Macro- and megafauna on the slopes of the Saya de Malha Bank of the Mascarene Plateau

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Abstract

A first characterization of the distribution and composition of benthic and demersal macro- and megafauna was derived based on video records sampled along five pre-determined transects up the slope on the western, northern and eastern sides of the Saya de Malha Bank on the Mascarene Plateau, starting at a maximum depth of 1000 m. Abundance was highest in the upper parts of eastern slope locations, primarily reflecting a relatively higher abundance of black corals (Antipatharia) than in other locations. A consistent feature of several transects, but most prominent in eastern and northern slopes, was the occurrence of patchy coral and sponge aggregations along the margin where the substrate was mostly hard. In some cases, these aggregations might be considered 'gardens' but reefs were not observed. Higher-level taxonomical composition of the fauna is presented. Demersal fish were widespread but not abundant, and within the depth range studied, there was a transition from a marginal shallow fish assemblage to a deepwater assemblage. Fishes were in most cases only assigned to family level, and 49 families were recorded. To thoroughly assess the biodiversity and abundance of fauna of the slopes of Saya de Malha Bank, further studies conducting more detailed video transects and sampling of specimens are warranted.

Keywords: benthos, fish, oceanic, bank slope, abundance, composition, Mascarene, Saya de Malha

Introduction

This paper presents first visual observations of benthic and demersal macro- and megafauna and substrates on the upper slopes of the Saya de Malha Bank, the more prominent amongst several shallow banks of the Mascarene Plateau in the Western Indian Ocean (Fig. 1). The paper is one in a series generated by an investigation of the Saya de Malha ecosystem facilitated by the FAO EAF-Nansen Programme and the RV *Dr Fridtjof Nansen*. In a separate account the benthos of the shallower parts of the bank, i.e. shallower than 50 m is described (Ramah *et al.*, this issue). The present paper explores macro- and megafauna and habitats from the margin of the shallow bank plateau downslope

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from approximately 50 m to 1000 m. Together these two accounts add significant new information to the relatively sparse older data on macro- and megabenthos in the area. The Saya de Malha Bank plateau is roughly triangular in shape and mostly less than 200 m deep. Its margin is characterised by steep slopes that ends in the surrounding abyssal depths except at the saddle that connects it to the Nazareth Bank at depth of around 1200 m.

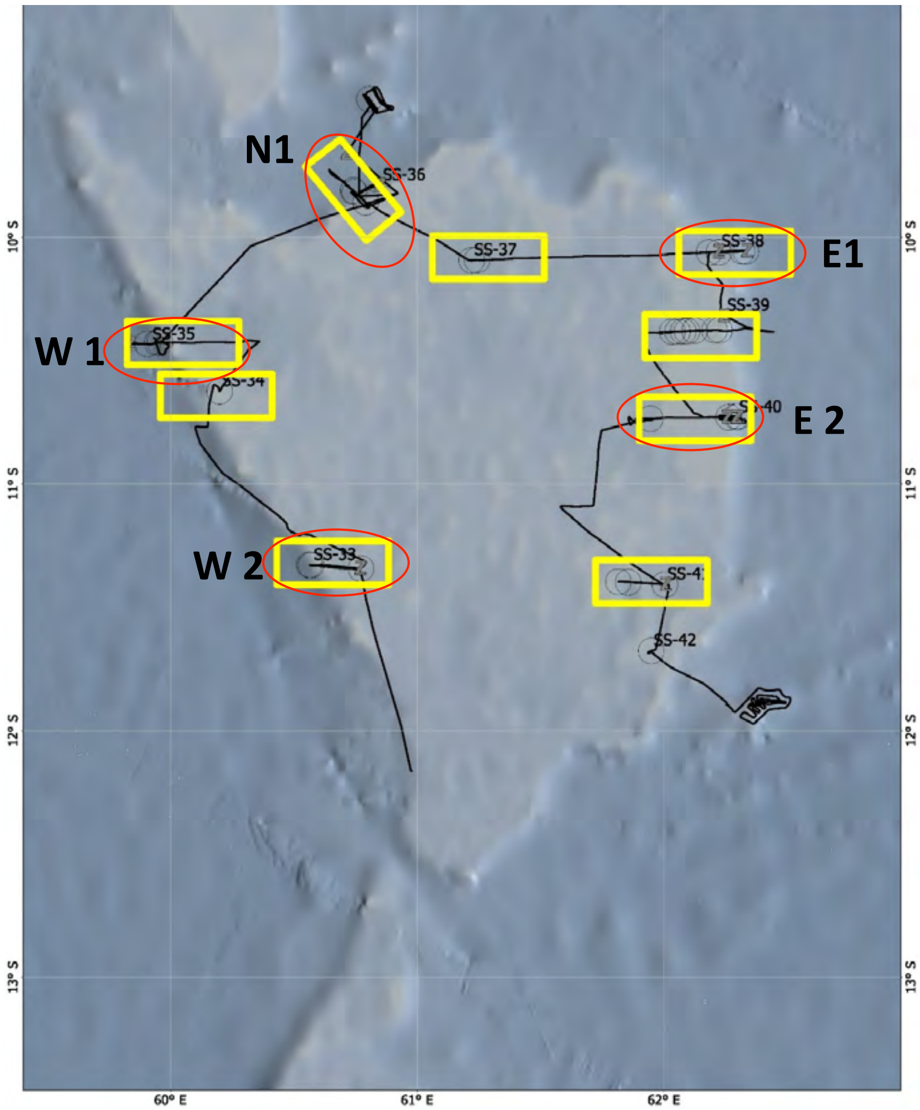

Figure 1. Survey track of the vessel, locations of targeted studies (Superstations, yellow rectangles). The five slope locations considered in this study are encircled in red. In these locations the VAMS vehicle was towed along transects to explore macro-and megafauna near and on the seabed. Saya de Malha Bank study 2018, RV *Dr Fridtjof Nansen, Leg II*.

The few previous studies of fauna and flora on Saya de Malha primarily targeted the shallow bank areas, and mostly used benthic samplers and trawls (Vortsepneva and Spiridonov, 2008 and papers cited therein; Strømme *et al.*, 2009). From the Russian accounts there are extensive species lists, and distributions and composition of faunal assemblages were compiled, mainly for the plateau (Vortsepneva and Spiridonov, 2008), but not for the slopes. The current study aimed to provide additional information using visual observations by video.

The targeting of macro- and megafauna reflected the special attention paid to occurrence of deepwater fish and taxa regarded as indicators of Vulnerable Marine Ecosystems (VMEs *sensu* FAO (2009)). VME-taxa expected in the area were sponges and corals that might form especially vulnerable assemblages such as sponge bed and coral gardens or reefs. These are features susceptible to significant adverse impacts of bottom fishing, should such fisheries develop in the area. Prior to this study no information was available on deepwater fish or the occurrence of VME-taxa in the Saya de Malha slope areas.

The data for the present paper were collected during the May 2018 expedition to Saya de Malha on the RV *Dr Fridtjof Nansen.* Serving multiple project objectives, the aim of the cruise was to characterize the ecosystem and morphology of the Saya de Malha Bank for the benefit of Seychelles and Mauritius that are sharing the management of the 'Joint Management Area' encompassing the major portion of the Saya de Malha Bank.

Saya de Malha waters are oceanic and oligotrophic (Kyewalyanga, 2015), and the bank is exposed to major regional ocean currents, with the eastern slope upstream and the western slope downstream of the westward flowing South Equatorial Current (Schott *et al.*, 2009; Vianello *et al.*, 2017). A working hypothesis for the study was that the composition of the fauna on the slopes would vary by depth and substrate character, but also with the regional circulatory influence with eastern and perhaps northern slopes being more exposed than the western slopes. Bio-physical coupling around shallow seamounts in the South Western Indian Ocean have been studied nearby (e.g. Harris *et al.* 2020), but not on the Saya de Malha Bank which is a more extensive feature than the isolated seamounts targeted elsewhere.

The objective and scope of this study was to develop a first characterization of the distribution and composition of benthic fauna and substrates derived from a visual census on the upper slope. Working within the bank margin to 1000 m depth, the approach was to carry out sampling along pre-determined transects up the slope on the western, northern and eastern sides of the Saya de Malha. Along these transects, fauna and substrate information was collected with a high-definition video camera operated from a Remotely Operated Vehicle (ROV).

Material and methods

The main vehicle used to collect data for this study was the Video Assisted Multisampler (VAMS) described in detail by Serigstad *et al.* (2015) and illustrated in Buhl-Mortensen *et al.* (2017). This vehicle consists of a tubular instrument cage connected to the vessel by a 2500 m optical cable. The vehicle has five remotely operated 0.1 m^2 van Veen grabs, and a tethered lightweight (75 kg) ROV with a HD camera for collecting video data in a radius of approx. 30 m around the cage. In all the slope locations selected for studying substrate, geomorphology, fauna and flora, the VAMS was used in towed transect mode where the vessel towed the VAMS cage along pre-determined paths at a speed of 0.1-0.4 knots while the ROV explored the underlying seabed. The operational depth range of the VAMS was 20-1000 m. For this study, slope transects running perpendicular to isobaths were run starting at 780-1000 m and moving up to the outer rim of the bank plateau. All dives were made during daytime and technical crew was only available for 8-12 hours per day.

The distance between the seabed and the ROV camera varied depending on conditions but was kept at 1-2 m during steady passage. The study was exploratory and there was frequently a need to stop to identify and enumerate organisms at or near the seabed. The vehicle was thus not moved with a constant speed along the transect. The amount of time spent focusing on specific targets was assumed roughly equal in the different locations and sampling periods.

Initial identification and counting of benthos and fish were carried out onboard the vessel, to be followed by land-based post-processing. Video records were achieved by continuous recording by skilled observers during the VAMS operations. Records were logged with data on time, position, depth, and substrate in a dedicated logging software developed by the Institute of Marine Research, Norway. The videos were revisited after the dives had been completed and again in several dedicated sessions after the cruise. Overlooked observations were added and erroneous/uncertain records amended accordingly. For each taxon, number of individuals or number of colonies appearing within the field of view was recorded, taking care not to record each more than once.

The VAMS and ROV was not equipped with megabenthos samplers, hence organisms could only be identified from the video footage and still images derived from the videos. Few taxa could consistently be identified to species or low taxonomic levels, hence the analyses in this paper were based on records at high taxonomical levels, usually class and in some cases order. The taxonomical categories used were the same for all transects. Fishes could normally be assigned to family. Some taxa could, however, be identified to genera and species and records of such cases were used to identify what appeared as prominent members of the slope assemblages.

Bathymetry mapping guided the work with the VAMS. The RV *Dr Fridtjof Nansen* is equipped with two Multi Beam Echo Sounders (MBES), Kongsberg EM 710 and EM 302. The operational depth of the EM 710 is 3 to 2000 m, and for the EM302 it is 10 to 7000 m. Both MBES can achieve a swath width of 5.5 times the water depth with high resolution and accuracy. Continuous seabed mapping using the EM 302 was carried out throughout the expedition whereas the EM 710 was used only when in water depths less than 1500 m, mainly on the Saya de Malha Bank plateau. The recorded data was viewed on Seafloor Information System (SIS), Kongsberg real time software designed to be the user interface and the real time data processing system for its hydrographic instruments, and on Olex, the onboard navigation planning system. The single-beam acoustics also provided data on bottom profiles and the SIMRAD EK80 Scientific Split Beam Echo Sounders with 18, 38, 70, 120, 200 and 333 kHz transducers mounted in a drop keel was run continuously.

The substrate characterization used in this fauna study was mainly based on video images, hence a crude classification distinguishing between 'sand', 'gravel', and 'rock' was chosen. There are transitions between sand and gravel. 'Sand' was used for fine, apparently homogeneous substrates, where typically ripple marks and tracks of crawling and digging animals occurred. 'Gravel' ranged from coarse sands with scattered small pebbles and stones, to coarse gravel beds such as found in e.g. *Lithothamnion* beds on the rim of the bank. 'Rock' encompassed bedrock of various character, e.g. basalt, limestone, cemented sand, but also boulders. In many areas, the seabed appeared as rock covered with only a superficial and uneven layer of soft sediment (i.e. mostly sand, but also gravel). In rocky areas and locations with sand and gravel, sampling with grabs to obtain sediment samples and samples of flora and fauna was impossible, hence the substrate classification was based on the video imagery.

Sampling and data

The track of the vessel during Leg 2 of the 2018 Saya de Malha study is shown in Figure 1. Yellow rectangles were locations selected for targeted studies, including transects using the VAMS and ROV. The slope transects were run in the two western (W1, W2), one northern (N1), and two eastern (E1, E2) rectangles encircled by a red eclipse. The remaining rectangles are shallow bank locations and not considered here. Within each rectangle, referred to as 'Superstations', several activities were carried out including VAMS dives, CTDs, plankton and fish sampling, among others.

At each of the five locations (W1-2, N1, E1-2) one or more VAMS dives were conducted, together forming a transect from maximum 1000 m up the slope to the plateau of the bank (Table 1a). For this account focused on slope assemblages, data from depths shallower than 60 m were disregarded. Due to various technical constraints and the inability to work the ROV around the clock, some transects had to be interrupted and were not completely sampled.

In some of the descriptions and analyses, the slope transects were split into four depth zones; 1. <100 m, 2. 100-249 m, 3. 250-499 m, 4. >499 m. Zone 1 represents the outer margin of the bank where there is a rather sharp break between the inner parts of the bank and the steeper outer slope. Zones 2, 3 and 4 were on the slope. Since the maximum range of the vehicle was 1000 m, all the three zones are 'upper slope' depth strata. Sampling levels in the different locations varied (Table 1b), and the E2 and W1 sites have the most complete and continuous sampling. The time spent in different depth zones is given in Table 1 b.

In order to facilitate comparisons between locations and depth zones, the recorded numerical abundances were standardized by observation time. This resulted in a matrix of standardized numbers for each taxon vs. depth zones, scaled to 100 hours of observation time. The standardized numerical abundance data were used in descriptions and exploratory analyses of abundance and taxonomical composition patterns.

Results

Thirteen successful VAMS dives with a total of 1462 minutes of observation time with the ROV was conducted on the upper slope and margin of the Saya de Malha Bank. Details on the sampling effort by four depth zones in each of five study locations is provided in Table 1. Video observations of substrate and organism numbers derived from video records formed the basis of accounts for individual slope locations and inter-location comparisons.

Table 1. List of VAMS locations with associated information on ROV dives, grabs and other observations. Saya de Malha Bank survey 2018, *RV Dr Fridtjof Nansen*. a) dive list and depth ranges., b) duration of observations in each of four depth zones, and the depth ranges actually observed.

a)

Location	Superstation	VAMS & grab st. number	Depth range (max.-min.), m	Hydrography station a.o.	Date
W1	35	19	1006-741	CTD #422 and LADCP 2000m	17.05.2018
		20	495-462		17.05.2018
		21	400-100		18.05.2018
W2	33	13	515-250		15.05.2018
		14	780-494		15.05.2018
		15	80-77	CTD #421 at 72m	15.05.2018
N1	36	22	1013-848		18.05.2018
		23	843-56 (38)	CTD #423 at 110m	19.05.2018
E1	38	27 (interrupted, no data)	1000	CTD #426 at 1418m	21.05.2018
		28	510-285		21.05.2018
		29	192-62		21.05.2018
E2	40	38	1000-410	CTD #429 at 1008m	23.05.2018
		39	420-233		23.05.2018
		40	145-73		23.05.2018

b)

Location	Depth zones	Observation time (mins)	Depth ranges observed, m
W1	>499 m	88	1000-741
	499-250	56	495-461, 400-255
	299-100	54	239-100
	<100	-	-
W2	>499 m	105	781-500
	499-250	89	491-250
	299-100	-	-
	<100	40	80-77
N1	>499 m	264	1027-848, 843-500
	499-250	56	499-250
	299-100	29	249-100
	<100	28	99-56
E1	>499 m	3	512-500
	499-250	107	499-285
	299-100	71	192-100
	<100	53	99-62
E2	>499 m	115	1000-500
	499-250	184	499-250
	299-100	62	145-100
	<100	58	99-73

Characterization of the locations on western, northern and eastern slopes

Western slope

The two locations W1 and W2 on the western slope were studied for 198 and 234 mins, respectively. The start depth of the dives was different, i.e. 1006 m and 781 m. Sandy substrate occurred at the beginning of the transects and some distance up the slope. In W1 there was sand from the start until 741 m, and then again when the transect was resumed at 490 m. In W2 the substrate was sandy from the start at 791 m until about 490 m.

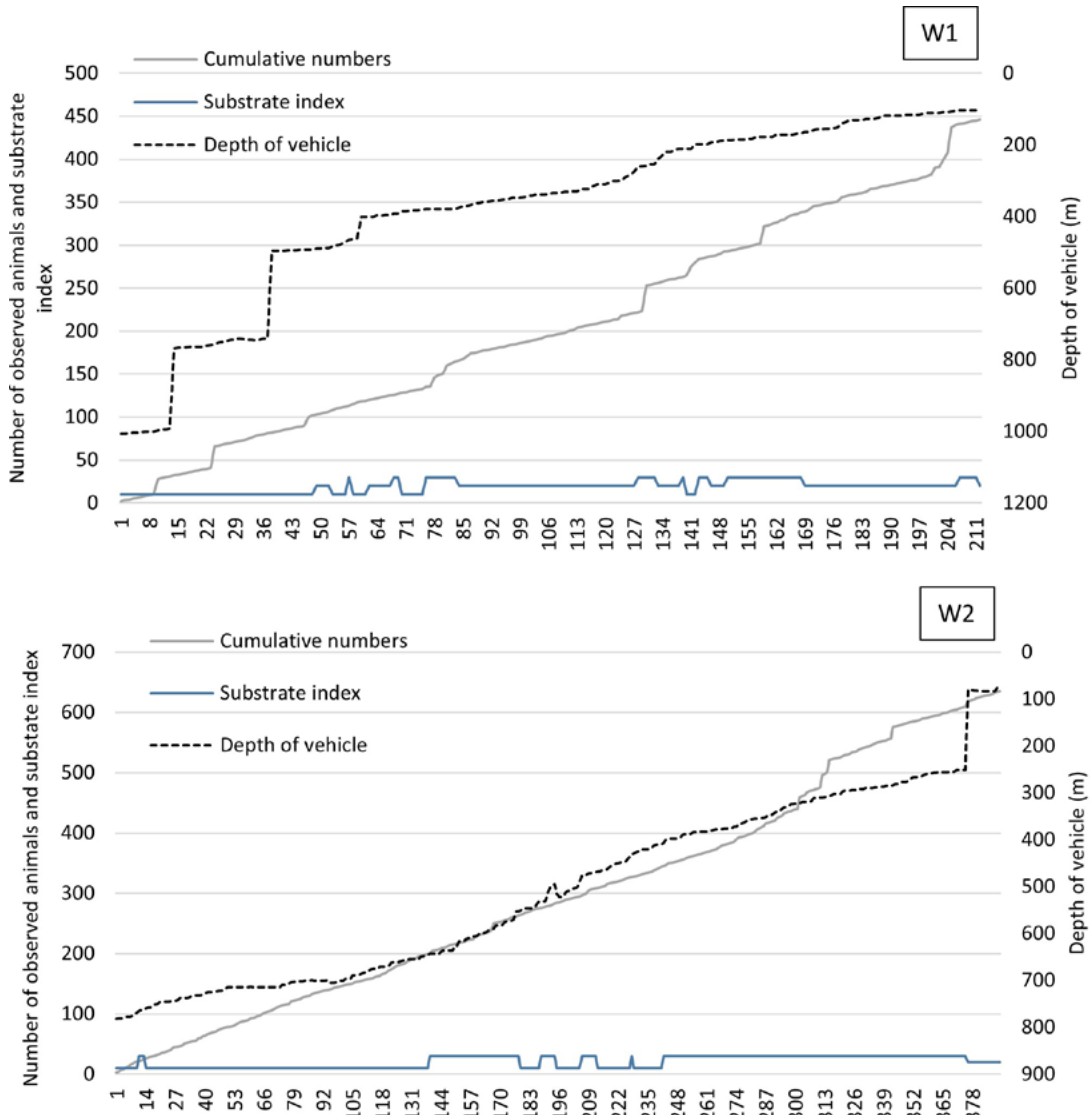

Figure 2. Cumulative numbers of animals observed by video along transects up the slope of the Saya de Malha Bank, RV *Dr Fridtjof Nansen*, 2018. Observations from the western W1 (upper) and W2 (lower) slope locations. The depth of the vehicle as the records were made (hatched line), and cumulative number of animals (solid line) are shown. Grey line indicates substrate associated with each record: 10=sand, 20=gravel and 30=rock. Vertical drops in the depth curve reflect interruptions in the dives and movement to a shallower location, not real depth changes along the transects.

Sandy patches also occurred at shallower depths where harder substrates dominated. Gravel was predominant, with several rocky outcrops. The rock appeared as cemented biogenic sand and gravel. Encrusting red algae, *Lithothamnion*, appeared for the first time at 151 m in W1 and patches of *Lithothamnion* gravel bed, also with brachiopods, was observed until the end of the transect at 100 m. In W2, *Lithothamnion* gravel beds was the habitat at 80-77 m but may have occurred deeper in the unsampled area between 250 and 80 m.

There was a steady accumulation of animal records along the two depth transects, indicating no pronounced patchiness or aggregation related to depth or substrate changes (Fig. 2). W2 had a higher number of animal records than W1, but the observation time was also appreciably higher in that transect.

In the W1 transect broken off seagrass leaves (*Thalassodendron ciliatum*) was observed as deep as 103 m. Live foliate green macroalgae (Ulvophyceae) occurred at the upper end of W2 at around 80 m.

Mesopelagic fishes were observed near the seabed in both transects (but were not recorded amongst benthic fauna). In W1, where abundance appeared highest, they occurred between 491 and 300 m, i.e. beneath the margin of the bank.

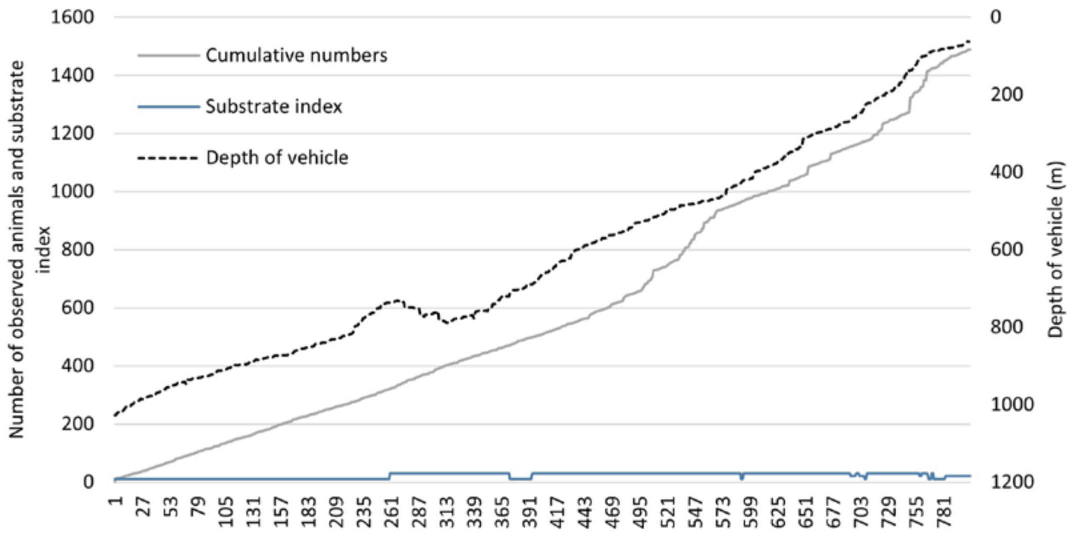

Figure 3. Cumulative numbers of animals observed by video along transects up the slope of the Saya de Malha Bank, RV *Dr Fridtjof Nansen*, 2018. Observations from the N1 northern slope location. The depth of the vehicle as the records were observed (hatched line), and cumulative number of animals (solid line) are shown. Grey line indicates substrate associated with each record: 10=sand, 20=gravel and 30=rock. Vertical drops in the depth curve reflect interruptions in the dives and movement to a shallower location, not real depth changes along the transects.

Northern slope

The single northern slope location was sampled for 377 minutes along a continuous transect from 1027-56 m.

The substrate was sand between the start and 732 m, whereas the shallower portion had boulders, bedrock and only small patches of soft sediments. The rock was variably appearing as cemented biogenic sand and more consolidated limestone. *Lithothamnion* was first observed at 158 m, and from about 140 m there was a transition from rather bare rocky substrate to rock and gravel with significantly more biota. This is reflected in a somewhat stepwise steepening of the cumulative number of animal numbers towards the end of the transect (Fig. 3).

At around 100 m a prominent rocky habitat with a coral and demospongian 'garden' occurred. At shallower depths extensive *Lithothamnion* beds were observed, and at 67 m the first foliate green algae appeared. At 57 m more and more calcified green algae was seen on the gravel beds. Scattered seagrass (*Thalassodendron ciliatum*) leaves were observed from 768m and throughout the depth range of the transect.

Mesopelagic fish were noted across a wide depth range from 920-300 m.

Eastern slope

The two eastern slope locations E1 and E2 were sampled for 234 and 419 minutes, respectively. At E1 a dive at 1000 m generated no data since it had to be interrupted due to high current speeds. The E2 transect was a near continuous transect from 1000-73 m.

The E2 transect had rocky substrate from the beginning until the end, only interrupted by very few patches of sand and some more extensive gravel areas toward the shallower end (Fig. 4). At the deep end the bedrock appeared as basalt, and further up the slope there was basaltic outcrops and walls, but also what appeared as limestone and cemented sand. The northeastern location, sampled from 512 m and up the slope, had a similar substrate distribution with rock until about 250 m and a mixture of rock and softer substrates towards the shallower end. In both these eastern transects, sandy patches were small, and the rocky habitats had only a thin layer of sediment, if any. *Lithothamnion* occurred on gravel beds from 186 m in E1 and 131 m of E2, and towards the shallower end of the transects encrusting algae (including calcified green algae, *Halimeda* sp.) were dominating in gravel beds where foliate green algae were also prominent.

The cumulative abundance curves suggested even abundance until about 100 m after which a pronounced increase was observed. This increase predominantly reflected elevated numbers of coral colonies, and this pattern was particularly pronounced in E2 where the abundance of corals was the highest. At depths shallower than 100 m patches of particularly

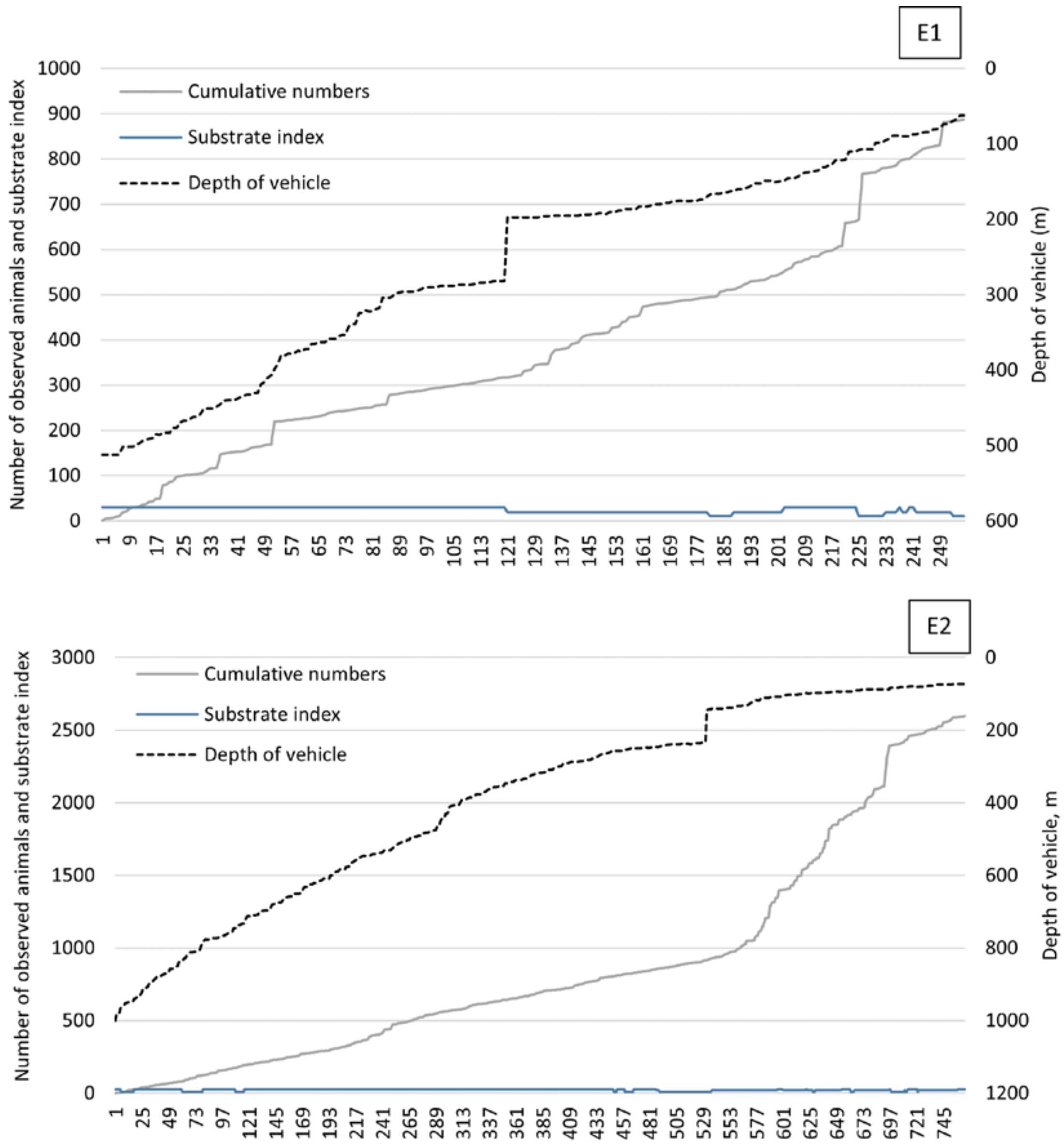

Figure 4. Cumulative numbers of animals observed by video along transects up the slope of the Saya de Malha Bank, RV *Dr Fridtjof Nansen*, 2018. Observations from the eastern E1 (upper) and E2 (lower) slope locations. The depth of the vehicle as the records were made (hatched line), and cumulative number of animals (solid line) are shown. Grey line indicates substrate associated with each record: 10=sand, 20=gravel and 30=rock. Vertical drops in the depth curve reflect interruptions in the dives and movement to a shallower location, not real depth changes along the transects.

high density occurred that would likely qualify as 'coral gardens' defined as 'a relatively dense aggregation of colonies or individuals of one or more coral species' (*sensu* OSPAR, www.ospar.org).

Foliate green algae occurred for the first time at 86 and 93 m in E1 and E2, respectively. Broken off seagrass leaves (*Thalassodendron ciliatum*) occurred at 186 m in E1 and scattered live seagrass appeared at 69 and 73 m and shallower in E1 and E2, respectively.

Mesopelagic fish were observed in E2 from around 750-300 m, with apparently highest numbers at around 400 m. Relatively high abundance was also noted at the beginning of the E1 transect at 510-500 m.

Numbers and composition of animals

Numbers of animals observed, standardized to 100 hours of observation time, by the four depth zones showed no obvious pattern other than the marked higher abundance in the two shallower depth zones in the eastern slope location E2 (Fig. 5). The elevated abundance in E2 mostly reflected a higher abundance of Antipatharia. The western slope locations seemed to have somewhat lower numbers than the northern and eastern locations, but differences were small and not

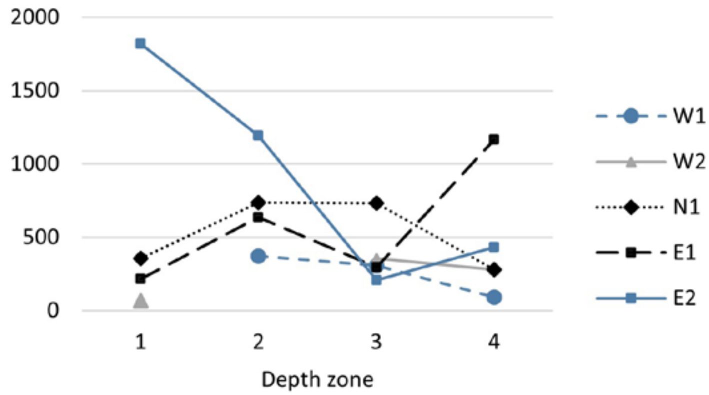

Figure 5. Abundance of megafauna at Saya de Malha western (W1-2), northern (N1) and eastern (E1-2) slope locations as observed by video imagery, RV *Dr Fridtjof Nansen*, 2018. Summed standardized abundance by depth zones: 1- <100 m, 2-100-249 m, 3-250-499 m, 4->499 m.

Table 2. Saya de Malha Bank, RV *Dr Fridtjof Nansen* 2018. Numbers of organisms observed by video in locations W1-2, N1, E1-2 and Depth zones 1-4. Numbers are standardized to 100 hours of observation time. Plants were excluded and fishes identified to families were pooled as 'Pisces'.

Location	W2	W2	W2	W2	W1	W1	W1	W1	N1	N1	N1	N1	E1	E1	E1	E1	E2	E2	E2	E2
Depth zone	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Demospongiae	7.5		27.0	0.0		44.4	62.5	0.0	39.3	262.1	30.4	1.1	28.3	8.5	29.0	0.0	150.0	46.8	9.2	5.2
Hexactinellida	0.0		11.2	21.0		0.0	17.9	53.4	0.0	0.0	62.5	35.2	0.0	8.5	16.8	266.7	19.0	24.2	25.0	132.2
Ctenophora	0.0		6.7	0.0		3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Actiniaria	5.0		6.7	0.0		14.8	12.5	0.0	0.0	0.0	5.4	9.8	3.8	4.2	0.9	0.0	6.9	19.4	2.7	13.0
Alcyonacea	0.0		57.3	21.9		42.6	23.2	2.3	67.9	17.2	26.8	30.7	11.3	74.6	96.3	200.0	132.8	159.7	68.5	67.8
Ceriantharia	5.0		0.0	0.0		0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
Hydrozoa	0.0		61.8	9.5		29.6	23.2	1.1	0.0	124.1	175.0	37.5	9.4	71.8	33.6	333.3	37.9	45.2	16.3	29.6
Pennatulacea	7.5		2.2	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	2.8	66.7	6.9	1.6	0.0	0.0
Scyphozoa	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
Scleractinia	0.0		3.4	0.0		0.0	0.0	0.0	0.0	17.2	23.2	0.4	0.0	7.0	9.3	0.0	0.0	14.5	12.5	2.6
Zoantharia	0.0		1.1	97.1		0.0	0.0	3.4	0.0	0.0	126.8	36.4	0.0	0.0	0.0	0.0	0.0	0.0	0.5	29.6
Antipatharia	0.0		19.1	0.0		61.1	7.1	0.0	0.0	113.8	3.6	0.8	115.1	77.5	28.0	166.7	882.8	724.2	2.7	7.8
Platyhelminthes	0.0		7.9	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.9
Bivalvia	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	172.4	0.0	0.0	0.0
Cephalopoda	0.0		1.1	0.0		1.9	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gastropoda	0.0		0.0	0.0		13.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	1.4	0.0	0.0	0.0	9.7	0.5	2.6
Scaphopoda	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
Brachiopoda	0.0		0.0	0.0		9.3	10.7	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.5	7.0
Annelida	0.0		1.1	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polychaeta	0.0		0.0	0.0		1.9	10.7	2.3	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	86.2	6.5	0.5	0.0
Pycnogonida	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Achelata	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	1.7	0.0	1.6	0.0
Anomura	0.0		6.7	2.9		1.9	32.1	1.1	0.0	3.4	10.7	4.5	0.0	1.4	0.9	33.3	0.0	0.0	0.5	14.8
Astacidea	0.0		0.0	1.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brachyura	2.5		1.1	2.9		0.0	3.6	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.9	33.3	0.0	0.0	0.0	0.9
Caridea	2.5		14.6	48.6		1.9	17.9	12.5	3.6	10.3	139.3	51.9	0.0	2.8	3.7	33.3	0.0	3.2	4.9	32.2
Cirripedia	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0
Isopoda	0.0		0.0	1.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Asteroidea	5.0		25.8	2.9		27.8	5.4	0.0	7.1	6.9	16.1	1.1	5.7	14.1	14.0	0.0	3.4	11.3	12.5	6.1
Crinoidea	0.0		1.1	0.0		0.0	0.0	1.1	0.0	0.0	3.6	0.8	0.0	145.1	5.6	0.0	72.4	3.2	2.2	1.7
Echinoidea	25.0		4.5	0.0		66.7	8.9	1.1	157.1	10.3	12.5	4.2	0.0	2.8	11.2	0.0	129.3	38.7	7.1	0.9
Holothuroidea	0.0		0.0	0.0		0.0	0.0	1.1	3.6	10.3	23.2	7.6	0.0	1.4	0.0	0.0	13.8	0.0	1.1	1.7
Ophiuroidea	0.0		6.7	3.8		1.9	3.6	0.0	0.0	0.0	21.4	6.4	0.0	1.4	0.9	33.3	0.0	3.2	8.7	3.5
Bryozoa	0.0		3.4	1.9		7.4	5.4	0.0	0.0	0.0	0.0	0.4	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0
Ascidiacea	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
Pisces	5.0	0.0	83.1	65.7	0.0	40.7	64.3	10.2	78.6	162.1	50.0	47.7	43.4	197.2	43.0	0.0	105.2	80.6	21.7	68.7
Total numbers recorded	65.0	0.0	353.9	280.0	0.0	370.4	308.9	92.0	357.1	737.9	732.1	281.0	217.0	638.0	297.2	1166.7	1820.7	1191.9	205.4	430.4

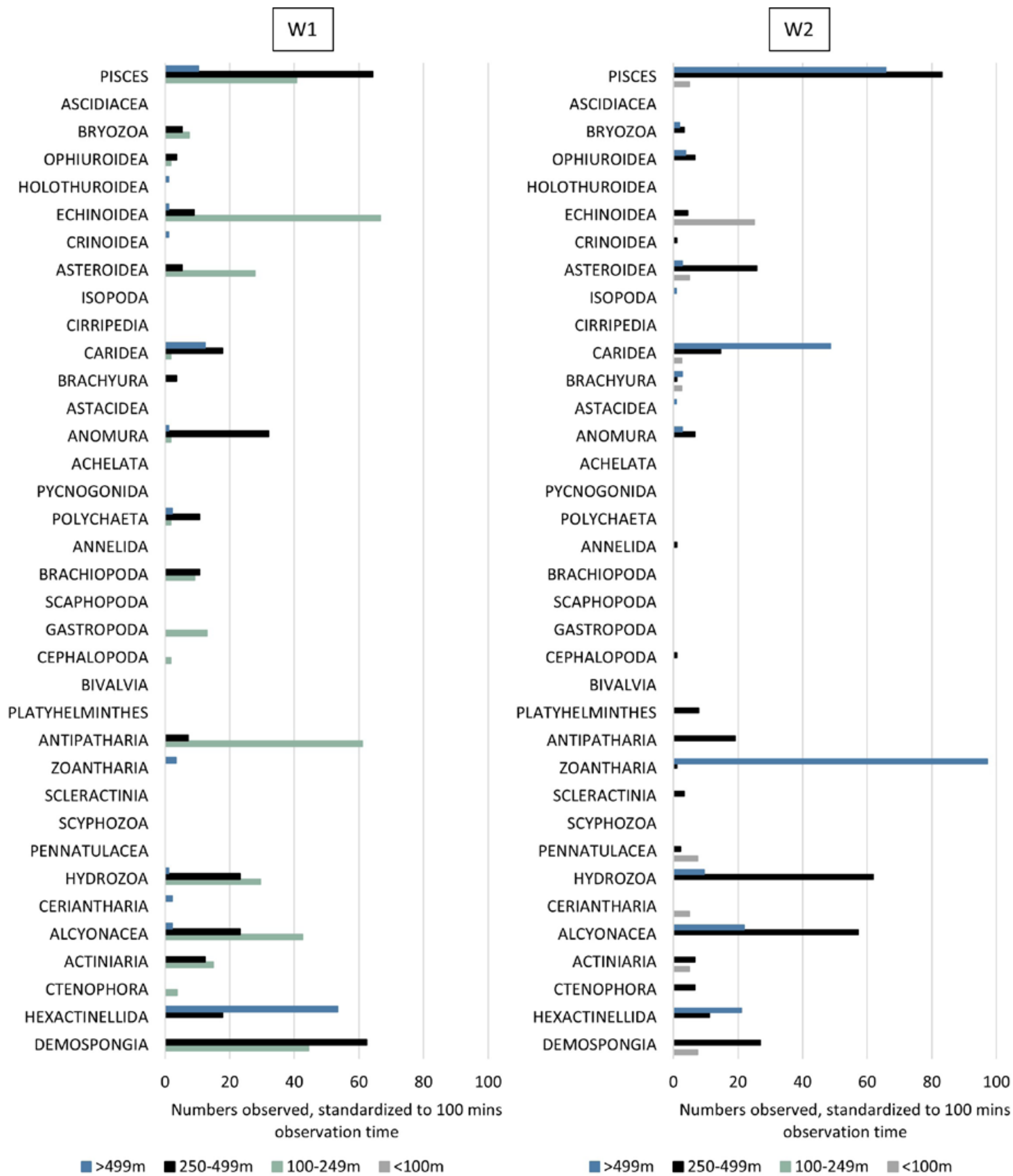

Figure 6. Higher-level taxonomical composition of the fauna recorded by video imagery on the western slope of Saya de Malha Bank, Locations W1 (left) and W2 (right). RV *Dr Fridtjof Nansen*, 2018. Note that two depth zones were not sampled: <100 m in W1, and 100-249 m in W2.

entirely consistent between depth zones (and data were missing in two depth zones). The data from the two locations that were sampled best, i.e. N1 and E1 with near continuous sampling of the entire transects, the patterns of abundance by depth were not very different.

The higher-level taxonomical composition of the animal assemblages observed, by location and depth zones, can be extracted from Table 2 and is further illustrated in Figure 6, 7 and 8.

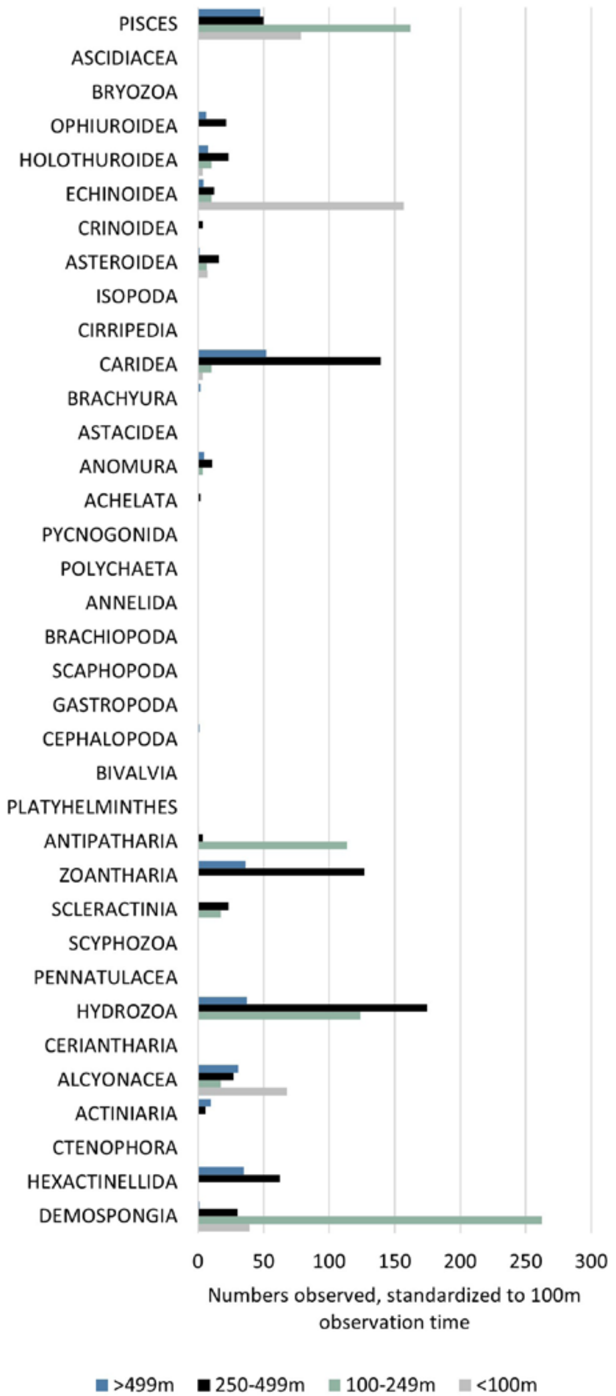

Figure 7. Higher-level taxonomical composition of the fauna recorded by video imagery on the northern slope of Saya de Malha Bank, Location N1. RV *Dr Fridtjof Nansen*, 2018.

Of the 35 categories used, the ten taxa with highest overall numbers were (from highest to lowest) Antipatharia, Pisces, Alcyonacea, Hydrozoa, Demospongiae, Hexactinellida, Echinoidea, Caridea, Zoantharia and Crinoidea. Cnidaria were important and diverse, and Antipatharia, Alcyonacea and Hydrozoa were prominent in all locations but particularly abundant in E2 where the already mentioned increased abundance was observed in the two shallower depth zones. Zoantharia mostly occurred as colonies attached to the hexactinellid sponge *Hyalonema* and was widespread (and possibly underestimated) with highest abundance on the western and northern slopes. Fish and shrimps/prawns were widespread but seldom very abundant. Amongst Porifera, Demospongiae occurred mainly in shallow strata, whereas Hexactinellida were more prominent in the deepest areas. Echinoderms were also common and diverse, with crinoids and echinoids as the more numerous groups.

Notes on individual taxa

Cnidaria

Amongst the overall most abundant taxa were cnidarians in class Anthozoa (orders Antipatharia and Alcyonacea and Zoantharia) and the class Hydrozoa. Actiniaria were frequent but not abundant, and some were species associated with hermit crabs. Common examples of each are illustrated in Appendix Figure A a).

The antipatharian occurring in greatest numbers was *Cirrhipathes* sp. of the family Antipathidae and the few other antipatharians observed were not identifiable from images. The highest densities were observed in Depth zone 1 and 2 but scattered colonies also occurred in deep areas. In some locations the spiral-shaped single strand *Cirrhipathes* sp. formed aggregations.

Thirteen genera of Alcyonacea were recorded (Table 3) across the depth range studied, but this was very probably only a subset of the genera occurring in the area. Some contributed to coral gardens and were more significant in deep than in shallow gardens. Pennatulacea were uncommon and only three genera were recognized (Table 3, Fig. A a). Solitary Scleractinia were infrequent and only one genus was identified, *Caryophyllia* sp.

Hydrozoa were ubiquitous in several locations as small white colonies Fig. A a), primarily in the Depth zones 3 and 4 on soft and rocky substrates. The genera *Errina* (*capensis*?), *Stylaster* (*subviolacea?*), *Conopora* (*tenuiramus*?), and *Sertularella* (*diaphana*?) were recognized. Most of the Hydrozoa were small and not well recorded from videos, hence numbers of colonies as presented above and diversity of taxa were probably underestimated.

On sandy and gravelly substrate at >500 m, the zoantharian *Epizoanthus* was very common and widespread with

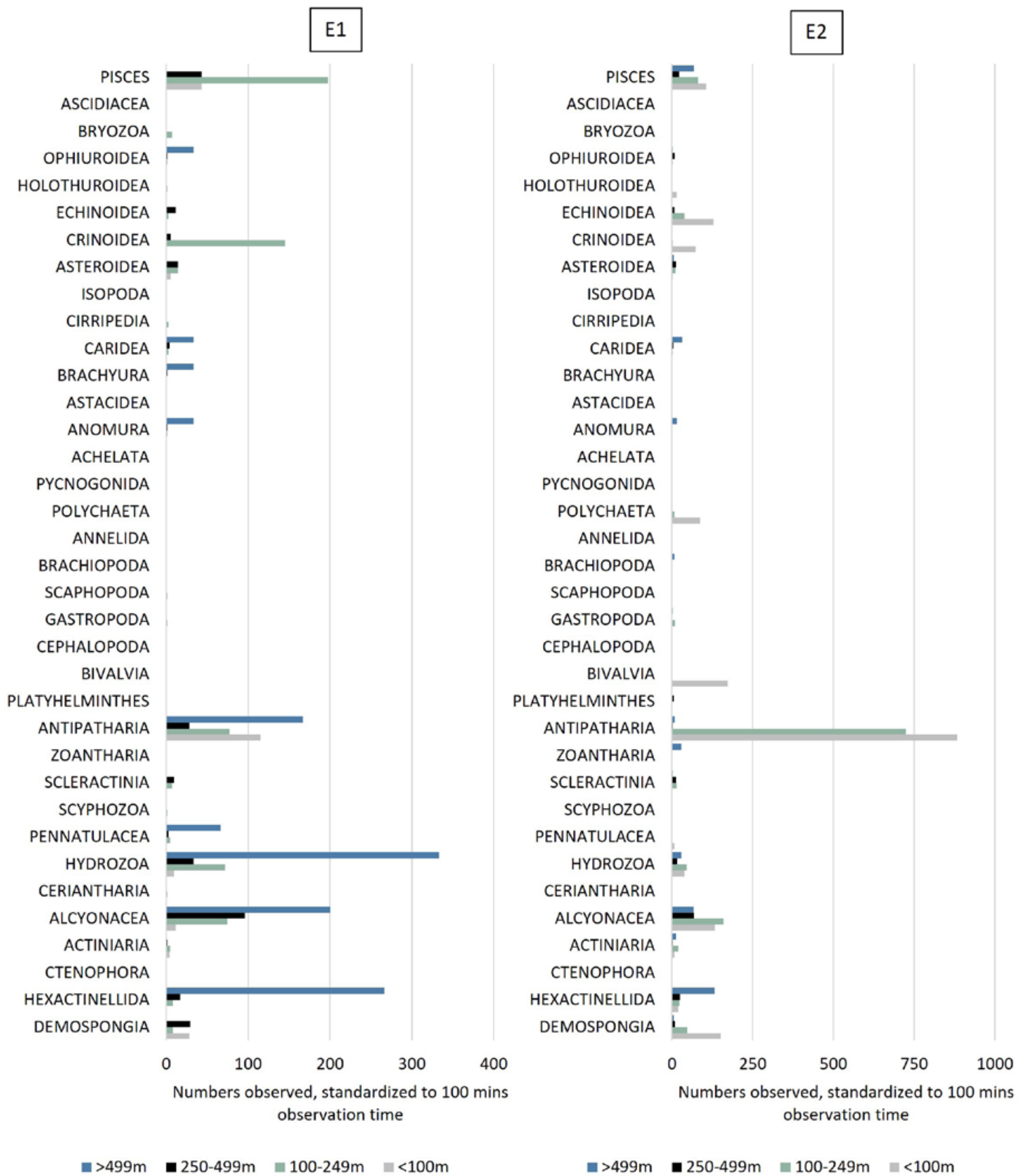

Figure 8. Higher-level taxonomical composition of the fauna recorded by video imagery on the eastern slope of Saya de Malha Bank, Locations E1 (left) and E2 (right). RV *Dr Fridtjof Nansen*, 2018. Note different scales on the numbers axes.

colonies occupying the anchorate spicules of the hexactinellid sponge *Hyalonema (Cyliconema) apertum.*

Seven of the Actiniaria were identified to genus (*Stephanauge* sp., *Dofleinia* sp., *Exocoelactis* sp., *Actinernus* sp., *Sicyonis* sp., *Hormathia* sp., *Paracalliactis* sp.) but several more to family level (e.g. two morphospecies in Hormathidiidae).

On the eastern and northern margins of the bank (Locations N1, E1 and 2), the density of corals (and sponges) was particularly high along the rim facing the deeper slope. The aggregations were multispecies assemblages typically observed at 75-120 m. Examples from Location E1 and E2, including aggregations of the antipatharian genus *Cirrhipathes* sp., are shown in Figure 9.

Table 3. Records of corals in the orders Alcyonacea, Pennatulacea and Scleractinia from Saya de Malha Bank. Identities and depth records of taxa for which good images were extracted from videos. RV *Dr Fridtjof Nansen*, 2018.

Order and family	Genus or species	Location and depth of observation, m				
		SS33	SS35	SS36	SS38	SS40
Alcyonacea:						
Nephtheidae	*Dendronephthya* sp.			83		
Acanthogorgiidae	*Acanthogorgia* sp.					88
Alcyoniidae	*Alcyonium* sp.					107
Nephtheidae	*Dendronephthya* sp.		111			
Ellisellidae	*Ctenocella* sp.				136	
Alcyoniidae	*Anthomastus* sp.				151	
Plexauridae	*Menella* sp.		168			
Alcyoniidae	*Anthomastus* sp.					237
Acanthogorgiidae	*Acanthogorgia* sp.					249
Acanthogorgiidae	Acanthogorgia sp. ?				285	
Primnoidae	*Callogorgia* sp.	294				
Alcyoniidae	*Anthomastus* sp.	383				
Acanthogorgiidae	*Acanthogorgia* sp.			463		
Acanthogorgiidae	*Acanthogorgia* sp.					657
Primnoidae	*Narella* sp.					710
Isididae	*Isidella* sp.			751		
Primnoidae	*Narella* sp.					774
Chrysogorgiidae	*Iridogorgia* sp.					806
Chrysogorgiidae	*Radicipes* sp.			821		
Chrysogorgiidae	*Chrysogorgia* sp.					848
Chrysogorgiidae	*Radicipes* sp.			878		
Pennatulacea:						
Pennatulidae	*Pennatula* sp.					75
Pennatulidae	*Pteroeides* sp.	82				
Pennatulidae	*Pennatula* sp.					84
Pennatulidae	*Pennatula* sp.				164	
Kophobelemnidae	*Kophobelemnon* sp.			757		
Kophobelemnidae	*Kophobelemnon* sp.			814		
Scleractinia:						
Caryophylliidae	*Caryophyllia* sp.				180	

Coral aggregations also occurred in deeper areas, mainly associated with rocky outcrops. Examples from Location E1, where such features were best developed, are shown in Figure 10. Similar observations were made in N1 and E2, but not in the western slope locations. Alcyonacean corals appeared to be prominent in these deep gardens.

Porifera

Multiple Demospongiae were observed in the two shallower depth zones where they were substrate-forming together with many other taxa. In deeper slope areas, fewer Demospongiae were observed and aggregations that might be classified as 'gardens' or 'sponge beds' were infrequent. The only example was the one shown in Figure 11 from the northeastern location E1 (SS 38) at 284 m. The sponges observed were Tetractinomorpha (Fig. A b).

Hexactinellida (Fig. A b) were common in all locations and some could be identified to genus and species level. On the western slope *Semperella schulzei* (600-800 m) and *Hyalonema (Cyliconema) apertum* (400-1000 m), and *Euplectella* sp. (400-500 m), possessing anchorate

Figure 9. Examples of multispecies coral and sponge gardens observed on margin of Saya de Malha Bank, in the eastern Locations denoted E1 and E2. Images are from 74 and 98 m. RV *Dr Fridtjof Nansen*, 2018.

spicules on the sand were present. Several representatives of Hexactinosida: *Aphrocallistes* (dead skeletons) and, likely *Farrea,* and several genera of Euretidae, were observed on bedrock habitats. These attach to the bottom directly by their base. Several specimens of *Pheronema* were also observed on both sandy and rocky substrata, and these have a wide tuft of anchorate spicules.

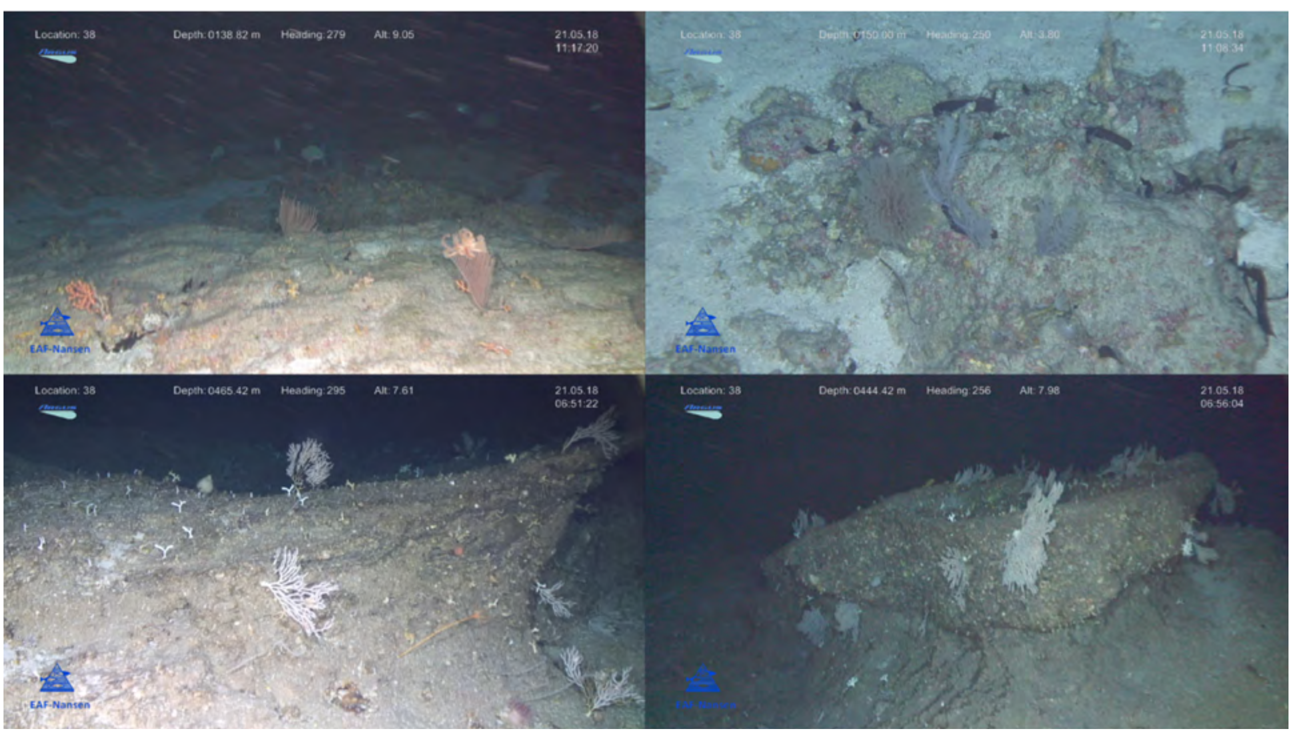

Figure 10. Examples of deep coral gardens observed on the slope of Saya de Malha Bank, in the Location denoted E1. The images are from 138 and 150 m (upper) and 465 and 444 m (lower). RV *Dr Fridtjof Nansen*, 2018.

Figure 11. Aggregation of Demospongiae observed at 285 m on gravelly substrate in the northeastern slope location (E1, SS 38) on Saya de Malha Bank. RV *Dr Fridtjof Nansen*, 2018.

On the eastern slope, no reliable observations were made of hexactinellids adopted for life on sands. The specimens living on hard substrata were more diverse; numerous specimens of live *Aphrocallistes* together with *Farrea* and several genera of Euretidae at depth of 200-1000 m, Corbitellinae (likely *Corbitella*) at about 200 m, representatives of the family Rossellidae at <400 m. The only hexactinellids with anchorate type of fixation observed was *Pheronema* at about 200 m.

Echinodermata

Echinoidea and Crinoidea featured among the ten more frequently observed taxa, but Asteroidea and Holothuroidea were also common. Images of some of the echinoderms observed are provided in Figure A.

Table 4 lists taxa of holothurians, asteroids and echinoids identified to lowest possible level from best images and associated depth records. These data do not reflect abundance, only best identities of recurring taxa. All the crinoids observed were stalkless and identified as Comatulidae and at least two morphospecies occurred in the area.

Crustacea

Shrimps provisionally assigned to Caridea ranked amongst the ten most abundant taxa. It is probable, however, that these records included both Caridea and Penaoidea. Images of recurring morphospecies are shown in Figure A d). Less common taxa were Anomura (hermit crabs, squat lobsters, and lithodoid crabs) and Brachyura (primarily specimens noted as *Chaceon* sp.). Only four burrowing lobsters were observed, three Achelata and one Astacidea (Fig. A e).

Mollusca

Bivalvia were not prominent in the observations other than in one location, i.e. the E2 (SS40) where an aggregation was seen at 87 m (Fig. A f). At least three morphospecies of cephalopods occurred (Fig. A f).

Ctenophora

The sessile ctenophore *Lyrocteis* sp. occurred in the two western slope locations attached to the seabed and various erect organisms (e.g. hexactinellid sponges, alcyonaria) (Fig. A f). The depth range of the records was 220-285 m.

Pisces

Fish occurred in all depth zones and locations, and representatives of 49 families were observed. However, about 40 % of the records could not confidently be assigned to a family, mainly because they were not examined closely enough or occurred too briefly to be identified. All the fish not assigned to family were teleosts and recorded as ‘unidentified Teleostei’.

Cartilaginous fishes were uncommon and contributed 5.3 % to the standardised abundance records for all

Table 4. Echinodermata records from Saya de Malha Bank. Identities and depth records of taxa for which good images were extracted from videos. RV *Dr Fridtjof Nansen*, 2018.

Order	Family	Species	Location and depth of observation, m				
Holothuriodea:			**SS33**	**SS35**	**SS36**	**SS38**	**SS40**
Synallactida	Stichopodidae	Stichopus sp. (*Stichopus pseudohorrens*?)			55		
Holothuriida	Holothuriidae	*Holothuria (Halodeima) edulis?)*					73
Holothuriida	Holothuriidae	*Actinopyga obesa?*					74
Holothuriida	Holothuriidae	*Holothuria (Halodeima) edulis?*)					74
Holothuriida	Holothuriidae	*Actinopyga ?*					75
Holothuriida	Holothuriidae	*Holothuria (Halodeima) edulis?*)					82
Holothuriida	Holothuriidae	*Holothuria (Halodeima) signata?)*					88
Holothuriida	Holothuriidae	*Holothuria* sp.					293
Synallactida	Synallactidae	Synallactidae gen. sp.1			573		
Synallactida	Deimatidae	*Oneirophanta* sp.?			608		
Synallactida	Synallactidae	Synallactidae gen. sp.2		759			
Synallactida	Deimatidae	*Oneirophanta* sp.?			797		
Elasipodida	Pelagothuriidae	*Enypniastes eximia*			884		
Persiculida		*Benthothuria* sp.			906		
Asteroidea:							
Valvatida	Ophidiasteridae	Ophidiasteridae gen. sp.	82				
Valvatida	Goniasteridae	Goniasteridae gen. sp.1		126			
Forcipulatida	Asteriidae	*Coscinasterias* sp.?		136			
Brisingida		Brisingida fam. Ind.1				136	
Forcipulatida	Pedicellasteridae			157			
Brisingida		Brisingida fam. Ind.1				158	
Valvatida	Oreasteridae?	Oreasteridae gen.sp.?		169			
Forcipulatida	Asteriidae	*Coscinasterias* sp.?				170	
Forcipulatida	Asteriidae	*Coscinasterias* sp.?				175	
Brisingida				198			
Notomyotida	Benthopectinidae	Benthopectinidae gen.sp.					243
Paxillosida	Astropectinidae	Astropectinidae gen. sp.	268				
Velatida	Pterasteridae	*Hymenaster* sp.	292				
Forcipulatida	Asteriidae	*Coscinasterias* sp.?		300			
Spinulosida	Echinasteridae	*Henricia* sp.					772
Echinoidea:							
Spatangoida					77		
Cidaroida					81		
Cidaroida							88
Cidaroida							89
Cidaroida							93
Cidaroida							94
Cidaroida							97
Cidaroida							100
subclass Euechinoidea				102			
Cidaroida	Cidaridae	*Prionocidaris ?*		102			
Cidaroida							102
Cidaroida	Cidaridae	*Prionocidaris ?*		103			
Superorder Echinacea				106			
Cidaroida				117			
Cidaroida				118			
Diadematoida	Diadematidae	*Astropyga radiata*		126			
Cidaroida						192	
Clypeasteroida	Clypeasteridae	*Clypeaster ?*			260		
Cidaroida						287	
Cidaroida							293
Cidaroida				348			
Cidaroida						358	
Cidaroida						440	
Echinothurioida	Echinothuriidae				798		
Echinothurioida	Phormosomatidae	*Phormosoma bursarium*			886		
Echinothurioida	Echinothuriidae	*Sperosoma* sp.			909		

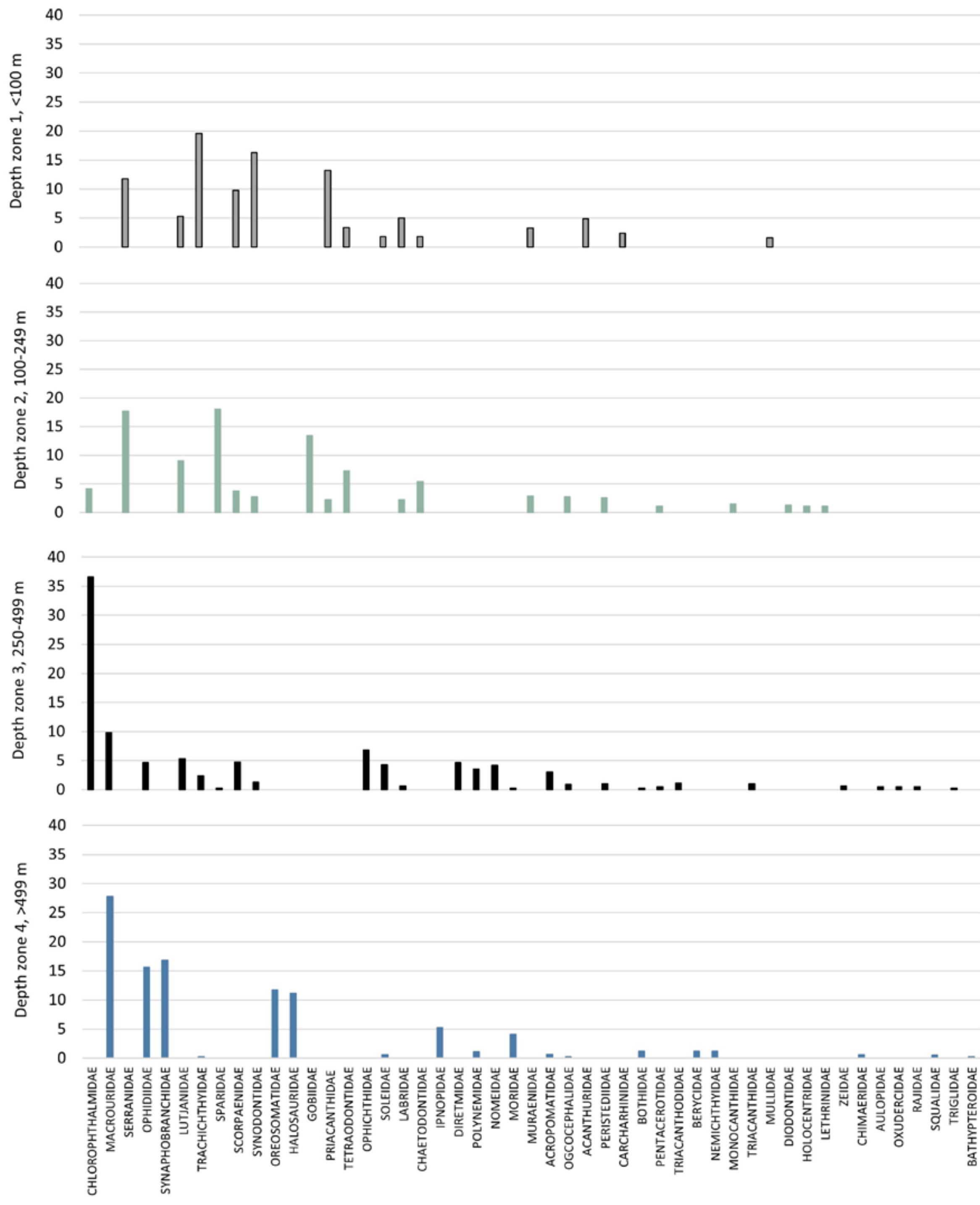

Figure 12. Fish families observed by ROV on the upper slopes of the Saya de Malha Bank, by depth zones. Compositions were derived by summing for each depth zone across the five study locations the standardised numbers observed, disregarding observations assigned to 'Unidentified Teleost'. Families are ordered from left to right according to declining total abundance in the entire study area. RV *Dr Fridtjof Nansen*, 2018.

depth zones and locations, reflecting sharks assigned to Squalidae and Carcharhinidae and some not assigned to family, a single Rajidae, and a single Chimaeridae. Apart from the single carcharhinid specimen, which was probably a silvertip shark (*Carcharhinus albimarginatus*) observed in Depth zone 1 (Location W2) at 77 m, all other observations of cartilaginous fishes were made in Depth zones 3 and 4.

Amongst the 45 teleost families, Chlorophthalmidae and Macrouridae were the most abundant with 70 and 64 records (12 and 11 % of the fish records identified to family, respectively). Families with 20-35 records were Serranidae, Ophidiidae, Synaphobranchidae, Lutjanidae, Trachichthyidae, Sparidae, Scorpaenidae, Synodontidae and Oreosomatidae. Some additional deepwater families such as Moridae, Halosauridae, and Ipnopidae were relatively frequently observed in the deepest areas.

The data were too sparse to compare fish abundance or family composition between the five slope locations. Pooling the data for all locations, some depth-related patterns emerged (Fig. 12). Macrourids were confined to Depth zones 3 and 4, and the Chlorophthalmidae to Depth zones 2 and 3. Figure 12 suggests that there may be a transition from the shallow plateau-associated fish assemblage, to a 'shelf-break' assemblage where the Chlorophthalmidae are prominent, and then to a deepwater fish assemblage from about 500 m with Macrouridae and other deep-sea families.

Images of some of the fishes observed are provided in Appendix Figure A f)-j) with, when available, more details on identity. The images were sorted by depth of occurrence from shallow to deep. While abundance appeared low at all depths, fish were consistently present in all habitats. Schooling Carangidae were observed in a few instances, as was aggregations of Sparidae associated with crevices. The Chlorophthalmidae were widespread and abundant and likely to be *Chlorophthalmus agassizi*.

In the two deepest depth zones representing the upper slope of the bank, at least seven morphospecies of Macrouridae were observed, probably two Ipnopidae, and one or more Moridae, Ophidiidae, Synaphobranchidae and Halosauridae. Only very few and seemingly solitary specimens of Trachicthyidae, probably *Hoplostethus atlanticus*, and Oreostomatidae, probably *Neocyttus acanthorhynchus,* were observed. Meso-and bathypelagic families were not included here because they were not recorded consistently.

Discussion

This study constitutes a first attempt to characterize the macro- and megafauna of the upper slopes of the Saya de Malha Bank, and it was not exhaustive. The VAMS vehicle used could only collect van Veen grab samples, and trawling was not permitted in the area. By reducing the influence of vessel motion and waves, the vehicle used in towed mode proved a good platform for lightweight ROV operations. However, using video imagery as the sole source of information constrained the study in several ways. Identification of organisms are tentative based on images alone, hence the taxonomical resolution remained low. The lack of scaling lasers on the ROV prevented recording of sizes of organisms, and it was also difficult to fully control key observation parameters such as distance to seabed, speed, and direction influencing observation volume and area. The investigation should therefore be regarded as an initial exploration. Specifically, the information provided on abundance patterns, standardized only by observation time, is therefore only indicative. Some main patterns of taxonomical composition and abundance still emerged but should be investigated in greater detail and with improved quantification methods in future studies.

Substrates were characterized visually and this may be acceptable for hard-bottom areas but less so for soft substrates. Studies of grab samples are needed to characterize soft substrates and to provide more insight into mineralization and consolidation processes. The impression from video data and scattered attempts to sample soft substrates was that the slopes had relatively little soft substrates. What appeared as sand may be rather consolidated sands with little loose material. Muddy areas were not observed on the slopes.

As expected, the abundance of organisms declined somewhat with depth and there was also a rather clear change in the composition of fauna (and flora) with depth from the deepest to shallowest areas observed. The deep occurrence of seagrass leaves down the slope illustrates an import of material from the adjacent inner parts of the bank which have extensive seagrass meadow patches. The occurrence of coral gardens and *Lithothamnion* beds along the margin, most pronounced in the eastern and northern transects, was a prominent feature. Demospongiae beds were uncommon, but in deeper areas hexactinellid sponges were ubiquitous and conspicuous.

The northern and eastern transects had more bare rock and consolidated sandy substrate that the western locations, and the abundance of suspension-feeding taxa was also highest in the east and north. This is an indication that the conditions for suspension feeders are better in areas most exposed to the main westwards-flowing prevailing currents.

Based on trawl data from depths shallower than the 500 m isobath collected in 1976 and 1977, Vortsepneva and Spiridonov (2008) provided a few comments on upper slope features. It is difficult to compare species lists between trawls and video observations. They noted that "Immovable sestonfeeders as a spongy, bryozoans and tunicate dominate in the slopes. East slope inhabits horny coral (Gorgonaria) that needs strong current. Abrupt change of assemblage can be observed on the border between slope and bottom." Although the data cannot be compared directly, these comments based on catch records correspond to some degree with the video observations from the present study.

The diversity of organisms was considerable but probably not high except in the shallowest slope locations. Conclusions on diversity are obviously tentative due to the low taxonomical resolution of the observations. The prominence of a few key taxa such as cnidarians, fish, echinoids and shrimps/prawns is probably not unexpected. It was somewhat surprising that 49 fish families occurred in the area, and the diversity may be quite high, partly reflecting the sampling of a range of assemblages from the margin of the bank to 1000 m depth.

Future studies should apply more quantitative approaches to study abundance patterns in greater detail and with higher confidence. Methods facilitating improved taxonomical resolution will be needed, also technology to obtain physical samples of organisms. That would permit stronger analyses and conclusions on abundance and diversity patterns. The videos and data from this investigation are kept by the EAF-Nansen contract partner (the Joint Management Area Commission), and by the Norwegian Marine Data Centre of the Institute of Marine Research. The results and data will contribute to future biodiversity assessments.

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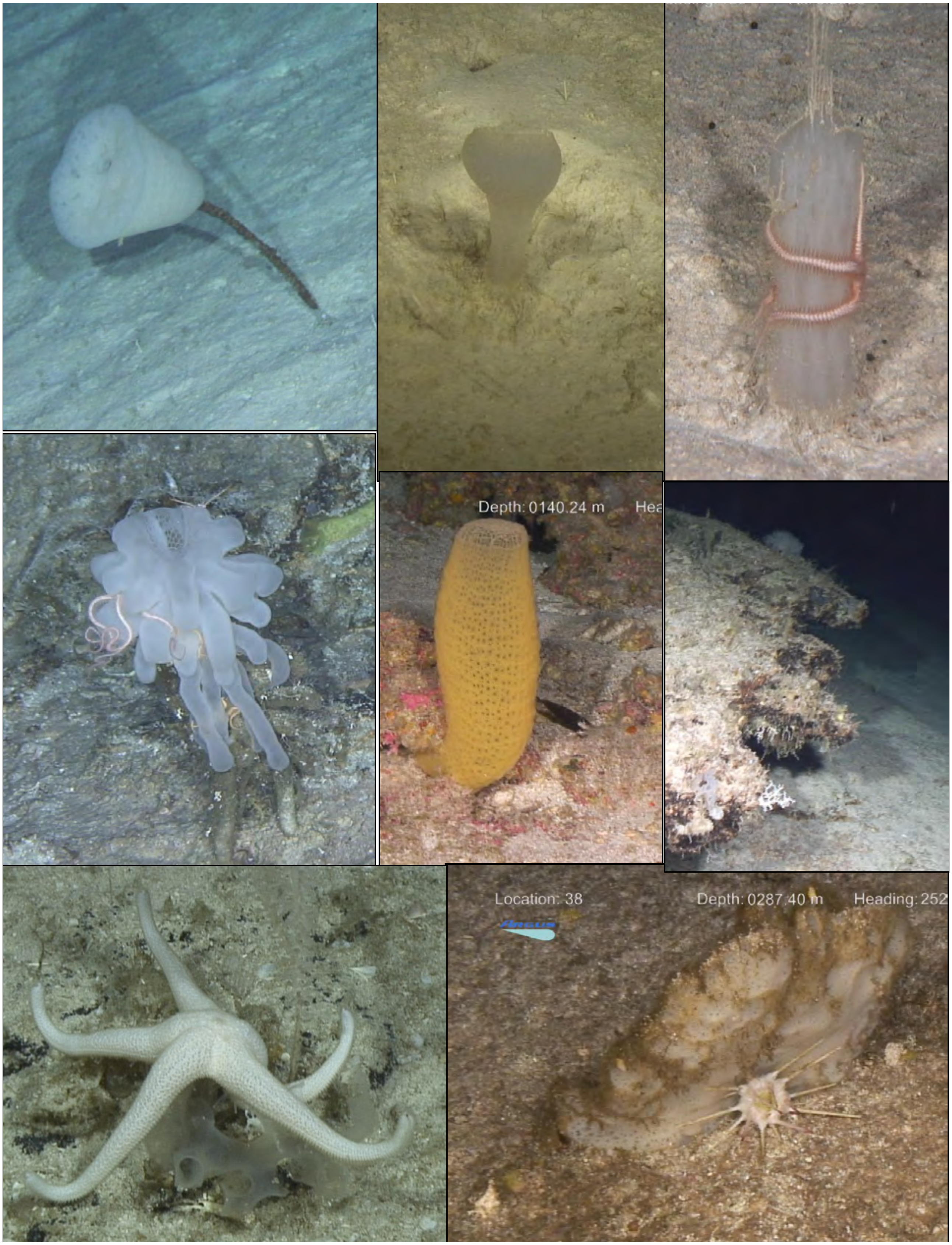
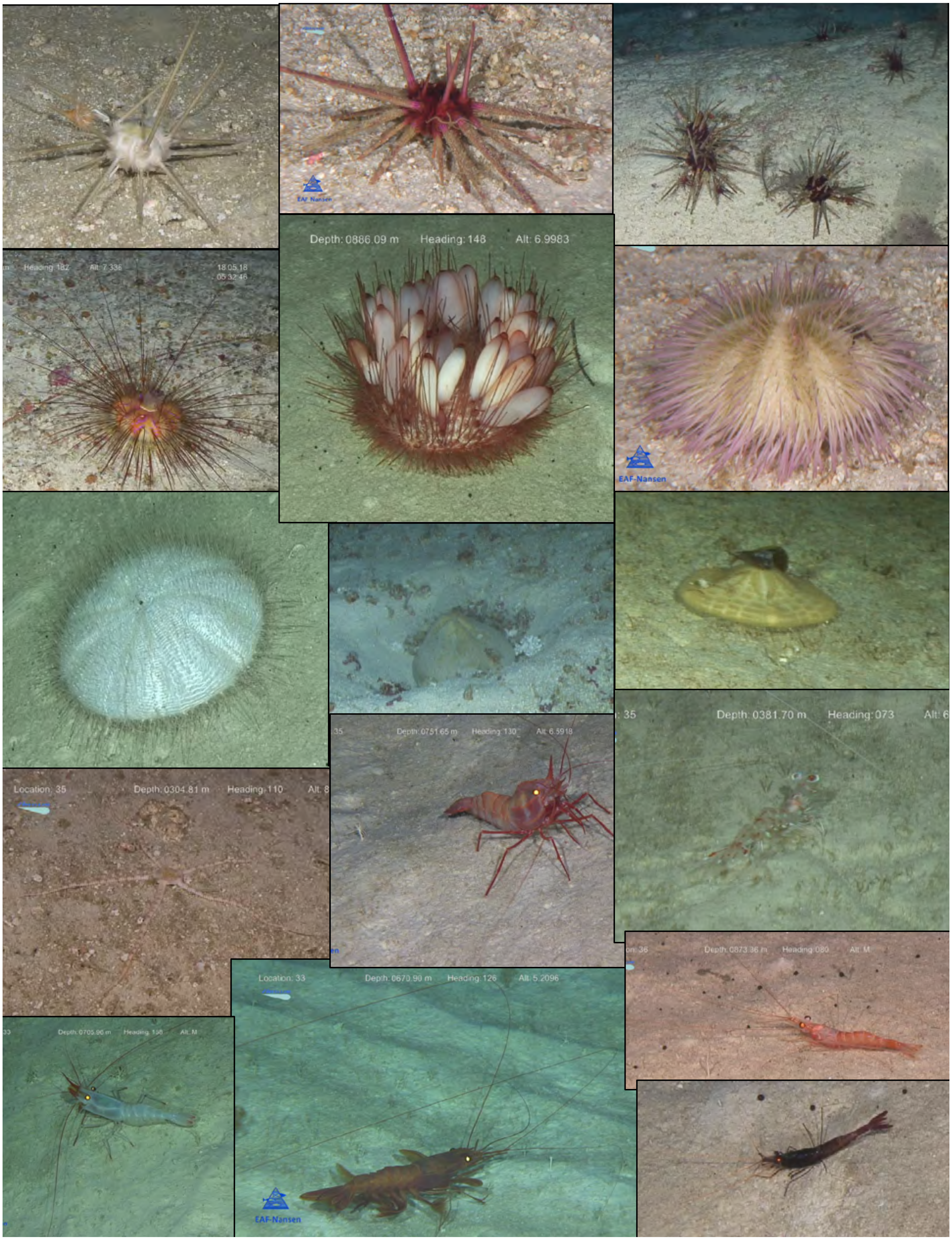
Appendix

Figure A. Selected images of invertebrates and fish extracted from video records from Saya de Malha Bank. SS-superstation. RV *Dr Fridtjof Nansen*, 2018. a) Cnidaria (from left to right, top to bottom): Zoantharia, possibly genus *Epizoanthus* (SS33, 728 m), Hydrozoa *Stylaster cf. subviolacea* (SS40, 877 m), Hydrozoa (top white colony) and Alcyonacea (with crab) (SS35, 379 m), Alcyonacea *Narella* sp. (SS40, 774 m), Alcyonacea *Anthomastus* sp. (SS40, 237 m), Scleractinia *Caryophyllia* sp. (SS38, 180 m), Alcyonacea *Chrysogorgia* sp. (SS40, 848 m), Alcyonacea *Acanthogorgia* sp. (SS40, 657 m), Alcyonacea *Alcyonium* sp. (SS40, 107 m), Pennatulacea *Pennatula* sp. (SS40, 75m), Antipatharia, *Cirripathes* sp. (two images from SS40, 271 and 108 m), Actiniaria *Sicyonis* sp. (SS40, 620 m), Actiniaria *Exocoelactis* sp. (SS40, 235 m), Hormathiidae (?) associated with hermit crab. (SS35, 400 m).



b) Porifera: hexactinellid sponge *Hyalonema* with zoantharia on anchorate spicules (SS 35, 765 m), hexactinellid, probably *Plathylistrum platessa* (SS 35, 995 m), hexactinellid, Pheronematidae (SS36, 990 m) with ophuiroid, hexactinellid, *Aphrocallistes beatrix* (SS38, 464 m), hexactinellid *Corbitellinae* (SS38, 140 m), hexactinellid *Farraea* (SS40, 710 m), asteroid (*Henricia* sp.) climbing on the hexactinellid *Farrae* (SS40, 772 m), Demospongiaa, Tetractinomorpha (SS38, 287 m).

c) Echinodermata: Asteroidea: *Hymenaster* (?) (SS33, 292 m), Astropectinidae (SS33, 268 m), Ophidiasteridae (SS33, 82 m), *Coscinasterias* sp.(?) (SS35,136 m), *Coscinasterias* sp. (?) (SS35, 136 m), Benthopectinidae (SS40, 243 m), Brisingida (SS35, 198 m), Brisingida (SS38, 136 m); Crinoidea: Order Comatulida (SS40, 74 m), Comatulida (SS40, 302 m), Comatulida (SS40, 80 m); Holothuroidea: Synallactidae (SS35, 760 m), juv. Stichopodidae? (SS40, 74 m), *Oneirophanta* sp.? (SS36, 797 m), *Enypniastes eximia* (SS36, 884 m).



d) Echinodermata continued, and Crustacea: Echinoids of order Cidaroida (SS35, 349m), order Cidaroida (SS35, 117 m), order Cidaroida, *Prionocidaris* (SS35, 103 m), *Astropygia radiata* (SS35, 127 m), *Phormosoma bursarium* (SS36, 886 m), superorder Echinacea (SS35, 106 m), *Sperosoma* sp. (SS36, 909 m), order Spatangoida (SS36, 77 m), Clypeaster (?)(SS36, 260 m); Ophiuroidea: indet. (SS35,304 m); Crustacea: Decapod shrimps (Dendrobranchiata and Pleocyemata) from SS 35 (751, 381 m), SS33 (705 m, 670 m), SS36 (873 m, 926 m).

e) Crustacea, Decapoda: Astacidea, Nephropoidea (*Acanthacaris* sp.?) (SS33, 757 m), Achelata (Palinuridae) (SS40, 94 m), Brachyura *Chaceon* sp. (SS38, 512 m and SS 36, 895 m), Anomura, Lithodoidea (SS33, 758 m and SS40, 624 m), Anomura, Paguroidea (SS35, 309 m), Anomura, Galatheoidea (SS35, 382 m).

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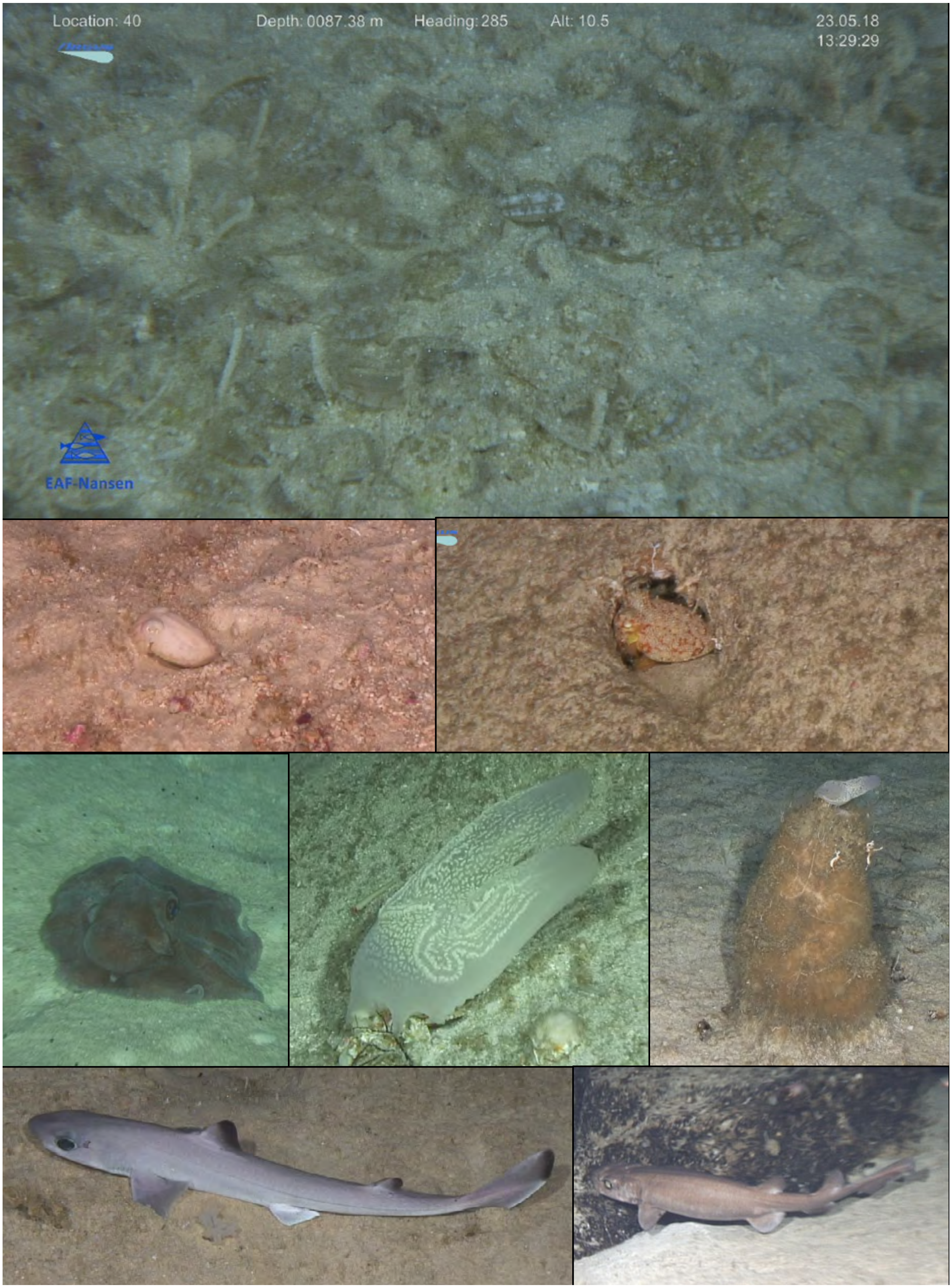
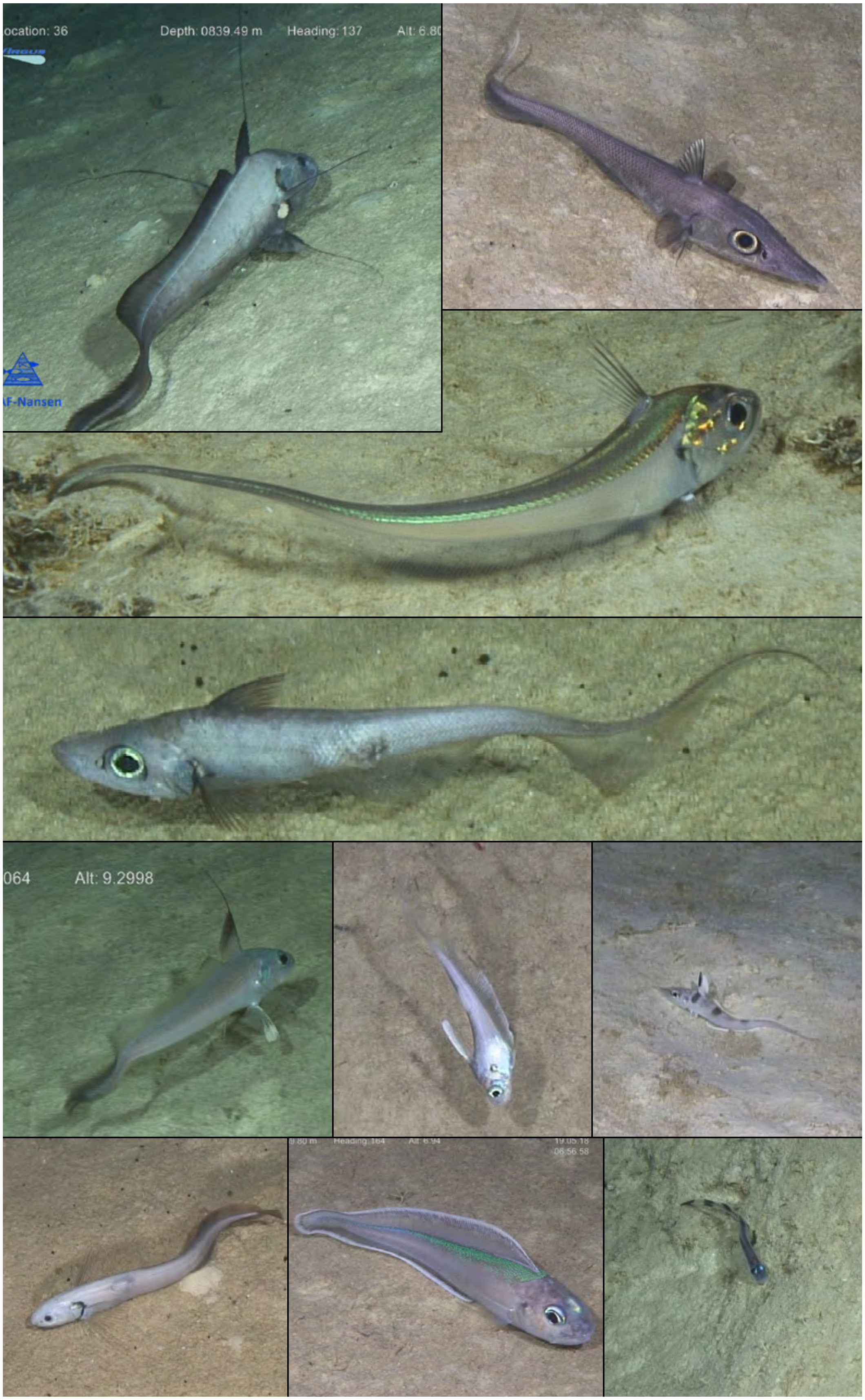


f) Mollusca: Bivalvia (SS40, 87 m), Cephalopod1 (SS40, 67m), Cephalopod2 (SS33, 274 m), Cephalopod3 (SS36, 904 m); Ctenophora: *Lyrocteis* sp. (SS35, 238 m), Ctenophora on top of hexactinellid sponge (SS33, 285 m); Pisces: Squalidae (SS40, 519 m) and indet. (SS40, 651 m).

g) Pisces continued: Sparidae, *Polysteganus* sp. (SS35, 198 m), Sparidae (SS36, 100 m), Peristediidae (SS35, 183 m), Peristediidae (SS36, 376 m), Muraenidae (SS35, 186 m), Tetraodontidae (SS38, 196 m), Tetraodontidae (SS40, 74 m), Mullidae (SS40, 74 m), Priacanthidae (SS38, 190 m), Serranidae, *Epinephelus aenus* (?) (SS38, 146 m).

h) Pisces continued: Carangidae, *Seriola rivoliana* (SS38, 107 m), Priacanthidae (SS40, 97 m), Lutjanidae (SS38, 72 m), Scorpaenidae (SS 40, 79 m), Scorpaenidae (SS40, 83 m), Synodontidae (SS40, 104 m), Chlorophthalmidae, *Chlorophthalmus* sp. (SS35, 384 m); same from SS35, 352 m; same from SS35, 356 m, Acropomatidae (SS38, 342 m), Ophichtiidae (SS33, 449 m), Bothidae (SS 33, 500 m).



i) Pisces continued, deepwater assemblage: Macrouridae1 (SS36, 840 m), Macrouridae2 (SS33, 657 m), Macrouridae3 (SS36, 890 m), Macrouridae4 (SS36, 526 m), Macrouridae5 (SS33, 701 m), Macrouridae6 (SS36, 557 m), Macrouridae7 (SS33, 505 m), Moridae (SS36, 872 m), Ophidiidae (SS36, 559 m), Ophidiidae (SS36, 501 m).

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j) Pisces continued, deepwater assemblage: Synaphobranchidae (SS36, 734 m; SS36, 870 m), Halosauridae (SS36, 930 m; SS36, 833 m), Trachicthyidae, probably *Hoplostethus atlanticus* (SS36, 567 m), Oreostomatidae, *Neocyttus acanthorhynchus* ? (SS36, 785 m), Ogcocephalidae (SS36, 663 m), Ipnopidae (SS36, 940 m), Ipnopidae (SS33, 710 m).