settlement length after a pelagic
20
21 phase of 3 to 4 weeks (growth data for congeners from Kavanagh and Alford, 2003).
22
23 According to Leis et al. (2007) such larvae of 10 mm SL can swim more than 8 km per day.
24
25
26 The juvenile, demersal perciform taxa *Antigonia capros*, *Aphanopus carbo*, *Trachurus*
27
28 *picturatus* caught above the seamount (Table 4) are common inhabitants of seamount and
29
30 slope biota. It is uncertain whether they were native to Senghor, or advected from elsewhere.
31
32 Adults of the anguilliform larvae listed in this table all occur in shallow waters of tropical
33
34 West Africa, but with uncertainties whether these adults also occur in the Cape Verde Islands.
35
36 *Ariosoma balearicum* was listed only by Lloris et al. (1991), but not by Vakily et al. (2002).
37
38 *Chlopsis bicolor*, *Chlopsis olokun* and *Dalophis* sp. remained completely unlisted for the
39
40 archipelago so far. However, there were such records for larval *A. balearicum* and *Ch. bicolor*
41
42 in Castle (1966), and the above-mentioned record by Lloris et al. was, in our opinion, based
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44 on Castle. These leptocephali were in the upper size range where they transform to juveniles
45
46 (data from Castle, 1970; Blache, 1977). The absence of any small larvae of these eels, or
47
48 small *Bothus* larvae, makes us assume that the origin of these larvae was in continental
49
50 waters. Leptocephali of these species and *Bothus* larvae commonly occur in the open ocean,
51
52 far away from any coast (for eels: Castle, 1966 and 1970; Blache, 1977; John and Zettler,
53
54 2005; and for Bothidae: Evseenko, 1982; Gordina, 1986). Evseenko (2008) demonstrated that
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3 African *B. podas* disperses westwards beyond the Cape Verde Islands, but does not reach the
4
5 American continent, whilst American congeners can cross the ocean eastwards due to
6
7 decreasing, instead of increasing, temperatures. Large scale southward transport of larvae of
8
9 Mediterranean-Atlantic species with the Canary Current was exemplified for leptocephali by
10
11 Castle (1966 and 1970), and for *Macrorhamphosus scolopax* by John (1979; respectively
12
13 Andres and John, 1984 for west of the Cape Verde Islands). At the root of the CVFZ near
14
15 Cape Timiris the transport of shallow living neritic larvae is westwards, and for a weak-wind
16
17 period of three months transport velocities were measured by current meters as well as by
18
19 larval growth data to be on average 4 to 11 km/d (John et al., 1991). This zonal transport
20
21 within the CVFZ, turning more meridionally farther south, is part of the Mauritanian Gyre's
22
23 cyclonic circulation (Mittelstaedt, 1991; John and Zelck, 1997; Lathulière et al., 2008) and
24
25 probably added the mentioned tropical neritic elements to the Senghor fauna.
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34 ***Larval vertical distribution***

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36 Early information on larval fish vertical distributions originated from temperate coastal
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38 waters, or the Californian upwelling area, with shallow thermocline, and led to the assumption
39
40 that few larvae occur below 125 m depth (Ahlstrom, 1959). Respective specific data from the
41
42 subtropical and tropical open ocean are still scarce. From the taxa dealt with in our results
43
44 section, sternoptychid hatchet fish larvae were hardly mentioned in earlier literature, due to
45
46 sampling waters mainly above 200 m depth (Gorbunova, 1977; Gordina, 1991; John and
47
48 Zelck, 1997; John et al., 2001; but contrary to Badcock and Merrett, 1976, who sampled down
49
50 to 1000 m depth).
51
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54
55 For the other taxa, the relative vertical segregation we found corresponds to other literature in
56
57 that *Ceratoscopelus spp.*, *Cyclothone*, *Diaphus* live in shallow water above the thermocline
58
59 (Ahlstrom, 1959; Badcock and Merrett, 1976; Gorbunova, 1977; Zelck, 1993; John and Zelck,
60
1997; John et al., 2000 and 2001). *V. nimbaria* is temperature-sensitive, submerging with the

1
2
3 temperature range 20 – 25°C. *Benthoosema suborbitale*, *D. atlanticus*, *H. macrochir*, *M.*
4
5
6 *nitidulum*, *Notolychnus valdiviae*, *Notoscopelus resplendens* and Paralepididae live medium
7
8 deep in thermocline waters. Their depth distribution thus follows the regionally changing
9
10 depth of the thermocline, comparatively deep in CVFZ and NACW-waters (these data;
11
12 Badcock and Merrett, 1976; John and Zelck 1997; Nellen and Ruseler, 2004; Rodríguez et al.,
13
14 2006), the Central Pacific (Gorbunova, 1977), shallower in the NW African upwelling area
15
16 (John, 1985; John and Zelck 1997; Rodríguez et al., 2006), and also in more southern SACW-
17
18 waters with an extremely shallow thermo- and oxycline (John et al. 2001; John, 2003: gross
19
20 data). Comparative data for the areas off the coast of Brazil and from the Central South
21
22 Atlantic towards Angola suggest that the mentioned myctophid larvae lived off the coast of
23
24 Brazil even below the sampled maximum (and thermocline) depth below 200 m (John and
25
26 Zelck, 1998). The seamount effect observed by us in that medium-deep, but generally above
27
28 and at summit's depth living larvae occurred shallower above the summit by some 20 to 30 m
29
30 can also be found in Nellen and Ruseler's (2004) two-groups averaged data at Meteor
31
32 Seamount for *Cyclothone*, *Diaphus*, *Lampanyctus alatus*, and *Vinciguerria* (species
33
34 unidentified). We believe that the shallower vertical distribution above the summit we
35
36 observed followed the ascent of the thermocline. Nellen and Ruseler (op. cit.) interpreted this
37
38 difference as an anticyclonic downwelling effect at the seamount slope. Mohn and Beckmann
39
40 (2002) described such downwelling effects on the basis of synoptic CTD-data with high
41
42 spatial resolution at the seamounts slope (but only a single station besides the seamount), and
43
44 a numerical model of tidal forcing. These authors expected "isolation to some degree" inside
45
46 of the downwelling ring, which, together with the larger size of the plateau, can explain the
47
48 higher diversity and abundance of bottom living fish there. Meteor Seamount (about 330 m
49
50 deep) is much deeper than Senghor Seamount, and thus interferes less with the daytime depths
51
52 of adult mesopelagic fish. Nevertheless, "thinning out effects" for such adults at Meteor and
53
54 Atlantis Seamount (250 m) were shown by Pusch et al. (2004) and Diekmann et al. (2006)
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3 and could also have occurred at Senghor, explaining the poor abundance, deviating species
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5 composition, and elevated diversity in our IKMT-material.
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10 **Conclusions**

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15 The Senghor Seamount lies in the Cape Verde Frontal Zone. The fish larval community is
16
17 highly diverse, myctophid dominated, and with lower gross abundance than areas closer to the
18
19 African coast. The following seamount effects were observed:
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21

- 22 • Senghor Seamount (and probably other shallow seamounts within the Canary/North
23
24 Equatorial Current) causes a topographical disturbance in the hydrographic structure.
25
26 Due to the limited spatial resolution of our CTD-measurements, the nature and
27
28 extension of this disturbance remains unknown.
29
30
- 31 • Senghor Seamount (and probably other seamounts reaching into the pycnocline)
32
33 causes an uplift of vertical distributions for fish larvae living deeper elsewhere, and a
34
35 “thinning out effect” for them.
36
37
- 38 • Such a “thinning out effect” is likely to occur there and elsewhere also in mesopelagic
39
40 micronekton, but could not adequately be analysed due to our too shallow catches.
41
42
- 43 • Senghor Seamount’s larval fish community (and similarly that of other small
44
45 seamounts investigated so far) has only a small percentage of larvae originating from
46
47 demersal parents. The much larger Meteor Seamount seems to be exceptional in this
48
49 respect.
50
51
- 52 • Senghor Seamount is crossed by large scale transport of fish larvae from NW African
53
54 coastal waters, via the flow along the Cape Verde Frontal Zone. Senghor Seamount
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56 thus may serve as “stepping stone” for such coastal species. However, this stepping
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58 stone is not absolutely necessary to colonize the Cape Verde Archipelago, since the
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60 next island is only 110 km further downcurrent.

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- The small diameter and “ideal shape” of the tall and shallow Senghor-Seamount make it an ideal subject to study several of the questions still left open in this study. A minimum of 14 oceanographic stations, with improved spatial resolution, would be appropriate. The oceanic environment distinctly up- and downcurrent of Senghor should again be included. Time series would be needed to test the retention, respectively “homing,” hypotheses.

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21
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23
24
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For Peer Review

Table 1: List of species identified from IKMT-samples at Senghor-Seamount.

Taxon	IKMT N total	Taxon continued	IKMT N total
<i>Antigonia capros</i>	1	<i>Hygophum taaningi</i>	1
<i>Aphanopus carbo</i>	1	Labridae/Scaridae	1
Apogonidae?	1	Melamphaeidae	1
<i>Ariosoma balearicum</i>	1	Muraenidae Leptocephalus	1
<i>Benthoosema suborbitale</i>	1	<i>Myctophum asperum</i>	1
<i>Bothus ?podas</i>	5	<i>Myctophum nitidulum</i>	1
<i>Ceratioidei/Centrophryne/Oneirodes</i>	2	<i>Nannobranchium</i> sp.	1
<i>Chauliodus danae</i>	2	<i>Nemichthys</i> Leptocephalus	4
<i>Chlopsis ?bicolor</i>	1	<i>Notoscopelus resplendens</i>	6
<i>Chlopsis olokun</i>	9	Notosudidae=Scopelosauridae	1
<i>Chromis lubbocki</i>	2	Scopelarchidae indet.	1
<i>Dalophis</i> sp.	2	Scorpaenidae (<i>Pontinus</i> ?)	1
<i>Diogenichthys atlanticus</i>	2	Sternoptychidae	3
<i>Diplospinus multistriatus</i>	1	<i>Taractes rubescens</i>	1
<i>Eurypharynx pelecanoides</i>	1	<i>Trachurus picturatus</i>	1
<i>Gonostoma atlanticum</i>	1	<i>Vinciguerria nimbaria</i>	2
<i>Gonostoma denudatum</i>	1	<i>Vinciguerria poweriae</i>	2
<i>Hygophum macrochir</i>	1		
		Gross	67

Table 2: List of identified taxa, their gross abundance, and frequency of occurrence in MCN. Occurrences refer to the 52 individual strata. For multivariate analysis, regroupings of some taxa to lower taxonomic categories have been made as follows: - taxon and its abundance discarded from analysis. + taxon lumped into a lower category, abundances cumulated. * Lumped category used for analysis.

Taxon	Comment for statistics	Total catch MCN	Frequency in MCN	Taxon (continued)	Comment for statistics	Total catch MCN	Frequency in MCN
Argentinoidei indet.	-	1	1	<i>Loweina rara</i>		2	2
Astronesthidae indet.		2	2	Macruridae indet.		4	4
<i>Bathylagus argyrogaster</i>		20	9	Melamphaeidae indet.		8	5
<i>Bathylagus bericoides</i>		14	9	Melanostomiatidae indet.	+	8	2
<i>Bathylagus longirostris</i>		3	3	Moridae indet.		1	1
<i>Benthalbella infans</i>		3	2	Myctophidae indet.	-	49	16
<i>Benthoosema suborbitale</i>		33	18	<i>Myctophum affine</i>		8	3
<i>Bothus podas</i>		1	1	<i>Myctophum asperum</i>		3	2
Bramidae indet.		5	3	<i>Myctophum nitidulum</i>		34	13
<i>Centrobranchus nigrocellatus</i>		1	1	<i>Nannobranchium atrum</i>		14	10
<i>Ceratoscopelus maderensis</i>		20	2	<i>Nannobranchium niger</i>		1	1
<i>Ceratoscopelus warmingi</i>		184	14	<i>Nannobranchium indet./other</i>	-	1	1
<i>Chauliodus danae</i>		12	8	<i>Nansenia c.f. pelagica</i>		1	1
<i>Chauliodus schmidti</i>		10	5	<i>Nemichthys scolopaceus</i>		2	2
<i>Chromis lubbocki</i>		2	1	Notacanthiformes <i>L. giganteus</i>		1	1
<i>Coryphaena indet.</i>	*	2	1	<i>Notolychnus valdiviae</i>		33	15
<i>Coryphaena equiselis</i>	+	1	1	<i>Notoscopelus resplendens</i>		43	14
<i>Cyclothone indet.</i>		42	16	<i>Omosudis lowei</i>		1	1
<i>Diaphus indet.</i>		50	14	<i>Paradiplospinus gracilis</i>	+	1	1
<i>Diogenichthys atlanticus</i>		241	33	Paralepididae indet.	*	29	15
<i>Diplospinus multistriatus</i>	+	3	3	<i>Paralepis brevis</i>	+	1	1
Gempylidae indet.	*	2	2	Perciformes indet./other		6	4
<i>Gigantactis sp.</i>	+	1	1	<i>Pollichthys mauii</i>		1	1
Gobiidae indet.		8	5	<i>Polyipnus polli</i>		1	1
<i>Gonichthys coccoi</i>		1	1	<i>Psenes pellucidus</i>		1	1
<i>Gonostoma atlanticum</i>		14	6	Scaridae indet.		1	1
<i>Gonostoma denudatum</i>		3	2	Scombridae/Tuna indet.		2	1
<i>Gonostoma elongatum</i>		1	1	<i>Scopelarchus analis</i>		1	1
<i>Gonostoma indet.</i>	-	3	3	<i>Scopelarchus guentheri</i>		6	3
<i>Hygophum benoiti</i>		6	3	<i>Scopelosaurus smithii</i>		1	1
<i>Hygophum hygomi</i>		5	4	Scorpaenidae indet.		3	2
<i>Hygophum macrochir</i>		103	19	Sternoptychidae hatchet	+	125	23
<i>Hygophum reinhardti</i>		22	13	Sternoptychidae indet.	*	9	2
<i>Hygophum taaningi</i>		13	8	<i>Sternoptyx sp.</i>	+	1	1
<i>Ichthyococcus ovatus</i>		11	6	<i>Stylephorus chordatus</i>	+	1	1
<i>Lampadena luminosa</i>	+	1	1	Stomiatoidei indet.	*	6	3
<i>Lampadena sp.</i>	*	2	1	<i>Symbolophorus rufinus</i>		10	7
Lampanyctinae indet./other	*	6	3	<i>Tetragonurus atlanticus</i>		2	2
<i>Lampanyctus alatus</i>		3	3	Trachipteridae indet.	+	1	1
<i>Lampanyctus pusillus</i>		20	1	<i>Valenciennellus tripunctulatus</i>		6	3
<i>Lampanyctus sp.</i>	+	8	6	<i>Vinciguerria nimbaria</i>		39	17
Lampriformes indet.	*	1	1	<i>Vinciguerria poweriae</i>		5	3
<i>Lepidophanes guentheri</i>		24	8	<i>Vinciguerria indet.</i>	-	5	4
<i>Lobianchia dofleini</i>		1	1	remains indet.	-	67	14
Lophiiform/Ceratiiform indet.	+	1	1				
				Gross		1455	

Tab. 3: Gross community structure parameters for IKMT and MCN. MCN listed by station numbers as well as by medians, total catch 1461 specimens, 76 taxa. IKMT only gross data: 68 specimens, total 37 taxa, median = 8.

Upper panel: Separated for adult's habitats. "Shallow" refers to bottom depths less than 200 m.

Mid panel: Percentages of family Myctophidae and faunistic indicative complex "Gonostomatidae" (today separated into families Gonostomatidae, Photichthyidae, and sternoptychid subfamily Maurolicinae. Maurolicinae contributed only 6 specimen here).

Lower panel: Abundances, taxa richness, diversity (Shannon-index, univariate) and evenness (Pielou-index).

Sequence #	1	2	3	4	5	6	8	10	Median	IKMT
Total catch [N]	191	164	204	236	78	148	157	283	MCN	68
Adult's habitat of larvae [%]									[%]	
Oceanic meso+bathypelagic	96.9	87.2	93.2	97.5	89.7	89.9	94.3	83.4	91.5	55.9
Oceanic epipelagic	1.1	0.0	1.0	0.4	1.3	1.4	0.0	0.0	0.7	0.0
Slope	0.5	0.0	0.0	0.4	1.3	0.7	0.6	0.4	0.5	5.9
Shallow	0.5	4.3	1.0	0.4	0.0	2.0	0.0	0.4	0.5	38.2
Uncertain	1.1	8.5	4.9	1.3	7.7	6.1	5.1	15.9	5.6	0.0
among above total contribute										
Myctophidae [%]	67.0	64.0	63.2	74.2	48.7	81.1	65.0	62.9	64.5	22.1
"Gonostomatidae" [%]	23.0	15.9	18.6	16.5	25.6	4.7	21.7	16.6	17.6	13.2
Fish [N/m ²]	38.9	32.1	40.4	46.9	26.6	27.6	29.1	51.6	35.5	0.08
Taxa original [N/haul], N total = 76	36	29	32	39	23	29	30	38	31	8
Taxa clustered [N], N total = 70	33	29	31	38	22	28	30	36	31	none
Diversity H'	2.659	2.412	2.876	2.652	2.608	2.410	2.825	2.850	2.656	3.296
Evenness J'	0.760	0.716	0.838	0.729	0.844	0.723	0.831	0.795	0.778	0.920

Table 4: Occurrences and lengths (SL) of taxa originating from shallow and slope habitats (MCN and IKMT-catches listed individually).

Sequence #		1	2	3	4	5	6	7	8	10
		SL	N SL	N SL	N SL	N SL	N SL	N SL	N SL	N SL
Taxon	Gear	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
<i>Antigonia capros</i>	IKMT			1 42						
<i>Aphanopus carbo</i>	IKMT			1 97						
Apogonidae	IKMT		1 13							
<i>Ariosoma balearicum</i>	IKMT									1 72
<i>Bothus podas</i>	IKMT	1 12		3 23, 23, 27				1 11		
<i>Bothus podas</i>	MCN		1 14							
<i>Chlopsis ?bicolor</i>	IKMT									1 lost
<i>Chlopsis olukun</i>	IKMT	4 45, >45, 50, 55								5 45, 52, 53, 59, 59
<i>Chromis lubbocki</i>	IKMT		1 10	1 11						
<i>Chromis lubbocki</i>	MCN		2 6, 6							
<i>Dalophis</i> sp.	IKMT	1 102							1 81	
Gobiidae indet	MCN	1 9	1 8	2 >8	1 6		3 3, 5, 8			
Labridae/Scaridae	IKMT								1 8	
Macruridae indet.	MCN	1 3					1 4		1 4	1 3
Moridae?	MCN				1 4					
Muraenidae	IKMT		1 >48							
Notacanthiformes	MCN					1 10				
Scaridae	MCN		1 6							
Scorpaenidae	IKMT								1 5	
Scorpaenidae	MCN		2 6, 6							
<i>Trachurus picturatus</i>	IKMT							1 22		

Table 5: Comparative larval abundances and taxa richness from subtropical and tropical East Atlantic submarine rises, compiled from literature data. Denominations were taken from the original sources. For the methods of recalculations see John (2003).

Area	Latit. [°]	Longit. [°]	Season	Author	Year	Abundance mean N/1m ²	Taxa richness N	Depth range 0-
Atlantis Bank	34 N	30 W	winter	Arkhipov et al.	2004	?	2	200m
Plato Bank	33 N	29 W	winter	Arkhipov et al.	2004	0.9	10	200m
Plato Bank	33 N	29 W	summer	Arkhipov et al.	2004	3.3	5	200m
Irving Bank	32 N	28 W	winter	Arkhipov et al.	2004	0.5	2	200m
Irving Bank	32 N	28 W	summer	Arkhipov et al.	2004	5.4	7	200m
Irving Bank	32 N	28 W	summer	Gordina	1991	6.0	43	100m
Hyeres Bank	31 N	29 W	summer	Arkhipov et al.	2004	3.9	6	200m
Probatov Bank	31 N	29 W	winter	Arkhipov et al.	2004	1.5	1	200m
Meteor Bank	30 N	29 W	summer	Belyanina	1984	?	38	
Meteor Bank	30 N	29 W	summer	Arkhipov et al.	2004	4.0	7	200m
Meteor Bank(<4000m)	30 N	29 W	summer	Nellen & Ruseler	2004	22.7	150	290m
Meteor Bank	30 N	29 W	autumn	Gordina	1991	5.0	52	100m
Meteor Bank(above)	30 N	29 W	winter	Nellen	1973	13.3	52	
Meteor Bank(near)	30 N	29 W	winter	Nellen	1973	21.0	65	
Senghor Seamount	17 N	22 W	spring	these data	2005	36.7	76	250m
Sierra Leone Rise	7 N	21 W	October	Gordina	1991	14.0	52	
Sierra Leone Rise	7 N	21 W	December	John	2003	58.8	52	200m corr.
Romanche area	1 N	22 W	Feb.-June	Lopes	1983	43.4	35 fams	200m
Udachnaya Bank	8 S	0 E	January	Gordina	1991	27.0	48	
Dampier Seamount	12 S	0 E	April	John	2003	33.5	45	200m
Valdivia Bank	26 S	6 E	summer	Gordina	1991	3.0	6	100m

Figure Captions

Fig. 1: Bathymetry of Senghor-Seamount (from <http://earthref.org/SNB/>) and location of stations. Spacing of isobaths is 100 m. Symbols: Solid dot depicts stations with MCN, IKMT and CTD successfully deployed. Circles: IKMT and CTD successful. Cross: MCN and IKMT successful. The inset shows the location of Senghor Seamount relative to the Cape Verde Archipelago. Station labels 1 to 10 were sequenced by geographical longitude from west to east and used to present biological data. Labels A and B, and respective arrows, depict the directions of cross-summit perpendicular hydrographic transects shown by Fig. 2.

Fig. 2: Hydrographical transects across Senghor Seamount (shaded, for its location and station positions see Fig. 1). Upper two panels (temperature above salinity) depict transect A from southwest to northeast. Third and fourth panel show cross-CVFZ transect B (from northwest to southeast). Dashed vertical lines represent CTD positions. Salinity values from the upper 20 m were discarded due to inaccuracies. Interpolations by Surfer contour-plot algorithm “Kriging”.

Fig. 3: Taxa richness versus number of fish in IKMT and MCN. Solid curves depict numbers of taxa per individual tow, dashed curves represent specimen numbers cumulated in sequence of stations. All regressions are significant at $p < 0.005$.

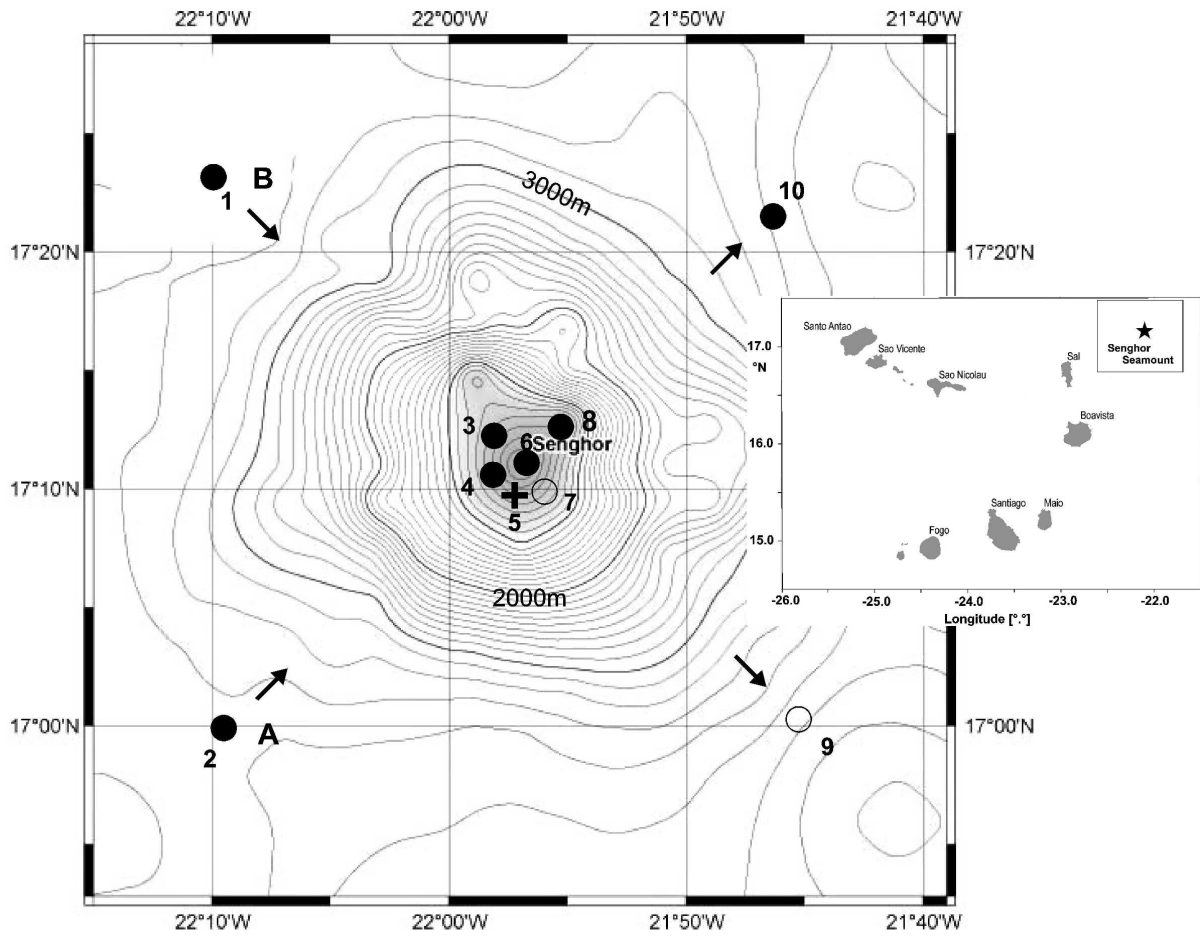
Fig. 4: Resulting dendrogram of the Cluster analysis (based on the Jaccard index and the group-average linkage algorithm) of MCN samples at Senghor Seamount. Numbers of samples refer to sampling stations (see Fig. 1). Abbreviations: downc = downcurrent of the seamount; on = above seamount; upc = upcurrent of the seamount. Further explanations are provided in text.

Fig. 5: Mean vertical distribution (MWD, see material and methods) per station (lower panel) of 8 representative taxa. These taxa exemplify shallow, mid-deep, and deep living larval taxa. All stations (numbers inserted at the bottom of the upper panel) were plotted against the

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3 geographical longitude of the midpoint of the tow. The corresponding bottom topography is
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5 illustrated in the lower panel.
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For Peer Review

Figure 1



Review

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Figure 2

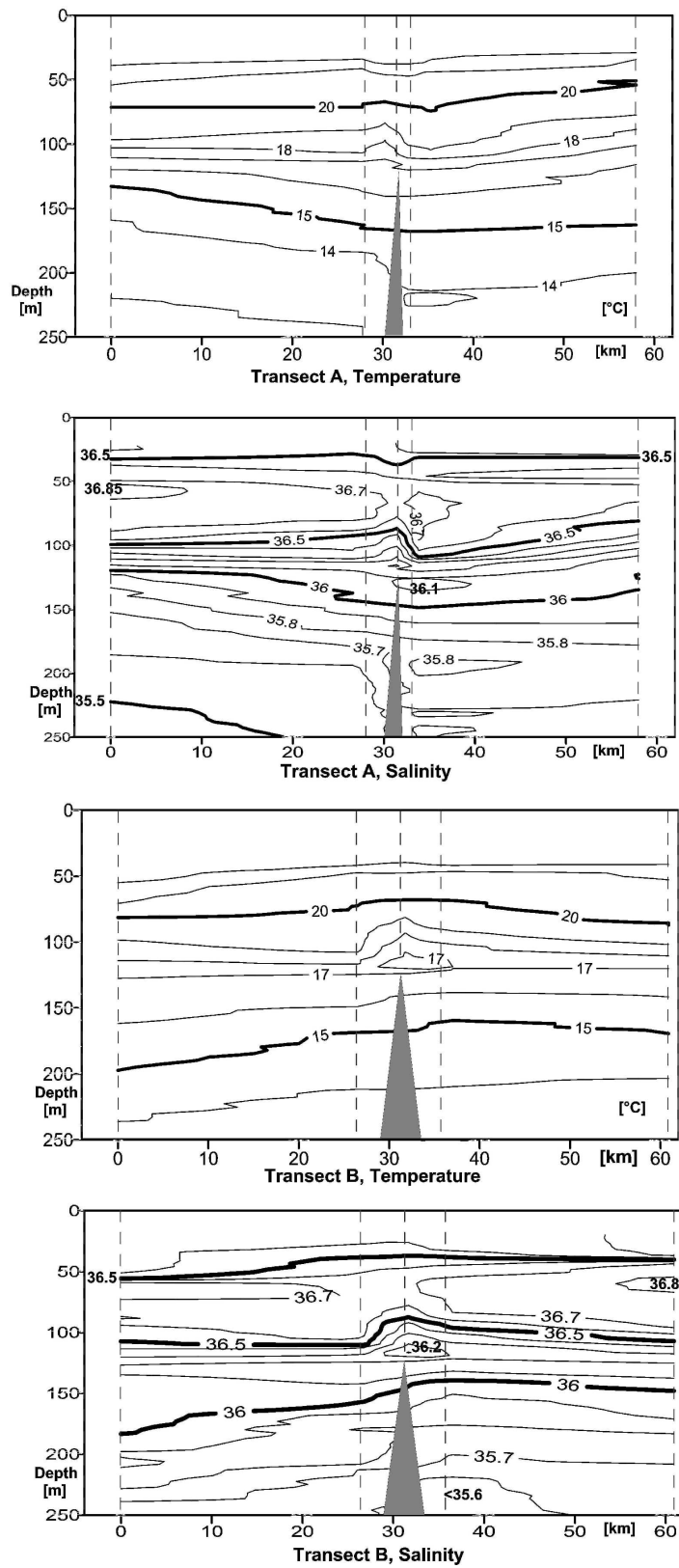


Figure 3

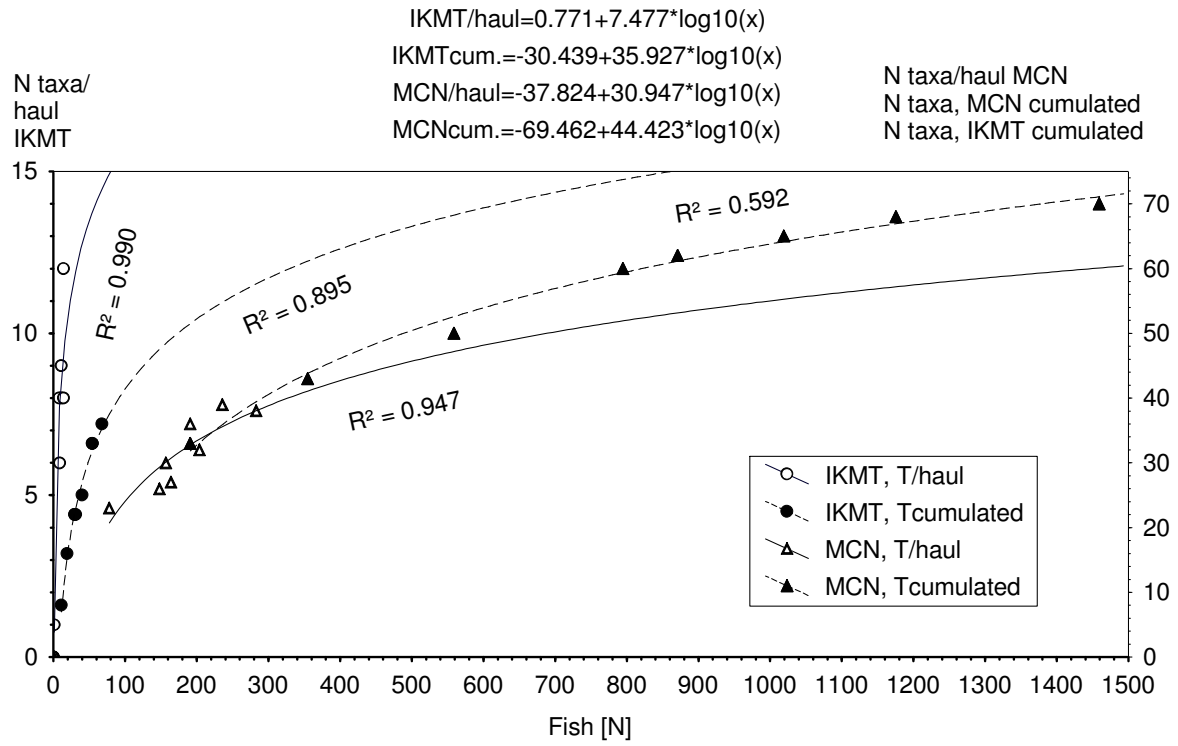


Figure 4

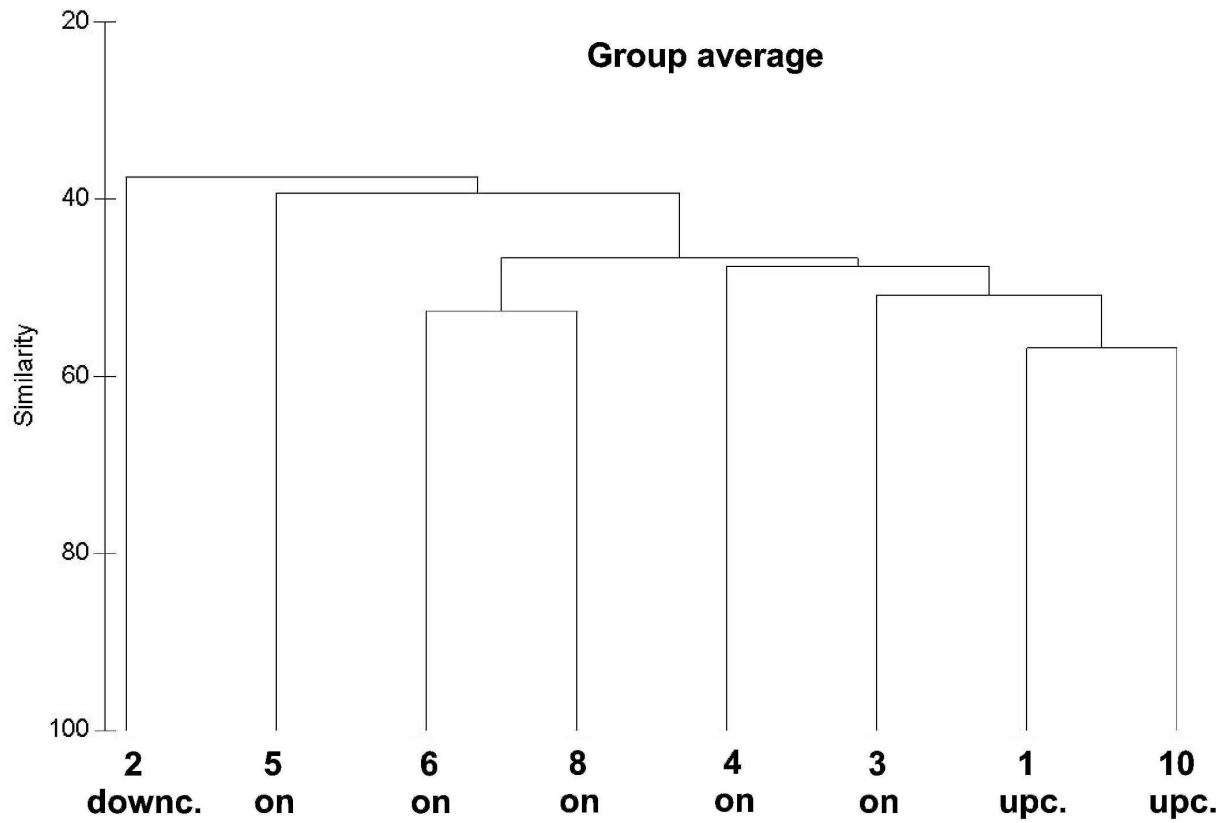


Figure 5

