Hadal fauna of the South Sandwich Trench, Southern Ocean: Baited camera survey from the Five Deeps Expedition.

Alan J. Jamieson[1]*, Heather A. Stewart[2], Johanna N.J., Weston[3], Cassandra Bongiovanni[4]

[1]Minderoo UWA Deep-Sea Research Centre, School of Biological Sciences and Oceans Institute, The University of Western Australia, IOMRC Building M470, 35 Stirling Highway, Perth, WA 6009

[2]British Geological Survey, Lyell Centre, Research Avenue South, Edinburgh, UK, EH14 4AP

[3]School of Natural and Environmental Sciences, Newcastle University, Newcastle Upon Tyne, UK, NE1 7RU

[4]Caladan Oceanic LLC, 5909 Luther Lane, Dallas, Texas, US, TX 75225

*Corresponding Author: alanj@armatusoceanic.com

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Abstract

The South Sandwich Trench is a 965 km long arcuate subduction trench spanning the South Atlantic and Southern oceans, isolated from most other hadal (areas where water depths exceed 6000 m) environments by thousands of kilometres. This feature represents the coldest known hadal ecosystem with ambient sub-zero temperatures recorded from bathyal depths to over 7000 m water depth. Very little research has been carried out into the hadal fauna of this trench since the Russian expeditions of the 1960s and 70s. Here, we report the first visual assessment of hadal fauna from the South Sandwich Trench from a series of seven baited camera and trap deployments between 6044 m and the deepest point at 8265 m water depth, a location called *Meteor Deep*. Three species of hadal fish (Liparidae), with very low population densities were observed at depths shallower than expected, likely due to the piezo-thermal effect decreasing their depth range. Four species of scavenging amphipods were recovered, extending the known distribution of *Eurythenes andhakarae*, *Hirondellea dubia*, and *Bathycallisoma schellenbergi* to the South Sandwich Trench. Large densities of brittle stars (Ophiuroidea) were seen in the shallower hadal depths, while dense aggregations of holothurians (Elpididae) were observed within trench-fill basins located along the deep trench axis coincident with a visible surficial layer of surface derived detritus. In addition, gastropods, sponges, and stalked crinoids were observed. Importantly, this study highlights the endemic community present at hadal depth within this somewhat unique high pressure-low temperature environment.

Introduction

The Austrian geologist Eduard Suess (1831-1914) hypothesized in 1909 that an undersea feature of great depth would lie to the east of the South Sandwich Islands in the Southern Ocean (Suess, 1909). This initial hypothesis was founded on the reported similarities between the South Sandwich Islands and the Lesser Antilles Island arc in the Caribbean Sea. In the latter, it was already known that a deep-water feature, which would later be known as the Puerto Rico Trench, lay towards the north and east (Bencker, 1936; Jamieson et al., 2020). Seventeen years later, in 1926, the German vessel *RV Meteor* confirmed this hypothesis by sounding a depth of 8264 m at where is now known as the northern sector of the trench (Mauer and Stocks, 1933). The exact depth and location of "Meteor Deep" has varied through the intervening century (Zhivago, 2002; Allaby, 2009; Stewart and Jamieson, 2019) but is now known to be 8265 ± 13 m at 55.230° S / 26.173° W (Bongiovanni et al., 2021).

Following a series of sounding expeditions in the 1920s and 1930s (Kemp and Nelson, 1931; Herdman, 1932, 1948; Heezen and Johnson, 1965), the South Sandwich Trench was found to be an arcuate trench that stretches 965 km between 55° S to 61° S latitude, broadly parallel to the South Sandwich Islands. The trench is formed by the subduction of the southernmost section of the South American Plate beneath the South Sandwich Plate (Stewart and Jamieson, 2019) at a rate of 65–78 mm per year (Smalley et al., 2007).

~~Also~~ in the 1950s, it was proven that life exists to depths over 10,000 m (Bruun, 1951, 1956). Furthermore, these newly coined 'hadal' (depths >6000 m) communities exhibited high levels of endemism within the deep subduction trenches (Wolff, 1960; Belyaev, 1966). This endemism was assumed a result of often extreme isolation, whereby trenches deeper than 6000 m are typically partitioned from the next nearest trench of equivalent depth by hundreds or thousands of kilometres (Jamieson, 2015). The drivers of high 'hadal' endemism are considered, in part, due to a lack of inter-trench connectivity and unique suites of environmental variables at regional scales promoting local speciation (Jamieson~~,~~ et al., 2010).

On a larger scale, Vinogradova (1959) and Kussakin (1973) both proposed distinct biogeographic regions for the deep Southern Ocean based on high levels of endemism of the deep-sea fauna in general. Within one of the sub-regions or provinces, the 'Antarctic–Atlantic Subregion', Belyaev (1989) further proposed the 'South Antillean Hadal Province', containing only the South Sandwich Trench to delineate it and its fauna from the surrounding abyssal ecosystems. The hadal 'South Orkney Trench' (Stewart and Jamieson, 2018) was later added to the South Antillean Province by Vinogradova (1997).

The South Sandwich Trench hadal fauna are therefore of interest from both biogeographical and ecological perspectives. The trench's nearest hadal neighbour is the smaller and shallower (6820 m)

South Orkney Trench (Vaigachev, 1968), 1068 km to the west (Stewart and Jamieson, 2018). The next hadal feature of similar size and depth is the Atacama Trench, 5243 km to the northwest (Stewart and Jamieson, 2018), parallel to the west coast of South America. All other hadal trench systems are over 10,000 km away (Stewart and Jamieson, 2018). The trench is uniquely positioned between the Antarctic and southern temperate zones and straddles the area where the Pacific and Atlantic oceans converge. This location may be significant for tracing the dispersal of deep-sea fauna and evaluating the influence of the Antarctic fauna on the deep South Atlantic communities (Malyutina, 2004).

The South Sandwich Islands archipelago and Scotia Arc experience gradients in mean sea-surface productivity. The first is an east-west trend of higher productivity over the trench to the east of the South Sandwich Island chain compared to a marked drop-off west of the islands (Hogg et al., 2021). A second gradient is a north-south trend where low mean primary productivity occurs to the south that increases to the north in the vicinity of the *Meteor Deep*. Peak primary productivity shows the same, but more marked difference between low productivity in the south and high in the north (Hogg et al., 2021) that coincides with an abrupt transition between the "Antarctic" and "sub-Antarctic" bioregions delineated at Saunders Island (Roberts, 2012). This creates a north-south divide in the middle of the trench that also coincides with a shorter annual sea ice duration over the north of the trench than the south (Perissinotto et al., 1992).

While most all other hadal trenches experience ambient bottom temperatures of between 1 and 4°C, the South Sandwich and South Orkney trenches are the only known sub-zero hadal environments (Belyaev, 1989). These factors suggest the South Sandwich Trench could provide critical insights for hadal ecology. However, working at such depths coupled with extremely low temperatures, sea ice and often highly adverse weather conditions have meant it has been sampled infrequently, particularly at the hadal depths, relative to other trenches.

Biological sampling at hadal depths: 20th Century

In 1963, the United States Naval Ship *Eltanin* visited the South Sandwich Trench and performed three bottom trawls at ~6660-7700 m and deployed cameras to 6710, 6880 and 7610 m water depth (Belyaev, 1989). All stations were between 54°S and 57°S. The trawl to 7686 m obtained 20 specimens of polychaetes (Polychaeta). No information ~~available~~ about the two other trawls is publicly available.

In early 1971, the RV *Anton Bruun* performed five bottom trawls between 6052 and 8004 m, and two dredges (6875 and 7281 m) in the South Sandwich Trench between 55°S and 56°S. The number of trawled species average 34.2 ± 15 s.d. and totalled 16,200 specimens. The dredges recovered six and 12 species comprising 20 and 144 specimens respectively (Belyaev, 1989).

Also in 1971, the Russian RV *Akademik Kurchatov* (cruise 11) visited the South Sandwich Trench (and South Orkney Trench) to examine the composition and distribution patterns of the hadal community (Andriyashev et al., 1973). Near *Meteor Deep*, they successfully performed 15 trawls and 11 grabs. The trench fauna was considered rich and highly diverse, with hauls ranging from 35–40 species and 636–7,300 specimens. The catches were dominated by Elasipoda (Holothuiroidea), Ophiura (Ophiuridae), Siboglinidae (formally Pogonophora), and Polychaeta (Annelida). Other less numerous groups such as sponges, crinoids, sea urchins, isopods, and sipunculids were also recovered (Malyutina, 2004).

Biological sampling at hadal depths: 21st Century

The first colour image of the hadal South Sandwich Trench was captured in 2002 from a single deployment of Sediment Profile Imaging (SPI) camera (Diaz, 2004) during the Antarctic Benthic Deep-Sea Biodiversity Project (ANDEEP) II Expedition on board RV *Polarstern* (Brandt et al., 2004a). The vertical camera mounted on the SPI took eight images spanning 6.4 m^2 of the seafloor at 6333 m water depth. It imaged a dark greyish brown sandy-silt seafloor with pebbles and over 75% surface bioturbation including faecal coils, tracks, and feeding mounds and pits (Howe et al., 2004). The observed megafauna comprised of anemones (Actiniaria), Ophiuridea, Crinoidea, Holothuroidea and unidentified shrimp (Howe et al., 2004).

The ANDEEP II Expedition also ~~successfully~~ obtained 18 specimens of 7 species using an epibenthic sledge at 6348 m water depth (Brandt et al., 2004b). Assessment of isopod diversity at this site revealed just two families, Munnopsididae and Haploniscidae, with the former being most abundant. One specimen of the bivalve *Vesicomya (Kelliella) sirenkoi* (Egorova, 1998) was recovered from 6348 m depth using an epibenthic sledge (Linse, 2004). The infaunal communities from two multicore sites at 6316 and 6319 m recovered 12 specimens of 10 species including the polycheates *Travisia glandulosa* McIntosh, 1879 (Travisiidae) and an unidentified species in the *Prionospio* genus (Blake and Narayanaswamy, 2004). The meiofaunal community at 6316-6319 m water depth was dominated by nematodes belonging to 19 genera with *Monhystera* (Monhysteridae) being the most dominant (Vanhove et al., 2004). These combined studies represented a small foray into hadal depths within a larger, predominantly abyssal, research programme. In a practical sense, the ANDEEP II expedition likely ~~represent~~ a more complete abyssal data set in which to compare community structure with the Antarctic shelf, rather than offering any major insight into the deeper trench ecosystem. Our understanding of the biodiversity of true hadal fauna in this trench is still derived from the trawl and dredge campaigns of the 20th Century.

This study is centred around the Five Deeps Expedition's visit to the South Sandwich Trench in early 2019 and reports on the baited camera and trap results. These new imaging data provide the first visual assessment of hadal fauna across the entire depth range of this trench. We also collated every published record of hadal species from the South Sandwich Trench, cross checked and corrected where appropriate via the World Register of Marine Species (WoRMS 2021) as a resource for future sampling campaigns in the future (See Supplemental Data).

Materials and Methods

The Five Deeps Expedition was a privately funded circumglobal expedition to dive a crewed submersible (DSV *Limiting Factor*) to the deepest point in each of the five oceans (Stewart and Jamieson, 2019; Jamieson, 2020). The South Sandwich Trench Expedition took place 2nd-10th February 2019, supported by the DSSV *Pressure Drop*, that first utilised an EM124 hull-mounted multibeam echosounder (MBES; Kongsberg, Norway) to map the trench axis (Figure 1A) (see Bongiovanni et al. (2021) for specifics on MBES data acquisition and processing). Once submersible dive sites were identified based on the MBES, three identical free-fall landers (Skaff, Flere and Closp) were deployed as navigation aids that were also equipped with baited HD video cameras (IP Multi SeaCam 3105; Deep Sea Power and Light, San Diego, CA), baited invertebrate traps (15 cm Ø x 100cm funnel tubes) and conductivity, temperature, and depth (CTD) profilers (SBE 49 FastCAT; SeaBird Electronics, Bellevue, WA). The bait was whole mackerel (Scombridae). Two additional baited camera landers (Bad Spoon and Bad Ape) were deployed that were equipped with bespoke HD video cameras and baited invertebrate traps. The DSV *Limiting Factor* (Jamieson et al., 2019) was then deployed to survey the seafloor via four HD video cameras. On this expedition, however, the submersible's cameras failed to return any usable footage. Hereafter, we describe the results from the landers only.

Study sites

The Five Deeps Expedition had three sampling sites. The first site, named *Factorian Deep* (60.479°S / 25.542°W), was located at the southern end of the trench (Figure 1B). *Factorian Deep* represents the deepest point in the Southern Ocean (south of 60°S). Five lander deployments were undertaken at this site between 6044 and 7342 m. The second site was *Bitter Deep* (57.432°S / 24.048°W) located roughly halfway along the roughly north-south oriented trench axis (Figure 1C). There three landers were deployed but only one recovered data in the form of physical amphipod samples and CTD data from 8082 m. The third site was at the deepest point of the entire South Sandwich Trench, *Meteor Deep* (Figure 1D) (55.230°S / 26.173°W) where one lander was deployed to 8265 m. Both *Bitter Deep* and *Meteor Deep* are located north of 60°S, thus technically in the South Atlantic Ocean (Bongiovanni et al., 2021). Details of the deployment sites are listed in Table 1.

Species identification

Image-derived species-level identification is difficult in some deep-sea fishes. This problem is exacerbated by there being no records of hadal fish from the South Sandwich Trench on which to refer. To avoid using species names without confidence, we followed the recommendations of Horton et al. (2021) regarding the identification of ~~imaged~~ based data. We identified based on an established family or genus and used 'sp.' to denote unknown species followed by a number relating to morphotype and the code 'SAND' to identify the locality for comparison with other studies from the Five Deeps image archive. For example, Liparid sp. 2-SAND denotes an unknown species and genus of the Liparidae family with the 2nd identified body form from the South Sandwich Trench. Additionally, we used '*indet*' to indicate an indeterminable species, and '*stet*' to signify a further identification level has not been attempted, following Sigovini (2016).

Identification of epifauna is more difficult often due to cryptic speciation, small body size and examination of key morphological characters from underwater imaging being insufficient. In the results, we resort to class-level descriptions. Further, we do discuss likely identifications in the discussion based on historical findings.

Upon recovery and initial sorting of the physical samples from the invertebrate traps, amphipods were preserved using 70% ethanol. The samples were morphologically identified to the lowest rank possible, following Dahl (1959), Barnard and Ingram (1990), Barnard and Karaman (1991), d'Udekem d'Acoz and Havermans (2015), Kilgallen (2015), Kilgallen and Lowry (2015), and Weston et al. (2021a). Identification was conducted with a stereomicroscope (Wild Heerbrugg M8). Dissected appendages were temporarily mounted with glycerol and imaged with Leica DMi8 inverted microscope and DFC295 camera. Whole-type specimens were photographed with a Canon EOS 750D DSLR camera, Tamron SP 90mm f/2.8 VC USD Macro 1:1 VC Lens with a polarising filter, and Falcon Eyes CS-730 copy stand and processed with Helicon Focus and Helicon Remote software (Helicon Soft).

Results

Bathymetry and environmental conditions

A little over 15,000 km^2 of new MBES data were collected spanning the entire length of the trench (Figure 1). The deepest point of the Southern Ocean, the *Factorian Deep*, was recorded as 7432 ± 13 m and the *Meteor Deep* was 8265 ± 13 m. The depth of *Factorian Deep* was verified by the submersible dive as 7434 ± 3 m (Bongiovanni et al., 2021). *Bitter Deep* has a maximum depth of 8082 ± 13 m (57.432°S / 24.048°W) as derived from the MBES dataset.

The sea surface temperature at the *Factorian*, *Bitter* and *Meteor* deeps were 0.5, 1.7 and 3.1°C respectively (Figure 2). Beyond 500m depth, the temperatures decreased reaching 0°C at 2000 m (*Factorian*) 2800 (*Bitter*) and 3500 m (*Meteor*). Their respective temperature minimums were -0.33°C

(4000 m), -0.26°C (4500 m) and -0.22°C (5000 m). Thereafter, the temperature increased due to adiabatic heating to 0°C at 7500, 7200 and 7400 m respectively. The bottom temperatures were 0.01°C (*Factorian Deep*; 7432 m), 0.13°C (*Bitter Deep*, 8082 m) and 0.16°C (*Meteor Deep*, 8265 m). Beyond 500 m, salinity at all three sites remained approximately linear, decreasing slightly, but averaging 34.6 ± 0.01 S.D.

In the absence of physical samples, visual interpretation of the geology was based on gross~~er~~ characteristics rather than classic examples of grain size and/or mineral grains. The observed seafloor substrates within the South Sandwich Trench were variable. Ranging from potential outcrop of subaqueous volcanic deposits at 6044 m (Figure 3A), to relatively firm sediment blanket visible in the foreground with up to boulder sized talus blocks in the background at 6640 and 7099 m (Figure 3B-C), to very soft and flat sediments, likely a comparatively thick sediment blanket, at the deepest sites within trench-fill basins along the trench axis with particularly conspicuous surficial fluff layers of organic matter (Figure 3D-E).

Demersal fauna

Three species of hadal snailfish (Liparidae) were seen. The shallowest lander deployment, 6044 m, recorded two species of ~~hadal~~ snailfish. The first, Liparid sp. *indet.* 2-SAND (Figure 4A), had large black eyes and a pink-blue (darker and more blue anteriorly) robust body form. The second, *Paraliparis* sp. 1-SAND (Figure 4B), was in comparison more slender and blue-pink in colour. At 6640 m, *Paraliparis* sp. 1-SAND was seen again in addition to a third species, Liparid sp. *indet.* 3-SAND (Figure 4C). Liparid sp. *indet.* 3-SAND exhibited the 'ethereal' body morphology described by Linley et al. (2016). It had a large head relative to body, a prominent snout, elongated pectoral fins, and a fragile, largely translucent body. Also present at 6640m was an unknown macrourid, Macrourid sp. *stet.* 1-SAND, ~~likely to of the~~ *Coryphaenoides* genus (Figure 4D). The only other nektonic fauna observed by the baited cameras were amphipods and mysids, both of which were too small to confidently identify from video. Very few were seen at 6044 m, but their numbers increased substantially with depth (Figure 4E-G). The size of the trap capture did not necessarily reflect the increase in observed presence, which is likely due to current speed and direction. No fish were observed at the 7099 m site or deeper.

Four scavenging amphipod species (Superfamily: Lysianassoidea) were collected across the sites (Table 2). *Eurythenes andhakarae* d'Udekem d'Acoz & Havermans, 2015 (Figure 5A) was found in single numbers in the three shallowest depths. *Bathycallisoma schellenbergi* (Birstein & Vinogradov, 1958) (Scopeloceridae) were recovered from 6640 m and the deepest four depths, with over 2000 collected from 7400 m (Figure 5B). *Hirondellea dubia* Dahl, 1959, was found at 6640 m and the deepest four depths with large catches at 7400 and 8265 m. The fourth species is an unidentified and likely new species of *Tryphosella* Bonnier, 1893, which was collected at 7400 and 7439 m.

Epifauna

At 6044 m, no sessile organisms were observed on camera. However, at 6640 m, the presence of brittle stars (Ophiuroidea) increased starkly over time (Figure 6A-B). Although the resolution of the video is insufficient to quantify their numbers, a reasonable estimate would be >100 ophiuroids moving around the lander after several hours on the seafloor. These brittle star populations were interspersed with the occasional gastropod (Figure 6C). At 7099 m, ophiuroids were again aggregating towards the lander over time but in far few numbers, estimated at <5. At 7099 m, the lander landed directly next to a stalked crinoid (Crinoidea; Figure 6D). Another 12 stalked crinoids were seen attached to rocks in the background among several glass sponges (Hexactinellida; Figure 6E).

At the deeper locations at the *Meteor, Bitter* and *Factorian Deeps*, no epifauna were observed throughout the main observation periods. During the moments prior to the lander touching down on the sediment, many holothurians of the Elpididae family could be seen (Figure 6F). The density of elpidids was very high, over 100 individuals on a visible seafloor area of 2 m^2. The bow wave from the lander touching down on the extremely soft sediment was sufficiently disruptive to relocate all the holothurians that never returned to the area during the 3, 2 and 8 h observation periods respectively.

Discussion

As part of the Five Deeps Expedition, this study conducted the first visual assessment of hadal fauna across the entire depth range of South Sandwich Trench, including the deepest point. The South Sandwich Trench hosts a suite of geological and environmental attributes that are uncommon among hadal trenches. In this habitat, we found three species of snailfish, four species of scavenging amphipods, and large aggregations of brittle stars, stalked crinoids, and elpidid holothurians.

Environmental conditions

This study confirmed that the ambient temperature in much of the hadal depths of the South Sandwich Trench is sub-zero. Furthermore, the geomorphology was more complex than anticipated with habitat and substrates more complex than previously observed (e.g., Figure 3A and 6E; Stewart and Jamieson, 2018, 2019). The large holothurian densities at the deeper trench axis and the large aggregation of deposit feeding ophiuroids in the upper trench indicate the influence of the highly productive surface waters on regional biomass through high particulate flux (Malyutina 2004; Hogg et al., 2021). Such a visible surficial fluff layer of surface derived detritus is unusual in trenches at these depths (personal observation), as are the high densities of holothurians. Although increasing biomass with depth in Antarctic trenches is documented (Vinogradova et al., 1993), and large holothurian densities are known from trenches (Wolff, 1970; Andriyashev et al., 1973), they are seldom observable from a static fixed-point camera.

Epifauna

The identity of the holothurians is unclear from these data. Historical trawl efforts have identified ten species: three from the Order Apodida and seven from the family Elpidiidae Théel, 1882. They do not appear to be of the genera *Peniagone* Théel, 1882 or *Amperima* Pawson, 1965. The holothurians visually captured in this study are possibly a combination of the known species: *Elpidia decapoda* Belyaev, 1975, *Elpidia lata* Belyaev, 1975, *Elpidia ninae* Belyaev, 1975, or *Kolga hyalina* Danielssen and Koren, 1879. Which species, if any, are dominant, remains unresolved.

The identification of ophiuroids is also notoriously difficult from video. There are however four known species from the trench (Belyaev, 1989), all within the same depth range observed in this study: *Ophiurochaeta* sp. Matsumoto, 1915 (Ophiomyxidae), *Amphiophiura* sp. Matsumoto, 1915 (Ophiopyrgidae) *Ophiuroglypha irrorata polyacantha* (Mortensen, 1933) (Ophiuridae) and *Ophioplinthus* sp. Lyman, 1878 (Ophiuridae). Similar to the holothurians, the dominant species was uncertain.

Two gastropods are known from the South Sandwich Trench (Belyaev 1989), albeit their taxonomic identifications are tenuous: *Tectibranchiata* sp. G.O. Sars, 1878 (Scaphandridae) and what is referred to as "*Gastropoda prosobranchia*" H. Adams and A. Adams, 1853 (Turridae) in Belyaev (1989). Both have depths ranges overlapping with this study (7206-7934 m and 6052-8116 m, respectively). The gastropods in this study appears to be of the Neogastropoda order which includes the superfamilies Buccinoidea (that includes Buccinidae) and Conoidea (that includes Turridae).

There is one known species of sponge of the Class Hexactinellida known from the South Sandwich Trench (Belyaev, 1989), but it belongs to the Rossellidae~~,~~ Schulze, 1885, family. This is likely not what was observed in this study. While there are no known records of crinoids, stalked or otherwise, from the South Sandwich Trench, other than an observation of 'Crinoidea' from 6333 m (Howe et al., 2004), it is likely they are of the Bathycrinidae~~,~~ Bather~~,~~ 1899~~,~~ family.

Demersal fauna

The fish of the South Sandwich Trench differed to that of other published accounts of hadal fish, specifically with regards to abundance, dominance, and vertical zonation (Jamieson et al., 2009; Fujii et al., 2010; Linley et al., 2016). While the deepest fish in any given trench are consistently liparids, there is typically one abundant species, interspersed with another rarer species. Notably, three liparids species were observed in the South Sandwich Trench. None of the species appeared to be numerically dominant over another and all in very low numbers. Another interesting observation is that in all trenches where liparids are present, they are found to be most abundant between 7000 and 8000 m water depth, with maximum numbers around 7500 m (Fujii et al., 2010; Linley et al., 2017). Contrastingly, in the South Sandwich Trench they were not seen deeper than 6640 m, which is 1000 m shallower than predicted.

Pressure tolerance is not an exclusive effect of hydrostatic pressure but is heavily influenced by the ambient temperature. Higher temperatures can enable tolerance of higher pressure, also known as the piezo-thermal effect (Cossins and MacDonald 1989; Childress 1995). While the ambient temperature of other trenches is between 1 and 4°C, the South Sandwich snailfish are adapted to temperatures of -0.05 ˚C ± 0.09 s.d. The piezo-thermal effect may help explain why the range of the South Sandwich snailfish are 1000 m shallower to snailfish from other trench systems and regions (Linley et al., 2017).

Of the three different morphotypes, Liparid sp. *indet.* 2-SAND had a body form more akin to the *Notoliparis* Andriashev, 1975 and *Careproctus* genera and is relatively similar compared to the other hadal snailfish species (e.g., *Notoliparis kermadecensis* (Nielsen, 1964) and *Pseudoliparis swirei* Gerringer & Linley, 2017). The only other record of liparids from this region is *Careproctus sandwichensis* Andriashev & Stein, 1998 recovered from 5435-5453 m in the South Sandwich Trench (Andriashev and Stein 1998). Based on external morphology, Liparid sp. *indet.* 2-SAND could be *C. sandwichensis* but physical samples would be required as confirmation. We can confidently place the second, and smaller, darker morphotype *Paraliparis* sp. *1*-SAND, in that genus based on its external morphology. The third morphotype, Liparid sp. *indet.* 3-SAND, resembles the 'ethereal' body form, which has been similarly observed 8178 m at the Mariana Trench (Linley et al., 2016). However, while this body type has been observed, a specimen has never been recovered. As such, a genus has not yet been determined or established (Linley et al., 2016).

In comparison to other hadal features, the overall species richness of scavenging amphipods was low (Fujii et al., 2013, Lacey et al., 2016; Weston et al., 2021b). Yet, each of the four species is ecologically notable. The surprising find in this study is perhaps the discovery of *Hirondellea dubia* in the South Sandwich Trench. To date, this species has only been known from southwest Pacific trenches i.e. Kermadec, Tonga, and New Hebrides trenches (Lacey et al., 2016) and the Mariana Trench (Ritchie et al. 2015). The nearest known population of *H. dubia* to the South Sandwich Trench is in the Tonga Trench, some 10,745 km to the west (Stewart and Jamieson, 2018). Additionally, this is the first record of *Bathycallisoma schellenbergi* in the Southern Ocean. This is less surprising as *B. schellenbergi* has been found at the nearby South Orkney Trench (1068 km away; Kilgallen and Lowry, 2015) and is considered to be a widespread, pan-oceanic species but is always limited to hadal depths (Belyaev, 1989; Blankenship et al., 2006; Lacey et al., 2016; Weston et al., 2021b). *Eurythenes andhakarae* is known to be localised to the Southern Ocean between 3069-4625 m (d'Udekem d'Acoz and Havermans, 2015; Havermans, 2016). Here, we find that *Eurythenes andhakarae* has a eurybathic vertical distribution (4030 m), similar to other sister species (Havermans, 2016; Weston et al., 2021a; 2021b). Moreover, this highlights the importance of expeditions to resolve the geographic and bathymetric ranges of species more fully. In addition, a consistent depth trend was observed - *Eurythenes* at the shallower hadal depths of the trench and *B. schellenbergi* and *H. dubia* at the deeper end, a common trend in most trenches studied to date (Blankenship et al., 2006; Fujii et al., 2013, Lacey et al., 2016; Weston et al., 2021a). However, to date these species identifications are based on morphology, therefore are *sensu lato* pending molecular analysis to confirm individual species, populations or population connectivity with other trenches.

Notable absences

In addition to scavenging amphipods, predatory liparids, and the epifaunal taxa (i.e., holothurians, ophiuroids and crinoids), there are few notable absent faunal groups. For example, most baited camera surveys at these depths show a conspicuous ~~present~~ of the penaeoidea (Decapoda), often *Cerataspis monstrosus* Gray 1828 in the abyssal-hadal transition zone and almost always *Benthesicymus crenatus* Bate 1881 in the upper trench depths (Swan et al., 2021). Indeed, Swan et al. (2021) reported on the global distribution of lower abyssal and hadal decapoda (including the observational data from this study) and concluded that bait-attending decapods were absent at depths exceeding 4000 m in both the Arctic and Southern oceans. Given the presence of Lysianassoid amphipods that *B. crenatus* typically preys upon, and the salinity and pressure being equal to most areas they are encountered, their absence is surprising. However, Howe et al.~~,~~ (2004) mentions the sighting of 'shrimp' at 6333 m but does not elaborate further on its identification. Similar to depth zonation patterns of liparids, it seems plausible that the sub-zero temperatures are playing an inhibiting role in their absence from the South Sandwich Trench.

Another notable absence was gelatinous fauna. Jamieson and Linley (2021) collated 136 recent lander observations from 14 deep sites spanning all oceans (including this dataset) of hydrozoans, scyphozoans, larvaceans and ctenophores and found no observations of any in the Arctic or in the South Sandwich Trench. However, a high frequency of near-bottom larvaceans were found in the nearest two study sites to the South Sandwich Trench: the South Shetland Trench (5200 m water depth) ~2000 km to the west and the Agulhas Fracture Zone (5493 m water depth) ~3000 km to the northeast. Hydrozoans, mostly Trachymedusae were also observed at these other two sites, but not in the South Sandwich Trench. Given the proximity of the abyssal South Shetland Trench to the hadal

South Sandwich Trench, this incongruence may be an abrupt boundary between abyssal and hadal, or perhaps more likely a regional environmental or temporal trend, as larvaceans are now known from hadal depths (e.g., Java and Kermadec trenches) and from other sub-zero environments (South Shetland Trench; Jamieson and Linley 2021).

Conclusion

The South Sandwich Trench is a relatively isolated hadal ecosystem that exhibits sub-zero temperatures, and partial sea ice cover ~~which is unique to all but one other hadal trench.~~ However, a similar hadal fauna to the better-studied trenches still persists. The vertical distribution of fish, and potentially the absence of groups such as the scavenging decapods, are likely due to the extremely low temperatures compared to most other trenches. Furthermore, the high densities of holothurians on the trench axis and the ophiuroids on the upper slopes suggest a significant energy input from the surface. However, the spatial and temporal heterogeneity in mean and peak surface productivity, and sea ice cover across the South Sandwich Trench could act as catalysts of ~~latitudinally~~ variation in diversity and abundance.

Future studies should aim to address three main ecological aspects: 1) the piezo-thermal effect on the physiology that drives vertical zonation at extreme depths, 2) the direct measurement of the particular organic carbon flux to the hadal depths of the trench and its role in supporting elevated populations of some taxa at spatial and temporal scales, 3) the genetic connectivity of species present in both the South Sandwich Trench and other hadal trenches that are often isolated by thousands of kilometres of abyssal and bathyal seafloor and 4) comparison of the hadal species to their non-hadal Southern Ocean relatives.

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Figure Legends

Figure 1. A-The South Sandwich Trench with new Five Deeps Expedition acquired bathymetry (colour) overlaid on GEBCO_2019 bathymetry (greyscale). B-The *Factorian Deep*, Southern Ocean. C-The *Bitter Deep*, South Atlantic Ocean. D-The *Meteor Deep*, South Atlantic Ocean. E-Regional location map. Red dots mark the deepest points in the trench (*Meteor Deep*) and the Southern Ocean (*Factorian Deep*). Black crosses on panels B-D mark the sample stations ~~on panels B-D mark the sample stations~~ listed in Table 1. All bathymetry sourced from Gebco Compilation Group (2019), Bongiovanni et al. (2021) and Caladan Oceanic LLC (2021).

Figure 2. Vertical temperature profiles for *Meteor Deep* (A) and *Bitter Deep* (B) and *Factorian Deep* (C) in the South Sandwich Trench.

Figure 3. Seafloor substrates of the South Sandwich Trench. A – Subaqueous volcanic deposits (6044 m; *Factorian Deep*), B and C– firm sediment with talus comprising large boulders (7099 and 6640 m respectively; *Factorian Deep*), D and E – soft sediment drape within enclosed basins located on the trench axis (D at 7439 m; *Factorian Deep*; E at 8266 m; *Meteor Deep*). The latter two represent the deepest point in the Southern Ocean and South Sandwich Trench respectively.

Figure 4. Demersal fauna of the South Sandwich Trench. A - Liparid sp. *indet.* 2-SAND (6044 m), B - *Paraliparis* sp. 1-SAND (6044-6640 m), C - Liparid sp. *indet.* 3-SAND (6640 m), D - Macrourid sp. *stet.* 1-SAND (6640 m), E – scavenging amphipod aggregation at 6640 m, F – scavenging amphipod aggregation at 7099 m, and G the largest aggregation of scavenging amphipods at 7439 m despite burial of the bait in soft sediment.

Figure 5. Two scavenging amphipod species recovered from the South Sandwich Trench. A - *Eurythenes andhakarae* (7099 m); and B – *Bathycallisoma schellenbergi* (8266 m). Scale bar represents 1 cm.

Figure 6. Epifauna of the South Sandwich Trench. A – aggregation of ophiuroids (6640 m), B – Single ophiuroid (6640 m), C – gastropod (6640 m), D – close-up of crinoid (7099 m), E – magnified and enhance image of crinoids and sponges (7099 m), F – high density of elpidid holothurians at 7400m at the point of lander touchdown with magnified inset showing characteristic tubular feet of Elpididae.

Tables

Table 1. Deployment details of the landers deployments in the South Sandwich Trench. Bottom time represents the time the traps were on the seafloor while film time is the duration of the filming period post landing. * indicates an estimated time.

Deployment	Date	Lander	Latitude	Longitude	Depth (m)	Location	Bottom time/ film time (min)
SST_SK1_7400	3/2/2019	Skaff	-60.4783	-25.5467	7432	*Factorian Deep*	486/486
SST_FL1_7400	3/2/2019	Flere	-60.4783	-25.5383	7400	*Factorian Deep*	500*/0
SST_BS1_7000	3/2/2019	Bad Spoon	-60.4933	-25.5350	7099	*Factorian Deep*	641/433
SST_BA1_6500	3/2/2019	Bad Ape	-60.5050	-25.5333	6640	*Factorian Deep*	770/520
SST_CL1_6000	3/2/2019	Closp	-60.5250	-25.5283	6044	*Factorian Deep*	125/125
SST_FL2_8100	5/2/2019	Flere	-57.5350	-23.9717	8082	*Bitter Deep*	125/125
SST_FL3-8200	10/2/2019	Flere	-55.2298	-26.1731	8265	*Meteor Deep*	172/172

Table 2. Scavenging amphipod samples and counts collected from baited funnel traps in the South Sandwich Trench. All samples were identified based on morphological.

Species	6044	6640	7099	7400	7432	8082	8265
Eurythenes andhakarae	1	1	1	-	-	-	-
Bathycallisoma schellenbergi	-	34	-	2178	37	34	339
Hirondellea dubia	-	>1000	-	>2000	575	54	>1000
Tryphosella sp.	-	-	-	132	203	-	-

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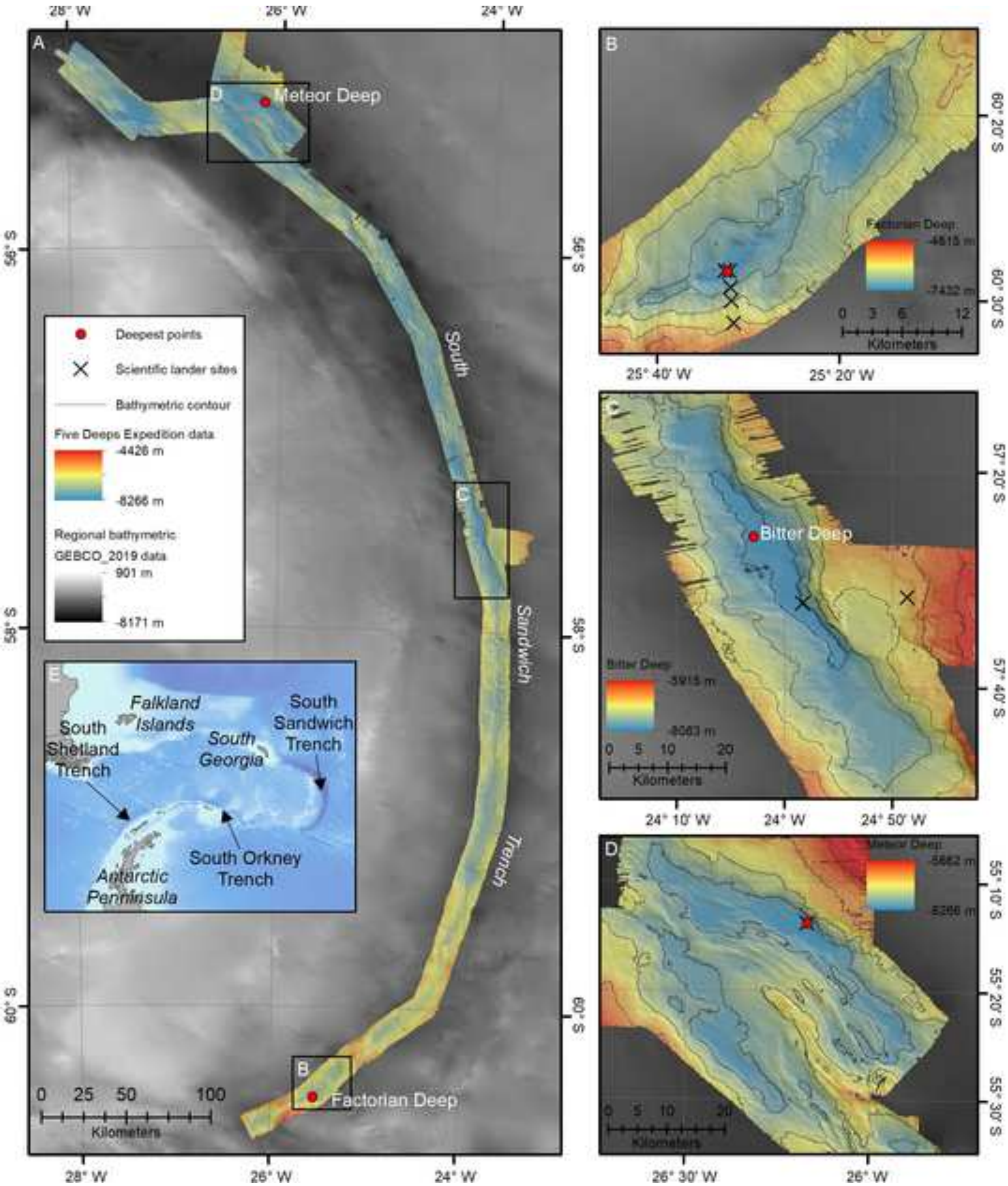
A
B
C
D
E
Meteor Deep
Factorian Deep
Bitter Deep
South
Sandwich
Trench
Deepest points
Scientific lander sites
Bathymetric contour
Five Deeps Expedition data
-4426 m
-8266 m
Regional bathymetric
GEBCO_2019 data
901 m
-8171 m
Falkland Islands
South Shetland Trench
South Georgia
South Sandwich Trench
South Orkney Trench
Antarctic Peninsula
0 25 50 100
Kilometers
28° W
26° W
24° W
56° S
58° S
60° S
Factorian Deep
-4815 m
-7432 m
0 3 6 12
Kilometers
25° 40' W
25° 20' W
60° 20' S
60° 30' S
Bitter Deep
-3915 m
-8063 m
0 5 10 20
Kilometers
24° 10' W
24° W
24° 50' W
57° 20' S
57° 40' S
Meteor Deep
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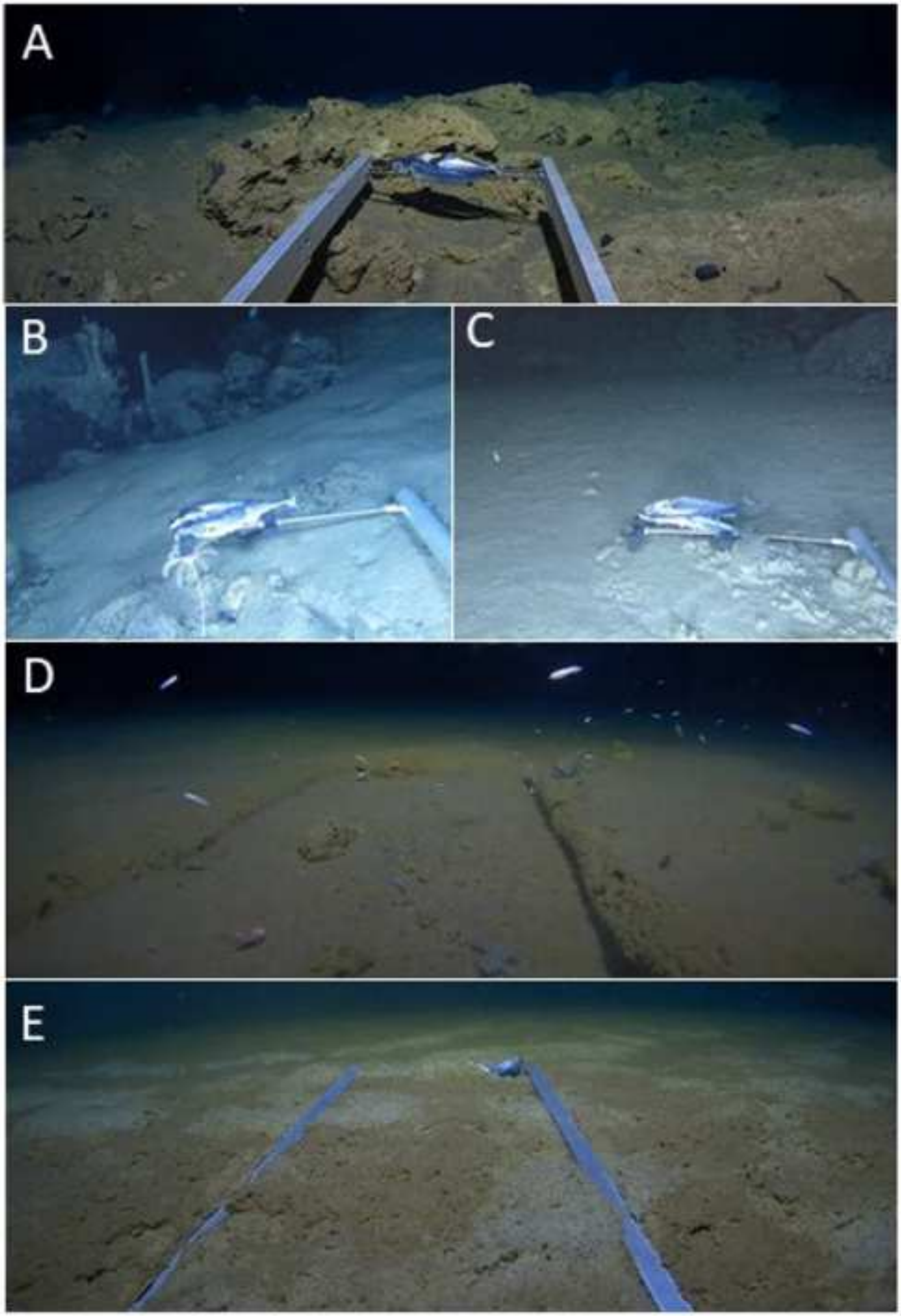
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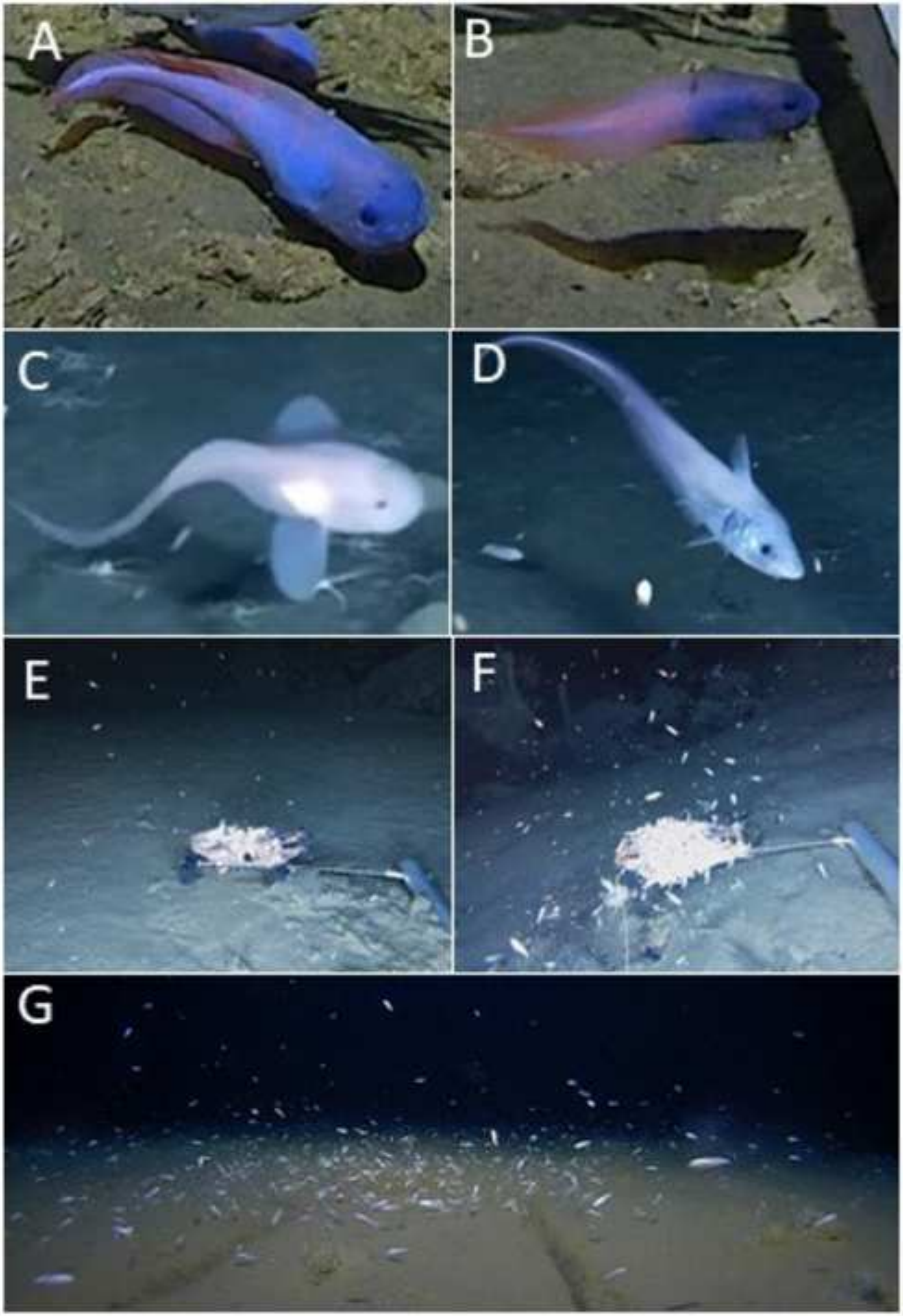
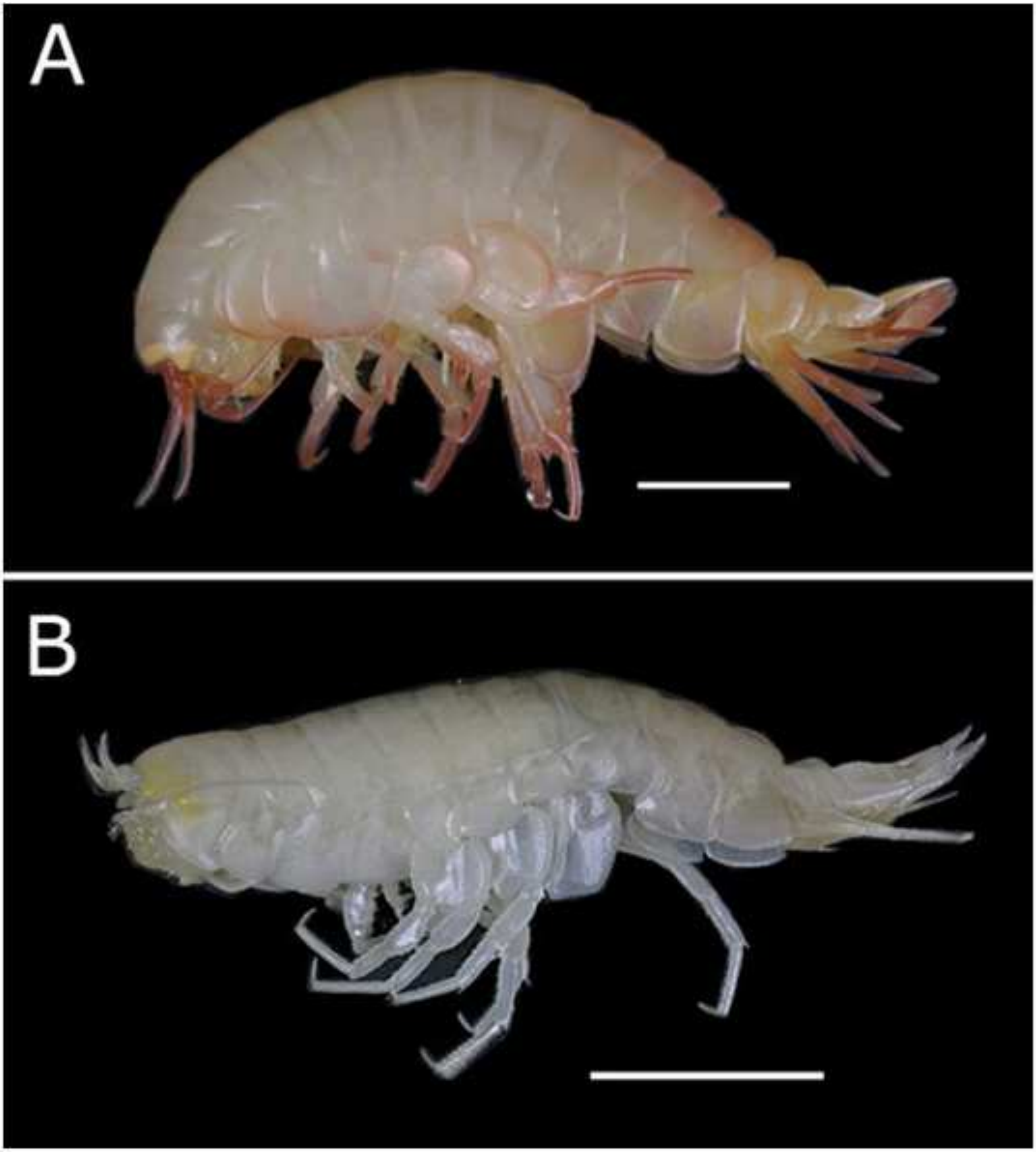
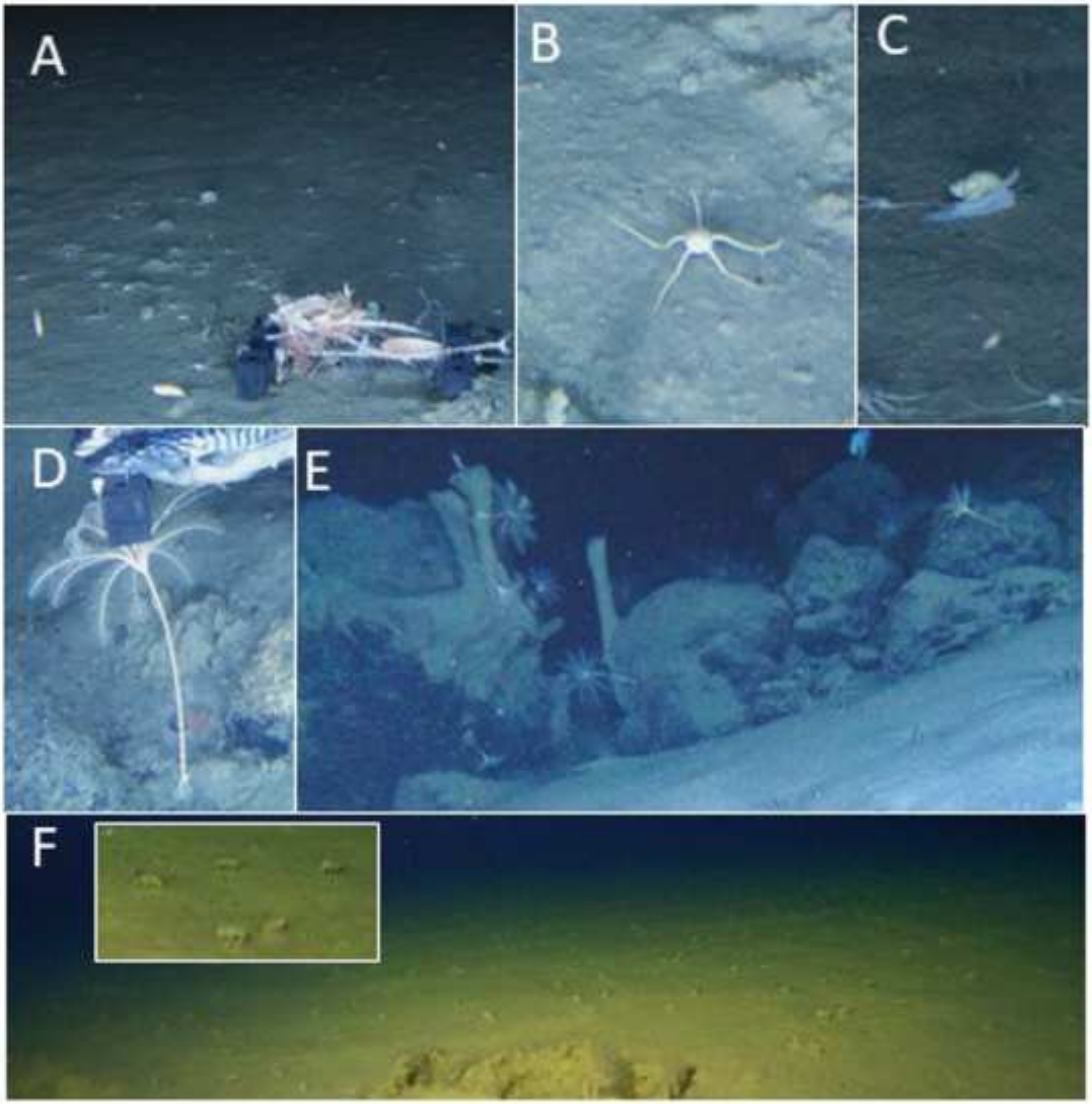
Click here to access/download;Figure;Figure 4.jpg




A
B


A
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F2

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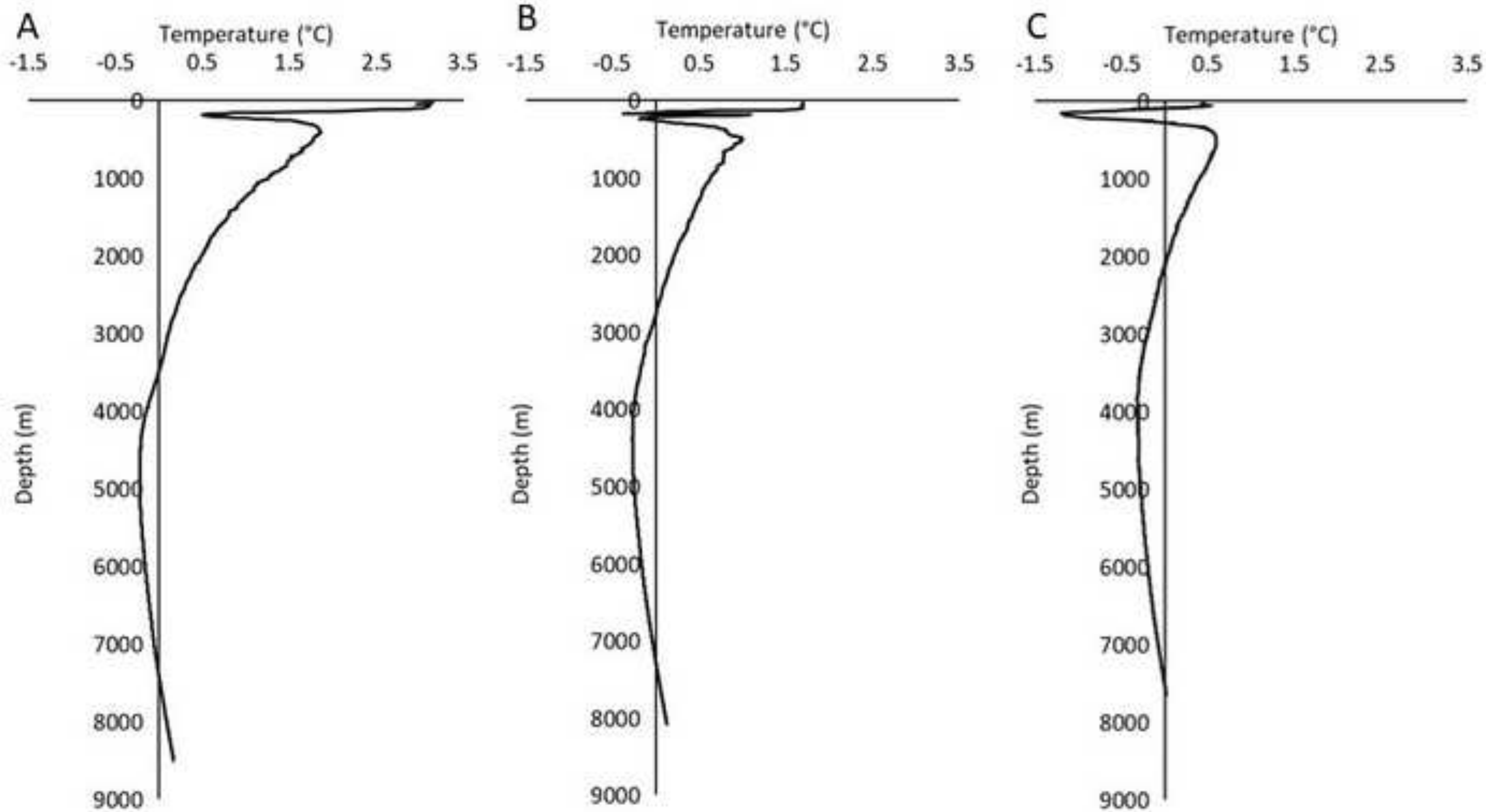

Supplemental Table S1: All published records of hadal species from the South Sandwich Trench, cross checked via World Register of Marine Species (WoRMS, 2021) and corrected where appropriate. Genus and species names in parentheses indicate the published record prior to correction following WoRMS (2021). ** indicates no known species in the WoRMS database.

Phylum	Class	Order	Family	Species	Min. Depth (m)	Max. Depth (m)	Authority	Record reference
Nematoda	Chromadorea	Araeolaimida	Diplopeltidae	Araeolaimus	6316	6319	de Man, 1880	Vanhove et al. 2004
				Diplopeltula	6316	6319	Gerlach, 1950	Vanhove et al. 2004
				Southerniella	6316	6319	Allgén, 1932	Vanhove et al. 2004
		Chromadorida	Chromadoridae	Acantholaimus	6316	6319	Allgén, 1933	Vanhove et al. 2004
			Cyatholaimidae	Paralongicyatholaimus	6316	6319	Schuurmans Stekhoven, 1950	Vanhove et al. 2004
		Desmodorida	Microlaimidae	Microlaimus	6316	6319	de Man, 1880	Vanhove et al. 2004
			Desmodoridae	Desmodora	6316	6319	de Man, 1889	Vanhove et al. 2004
				Pseudochromadora	6316	6319	Daday, 1899	Vanhove et al. 2004
		Desmoscolecida	Desmoscoledidae	Tricoma	6316	6319	Cobb, 1894	Vanhove et al. 2004
		Monhysterida	Linhomoeidae	Linhomoeus (Paralinhomoeus)	6316	6319	Bastian, 1865	Vanhove et al. 2004
			Monhysteridae	Monhystera	6316	6319	Bastian, 1865	Vanhove et al. 2004
				Diplolaimella	6316	6319	Allgén, 1929	Vanhove et al. 2004
			Xyalidae	Daptonema	6316	6319	Cobb, 1920	Vanhove et al. 2004
				Manganonema	6316	6319	Bussau, 1993	Vanhove et al. 2004
		Plectida	Camacolaimidae	Procamacolaimus	6316	6319	Gerlach, 1954	Vanhove et al. 2004
			Aegialoalaimidae	Aegialoalaimus	6316	6319	de Man, 1907	Vanhove et al. 2004
			Diplopeltoididae	Diplopeltoides	6316	6319	Gerlach, 1962	Vanhove et al. 2004
			Leptolaimidae	Leptolaimus	6316	6319	de Man, 1876	Vanhove et al. 2004
	Enoplea	Enoplida	Oxystominidae	Thalasooalaimus	6316	6319	de Man, 1893	Vanhove et al. 2004

Porifera	Hexactinellida	Hexasterophora	Rossellidae	*Hyalascus (Hyalospongidae*?)	6766	7216	~~Ijima, 1896~~	Belyaev (1989)
				"Hexactinellida"	7044	7044	~~Schmidt, 1870~~	This study
Cnidaria	Anthozoa	Pennatularia	Kophobelemnonidae	*Kophobelemnon molanderi*	6052	6150	Pasternak, 1975	Belyaev (1989)
			Umbellulidae	*Umbellula lindahli*	6052	6150	Kölliker, 1875	Belyaev (1989)
		unknown	unknown	"Anemone"	6333	6333	~~Ehrenberg, 1834~~	Howe et al. 2004
Annelida	Polychaeta	Eunicida	Lumbrineridae	*Abyssoninoe (Lumbrineris) abyssorum*	6052	6150	(McIntosh, 1885)	Belyaev (1989)
		Phyllodocida	Aphroditidae	*Laetmonice benthaliana*	6766	6875	McIntosh, 1885	Belyaev (1989)
			Goniadidae	*Bathyglycinde longisetosa*	7218	7934	Levenstein, 1975	Belyaev (1989)
			Phyllodocidae	*Sige (Eulalia) sandwichensis*	6052	7218	(Uschakov, 1975)	Belyaev (1989)
			Polynoidae	*Bathymoorea* aff. *renotubulata*	6052	6150	(Moore, 1910)	Belyaev (1989)
				Macellicephala tricornis	7200	8116	Levenstein, 1975	Belyaev (1989)
				Macellicephaloides sandvichensis	7200	7934	Levenstein, 1975	Belyaev (1989)
			Sigalionidae	*Leanira quatrefagesi*	6050	6150	Kinberg, 1856	Belyaev (1989)
		Drilomorpha	Capitellidae	*Notomastus latericeus*	6875	7216	Sars, 1851	Belyaev (1989)
		Terebellida	Fauveliopsidae	*Laubieriopsis brevis*	6052	6150	(Hartman, 1967)	Belyaev (1989)
			Flabelligeridae	*Ilyphagus (brada)* sp.	6052	7934	Chamberlin, 1919	Belyaev (1989)
			Maldanidae	*Notoproctus oculatus antarcticus*	6766	6875	Arwidsson, 1911	Belyaev (1989)
			Opheliidae	*Travisia (Kesun abyssorum) glandulosa*	6052	8116	McIntosh, 1879	Belyaev (1989)
			Cirratulidae	*Tharyx* sp. ~~sp.~~	7200	8116	Webster & Benedict, 1887	Belyaev (1989)
			Cirratulidae	*Chaetozone biannulata*	743	6337	Blake 2018	Blake and Narayanaswamy 2004
			Ampharetidae	*Amphicteis gunneri*	7686	7686	(M. Sars, 1835)	Belyaev (1989)
		Sabellida	Siboglinidae	*Spirobrachia leospira*	8004	8116	Gurjeeva, 1975	Belyaev (1989)
		Spionida	Spionidae	Prionospio sp. 1	6316	6319	Malmgren, 1867	Blake and Narayanaswamy 2004

			Travisiidae	Travisia (Kesun abyssorum) glandulosa	6316	6319	McIntosh, 1879	Blake and Narayanaswamy 2004
Echuira	Echiuroidae	Bonelliida	Bonelliidae	*Jakobia birsteini*	7200	7216	Zenkevitch, 1958	Belyaev (1989)
Echinodermata	Crinoidea			"Crinoidea"	6333	6333	Miller, 1821	Howe et al. 2004
				"Stalked Crinoid"/ Bathycrinidae?	7099	7099	Bather, 1899	This study
	Echinoidea	Spatangoida	Pourtalesiidae	*Pourtalesia* aff. *Debilis*	6100	6650	Koehler, 1926	Belyaev (1989)
	Ophiuroidea	Ophiurae	Ophiomyxidae (Ophiodermatidae)	*Ophiurochaeta* sp.	6052	6150	Matsumoto, 1915	Belyaev (1989)
			Ophiopyrgidae (Ophiuridae)	*Amphiophiura* sp.	6052	6150	Matsumoto, 1915	Belyaev (1989)
			Ophiuridae	*Ophiuroglypha (Ophiura) irrorata polyacantha*	6052	6150	(Mortensen, 1933)	Belyaev (1989)
				Ophioplinthus (Ophiurolepis) sp.	6052	7216	Lyman, 1878	Belyaev (1989)
				"Ophiuroidea"	6333	6333	~~Gray, 1840~~	Howe et al. 2004
				"Ophiuroidea"	6044	6640	~~Gray, 1840~~	This study
	Asteroidea	Paxillosida	Porcellanasteridae	*Eremicaster vicinus*	6052	6150	Ludwig, 1907	Belyaev (1989)
				Porcellanaster sp.	6052	6150	~~Wyville Thomson, 1879~~	Belyaev (1989)
		Velatida	Pterasteridae	*Hymenaster* sp.	6052	6150	Wyville Thomson, 1873	Belyaev (1989)
	Holothuroidea	Apodida	Myriotrochidae	*Neolepidotrochus (Lepidotrochus) variodentatus*	6766	7934	(Belyaev & Mironov, 1978)	Belyaev (1989)
				Prototrochus bipartitodentatus	7694	8116	(Belyaev & Mironov, 1978)	Belyaev (1989)
				Prototrochus sp. (aff. *Longissimus**)*	6052	6150	Belyaev & Mironov, 1982	Belyaev (1989)
		Elasipodida	Elpidiidae	*Amperima velacula*	6052	6150	Agatep, 1967	Belyaev (1989)
				Elpidia decapoda	6052	6150	Belyaev, 1975	Belyaev (1989)
				Elpidia lata	8004	8116	Belyaev, 1975	Belyaev (1989)
				Elpidia ninae	6766	7634	Belyaev, 1975	Belyaev (1989)
				Kolga hyalina	6052	6150	Danielssen & Koren, 1879	Belyaev (1989)

				Peniagone herouardi	7694	7934	Gebruk, 1988	Belyaev (1989)
				Peniagone incerta	6052	6875	(Théel, 1882)	Belyaev (1989)
				"Elpididae"	7439	8266	Théel, 1882	This study
		unknown	Unknown	"Holothuroidea"	6333	6333	not listed	Howe et al. 2004
Mollusca	Scaphopoda	Galilida	Entalinidae	*Entalinidae* sp.	6052	6150	~~Chistikov, 1979~~	Belyaev (1989)
	Gastropoda	Toxoglassa	Turridae	*"Gastropoda prosobranchia"*	6052	8116	H. Adams & A. Adams, 1853 (1838)	Belyaev (1989)
		Tectibranchiata	Scaphandridae	*Tectibranchiata sp.*	7206	7934	~~G.O. Sars, 1878~~	Belyaev (1989)
		Neogastropoda		"Neogastropoda"	6640	6640	Wenz, 1938	This study
	Bivalvia	Nuculida	Nucalanidae (Ledellidae)	*Parayoldiella (Parayoldiella) sp.*	8004	8116	Filatova, 1971	Belyaev (1989)
			Nuculanidae	*Yoldia (Yoldiella)* sp. sp.	6875	6875	A. E. Verrill & Bush, 1897	Belyaev (1989)
			Malletiidae	*Malletia* sp. n.	7200	7934	Desmoulins, 1832	Belyaev (1989)
			Lyonsiellidae	*Policordia* sp. 1	7200	7216	~~Dall, Bartsch & Rehder, 1938~~	Belyaev (1989)
			Neilonellidae	*Pseudoneilonella (Tindaria)* cf. *virens*	6464	6464	(Dall, 1890)	Linse 2004
			Yoldiidae	*Yoldiella sp. 1*	6464	6464	~~A. E. Verrill & Bush, 1897~~	Linse 2004
			Yoldiidae	*Yoldiella sp. 2*	6464	6464	~~A. E. Verrill & Bush, 1897~~	Linse 2004
		Mytilida (Lucinida)	Mytilidae	*Dacrydium* sp.	6050	6150	~~Torell, 1859~~	Belyaev (1989)
		Verticordiidae	Verticordiidae	*Laevicordia* sp.	6050	6150	~~Seguenza, 1876~~	Belyaev (1989)
		Arcidae	Limopsidae	*Limopsis sp. n. 1*	6464	6464	~~Sasso, 1827~~	Linse 2004
		Pectinida	Propeamussiidae	*Cyclopecten sp. 2*	6464	6464	~~A. E. Verrill, 1897~~	Linse 2004
		Venerida	Vesicomyinae	*Vesicomya (Kelliella) sirenkoi*	6464	6464	(Egorova, 1998)	Linse 2004
			Cuspidariidae	*Cuspidaria* cf. *tenella*	6464	6464	E. A. Smith, 1907	Linse 2004
				unidentified heterodont	6464	6464	Neumayr, 1884	Linse 2004
Sipuncula	Sipunculidea	Golfingiida	Golfingiidae	*Nephasoma (Golfingia) minuta*	6052	6150	(Keferstein, 1862)	Belyaev (1989)

				Nephasoma (Nephasoma) diaphanes diaphanes	6052	6150	(Gerould, 1913)	Belyaev (1989)
			(Phascolionidae)	*Phascolion (montuga) lutense*	6052	6150	Selenka, 1885	Belyaev (1989)
Arthopoda	Malacostraca	Mysida	Mysidae	*Amblyops* sp. n. 2	7200	7216	~~G.O. Sars, 1872~~	Belyaev (1989)
		~~Mysida~~		*Neobirsteiniamysis (Birsteiniamysis)* sp. n.	7200	7216	Hendrickx & Tchindonova, 2020	Belyaev (1989)
		Cumacea	Nannastacidae	*Cumacea* sp. ~~sp.~~	6766	7216	~~Bate, 1866~~	Belyaev (1989)
		Tanaidacea	Akanthophoreidae (Leptognathiidae)	*Chauliopleona (Leptognathia) armata*	6052	6150	(Hansen, 1913)	Belyaev (1989)
				Chauliopleona (Leptognathia) gracilis	6052	7218	(Krøyer, 1842)	Belyaev (1989)
			Leptognathiidae	*Leptognathia (paraforcifera**)*	6052	6150	Sars, 1882	Belyaev (1989)
			Neotanaidae	*Neotanais kurchatovi*	7200	7934	Kudinova-Pasternak, 1975	Belyaev (1989)
		Isopoda	Acanthaspidiidae	*Iolanthe (Acanthaspidia) curtispinosa*	6766	7216	(Vasina & Kussakin, 1982)	Belyaev (1989)
			Arcturidae	*Arcturus* sp.	7200	7216	~~Latreille, 1829~~	Belyaev (1989)
			Desmosomatidae	Multiple species	6348	6348	~~G. O. Sars, 1897~~	Brandt et al. 2004
			Haploniscidae	Multiple species	6348	6348	~~Hansen, 1916~~	Brandt et al. 2004
		Amphipoda	Eurytheneidae	*Eurythenes* sp.	6044	7099	~~S. I. Smith in Scudder, 1882~~	This study
			Scopelocheidae	*Bathycallisoma schellenbergi*	6640	8265	(Birstein & Vinogradov, 1958)	This study
			Hirondelleidae	*Hirondellea dubia*	6640	8265	Dahl, 1959	This study
				Hirondellea sp.	7400	7432	~~Chevreux, 1889~~	This study
		Decapoda	unknown	"shrimp"	6333	6333	~~Latreille, 1802~~	Howe et al. 2004
	Pycnogonida	Pantopoda	Austrodecidae	*Pantopipetta longituberculata*	6052	6150	(Turpaeva, 1955)	Belyaev (1989)
Hemichordata	Enteropneusta	Enteropneusta	Torquaratoridae?	*Enteropneausta* sp.	8004	8116	Holland et al. 2005	Belyaev (1989)
Chordata	Actinopteri	Gadiformes	Macrouridae	Macrourid sp. *stet.* 1-SAND (*Coryphaenoides*?)	6640	6640	Gunnerus, 1765	This study
		Perciformes	Liparidae	Liparid sp. *indet.* 2-SAND	6044	6044	~~Gill, 1861~~	This study

	Paraliparis sp. 1-SAND	6044	6640	~~Colett, 1879~~	This study
	Liparid sp. *indet.* 3-SAND	6640	6640	~~Gill, 1861~~	This study

Conflict of Interest

The authors declare no conflicts of interest

Dear Editor,

We hereby submit the revised manuscript entitled "Hadal fauna of the South Sandwich Trench, Southern Ocean: Baited camera survey from the Five Deeps Expedition" for publication in Deep-Sea Research Part II as part of the South Sandwich special issue headed by Martin Collins at BAS. Many thanks to the editor and the two reviewers for their helpful comments.

While most of the comments and corrections were minor and easy to deal with, Reviewer number 2's comments were harder. Their comment on the surface productivity, I think, has greatly improved the intro to the area. However, the second comment regarding TMAO and the drivers of depth in fishes is a lot harder and well beyond the scope of this paper. I have written a justification for not going down this route in the responses document.

Also, reviewer 1 asked for greater comparison with Russian data (and others we presume). This is very hard as the available data is split between a lot of cores at the shallow end, a lot of trawls at the deep end and our camera survey through the middle therefore it is not very helpful or meaningful to try and compare any of these, instead we decided to include a supplementary table listing every known species from STT in the literature in the hope that this will serve as a useful resource to those visiting the area in the future. This list has been extensively cross checked with the WoRMS data base.

I hope this is all to your satisfaction.

Regards

Alan Jamieson on behalf of co-authors.