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Bait attending fishes of the abyssal zone and hadal boundary: Community structure, functional groups and species distribution in the Kermadec, New Hebrides and Mariana trenches

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ABSTRACT

Baited landers were deployed at 83 stations at four locations in the west Pacific Ocean from bathyal to hadal depths: The Kermadec Trench, the New Hebrides Trench, the adjoining South Fiji Basin and the Mariana Trench. Forty-seven putative fish species were observed. Distinct fish faunal groups were identified based on maximum numbers and percentage of observations. Both analyses broadly agreed on the community structure: A bathyal group at < 3000 m in the New Hebrides and Kermadec trenches, an abyssal group (3039 – 4692 m) in the Kermadec Trench, an abyssal-hadal transition zone (AHTZ) group (Kermadec: 4707–6068 m, Mariana: 4506–6198 m, New Hebrides: 2578–6898 m, South Fiji Basin: 4074–4101 m), and a hadal group of endemic snailfish in the Kermadec and Mariana trenches (6750–7669 m and 6831–8143 m respectively). The abyssal and hadal groups were absent from the New Hebrides Trench. Depth was the single factor that best explained the biological variation between samples (16%), the addition of temperature and average surface primary production for the previous year increased this to 36% of variation.

The absence of the abyssal group from the New Hebrides Trench and South Fiji Basin was due to the absence of macrourids (*Coryphaenoides* spp.), which defined the group. The macrourids may be energetically limited in these areas. In their absence the species of the AHTZ group appear released of competition with the macrourids and are found far shallower at these sites.

The fish groups had distinct feeding strategies while attending the bait: The bathyal and abyssal groups were almost exclusively necrophagous, the AHTZ group comprised predatory and generalist feeders, while the hadal snailfishes were exclusively predators. With increasing depth, predation was found to increase while scavenging decreased. The data suggest scavenging fish fauna do not extend deeper than the hadal boundary.

1. Introduction

The abyssal zone (3000–6000 m) accounts for the majority of the world's surface (Vinogradova, 1997) with the average global ocean depth of ~4200 m (Danovaro et al., 2014; Thurber et al., 2014). With the exception of some small, isolated basins (e.g. in the Mediterranean sea, parts of the Indo-West Pacific and the Guatemalan Basin), deep water corridors are found between the majority of the world's abyssal basins (Briones et al., 2009). It is assumed that abyssal fish species possess large geographical ranges unimpeded by depth barriers (Vinogradova, 1997).

Despite assumed wide distribution, the bathymetric and geographic extent of abyssal fish species is only known at the resolution of which sampling has occurred (Carney, 2005). The abyssal, and in particular the lower-abyssal to abyssal-hadal transition zone (AHTZ; Jamieson et al., 2011), are seldom studied due to the technical challenges of sampling at increasing distance from the vessel, and hydrostatic pressures. Furthermore, the geographic extent of the abyssal zone is such that even geographically wide studies are performed in relatively small areas and there are few that unequivocally define geographic boundaries. This is especially the case in the

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Pacific Ocean due to its immense size (165.2 million km^2, mean depth =4280 m). The expense of sea-time has led to a tendency for research to be carried out in relatively close proximity to land masses (Kintisch, 2013), specifically around nations actively involved in deep-sea research (e.g. Japan, New Zealand, USA). Studies seldom addressed the distribution of fishes on greater geographic scales and across areas of contrasting environmental conditions. Fish beyond the abyssal-hadal transition zone have rarely been studied (Fujii et al., 2010; Jamieson et al., 2010; Nielsen, 1964) although the bathymetric range of fishes is known to exceed 8000 m (Linley et al., 2016; Yancey et al., 2014).

In addition to the geographic and bathymetric expanse, the deep Pacific Ocean seafloor underlies highly variable surface productivity, with two very large oligotrophic gyres in the northern and southern hemispheres. The distribution and community structure of deep fishes is often observed to change in response to variation in overlying surface productivity resulting in a non-homogeneous distribution. This effect is usually explored through comparison of a high and low productivity location (e.g. Cousins et al., 2013a; Priede et al., 2003; Sulak, 1982). Determining the drivers of community structure and thereby disentangling the effects of depth, location, food supply and other environmental parameters requires standardised data over large areas and greater depth ranges.

Conventional sampling of abyssal fish using trawls is problematic. It is very time consuming and requires specialised and expensive vessels and equipment, which reduces opportunity and restricts access (Kintisch, 2013). These challenges have prompted extensive use of free-fall baited landers as an alternative to trawls, which offer increased opportunity for access from vessels of a wide range of size and capabilities, relatively unrestricted by depth. With baited landers, the results are limited to scavenging species and species that prey upon scavengers (necrophagivores), collectively referred to as 'bait-attending'.

The baited lander methodology emulates a natural process. Large food falls, often in the form of the carcasses of shallower living fauna but also including wood and macroalgae, represent a local and highly concentrated organic input to the deep sea. The scale of such food falls can range from fishes and birds (mesocarrion ~1 kg), to seals and dolphins (macrocarrion ~100 kg) and the largest cetaceans (megacarrion >100 000 kg) (Bailey et al., 2007; Britton and Morton, 1994; Higgs et al., 2014; Kemp et al., 2006; Smith et al., 2015; Stockton and DeLaca, 1982). Particulate material from surface productivity decreases rapidly with depth (Lutz et al., 2007) whereas carrion-falls should in theory occur irrespective of depth. It is hypothesised that direct scavenging (or indirect predation through 'bait-attending') may have an increasingly important role in maintaining deep-water fish communities with increasing depth (Yeh and Drazen, 2011).

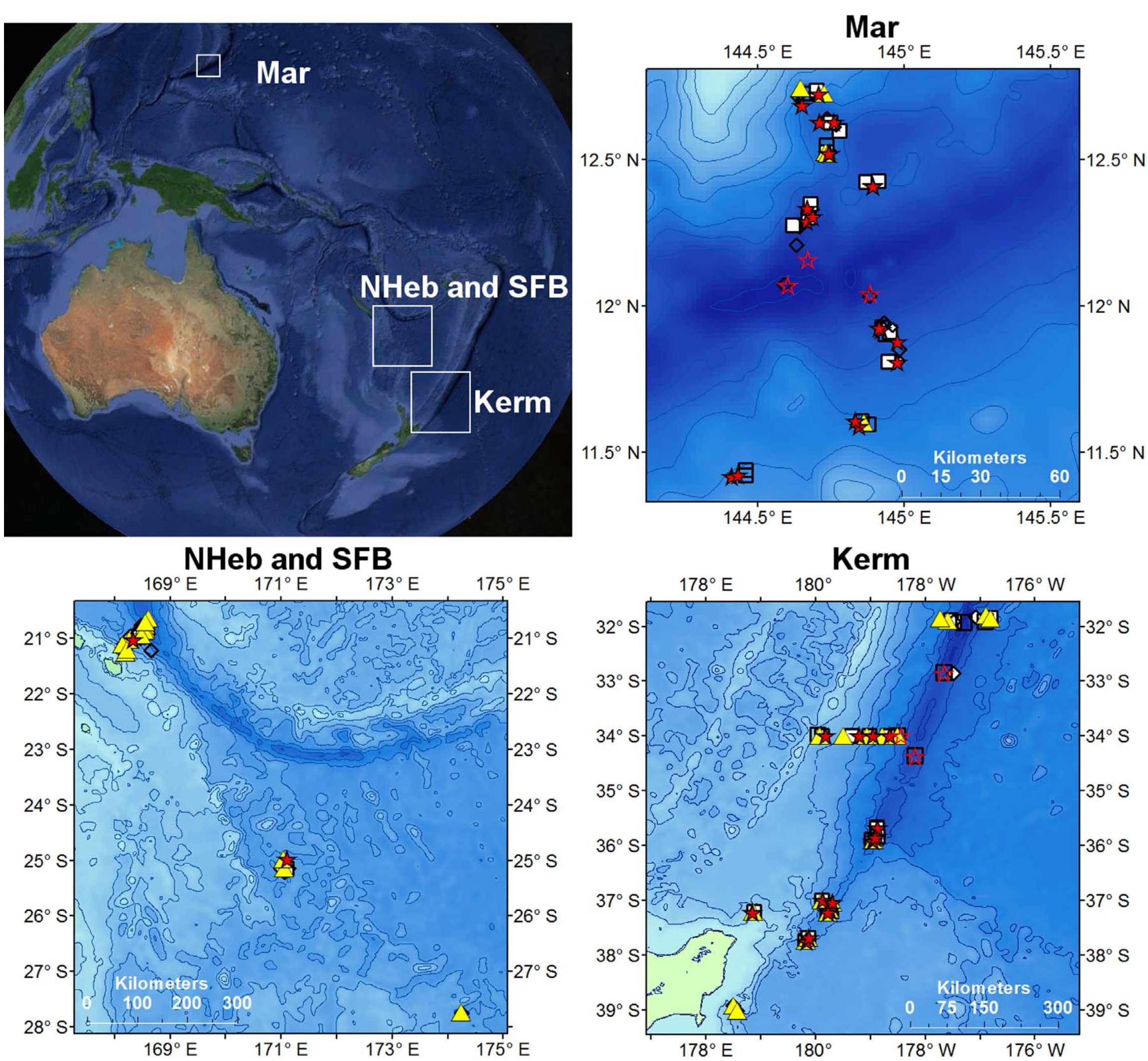

Fig. 1. Sampling locations. Triangles represent *Abyssal-lander* deployments, stars the *Hadal-lander* deployments, squares the *Large Fish Trap* and diamonds the *Small Fish Trap*. Deployments that did not record fish are hollow outlines. Isobaths have been added at 1000 m intervals.
Global overview is adapted from Google Earth (Google, 2016), the location maps are produced from GEBCO bathymetry data (GEBCO, 2015).