Deep-Sea Forum Small Grants Round 2014: FINAL REPORT, DSSG14

"Anthropogenic contaminants (PCBs and PBDEs) at full ocean depth"

Awarded to Alan Jamieson (The University of Aberdeen, now Newcastle University) and Zulin Zhang, James Hutton Institute.

Summary

Anthropogenic impacts on natural remote environment are extensive and are currently evident, and often rather conspicuous at even the highest altitude environments [1,2] to the deep sea floor [3,4]. In the marine environment, impacts in the form of litter have been observed as deep as at 7216 m in the Ryukyu Trench and during the 2009 HROV *Nereus* dive to Challenger Deep in the Mariana Trench, an anecdotal report of a raincoat on the seafloor at over 10,900 m was circulated [5]. The significance of solid litter items on the seafloor is not entirely understood relative to the impacts that the bioaccumulation of anthropogenic contaminants have on marine fauna, particularly invertebrates [6].

Organic contaminants such as polychlorinated biphenyls (PCBs) and Polybrominated diethers (PBDEs) are a group of persistent compounds whose presence is indicative of anthropogenic pollution. PBDEs and PCBs are two important classes of synthetic industrial chemicals which are also environmentally-persistent endocrine disrupting compounds (EDCs) with bioaccumulative and toxic properties.

In marine environments, these contaminants have been shown to collect in deep-sea sediments [7] transported by living or dead biota, or absorbed by surface derived detritus. These contaminants are thought to bioaccumulate in the food chain [8] and it has been reported that some deep-sea fauna show higher loads of organochlorine compounds as compared to surface living species [9]. Despite this, only a few studies have determined the presence of anthropogenic contaminates in deep-sea biota [9, 10,11, 12] and these studies rarely extend far beyond depths of the continental slopes and rises.

The objective of this study was to determine the extent in which anthropogenic contaminants have penetrated the depths of the oceans. We analysed two species of amphipod from two hadal trenches (Mariana and Kermadec) from the Northern and Southern Pacific respectively, at multiple depth ranges (7000-10,5000m) for both PCBs and PBDEs.

The salient finding was that PCBs and PBDEs were present in all samples across all species at all depths in both trenches. The ΣPCB7 concentrations ranged from 147.3-905 ng g^{-1} dw in the Mariana and 18.03-42.85 ng g^{-1} dw in the Kermadec, with mean values of 382.28 ng g^{-1} dw ±281.6 S.D and 25.24 ng g^{-1} dw ± 9.1 S.D respectively. The results were published in the first ever volume of *Nature Ecology and Evolution*. The publication was held for 6 months, waiting for the first edition of the Journal, but

upon its release this paper received considerable media attention in February 2017. By May the paper had as altmetric score of 1989 and is ranked 35 out of 243,557 tracked articles of a similar age in all journals and is ranked 1st of 102 articles published in the *Nature Ecology and Evolution*. Within 48 hours of the paper going on line and Nature releasing a press statement, it had received over 3000 articles on line, including many several live and recorded international TV and radio interviews and an invitation to present the results at the United Nations building in New York. Some media highlights included a live interview with Kaye Burley on Sky news, rotational coverage on BBC News and BBC World News, top story of the day in The Guardian (shared 20,320 in 12h) and the BBC Science and Environment page got 1.6m views in first 24 h. It was also the most listened to interview on American Public National radio on that day. A list of the media tracking in list below.

The take home message of the paper was: The extreme hydrostatic pressures that characterise the hadal zone require non-trivial evolutionary adaptations for survival, and present major engineering challenges in accessing full ocean depth. Such statements underpin the perspective that the hadal zone is remote and inaccessible, with popularist analogies generally reinforcing this view, such that if Mount Everest was placed into the Mariana Trench its summit remains a mile below the surface. However, the distance from the surface to full ocean depth is actually only equal to the widest point of the Mississippi River, and half the length of Manhattan Island. These alternative views emphasize that our proximity to these extreme locations is far from remote, which is why even the deepest chasms of the ocean are no longer pristine. The challenge moving forward is to determine the physiological consequences of such contamination and understand knock-on effects on ecosystem function.

The paper has thus received exceptional media coverage as well as professional visibility and the Marine Alliance for Science and Technology, Scotland (MASTS) Deep Sea Forum small grant award is acknowledged in the paper by name. This paper has also been ranked as a 4* for REF in the Newcastle University Internal Quality Assurance exercise.

The full reference of the paper is: Jamieson, A.J., Malkocs, T., Piertney, S.B., Fujii, T., Zhang, Z. (2017) Bioaccumulation of persistent organic pollutants in the deepest ocean fauna. *Nature Ecology and Evolution*. 1, 0051

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Selected Media

The following is some of the media coverage from the first 48 hours of the paper being published:
Banned chemicals from the 70s found in deepest reaches of the ocean
Published on: 13 February 2017

http://www.ncl.ac.uk/press/news/2017/02/deepsea/#hp-banner

3,090 articles/blogs of the story (excluding tweets).

Toxic chemicals at 'sky high' levels in deepest oceans (Guardian, p20; Wall Street Journal, p4; Sky News; The Economist; BBC Radio 4 and most other national and international media)

The Guardian - top story of the day, most shared. 20,320 shares in first 12 hours
https://www.theguardian.com/environment/2017/feb/13/extraordinary-levels-of-toxic-pollution-found-in-10km-deep-mariana-trench

http://www.economist.com/news/science-and-technology/21716891-nasty-chemicals-abound-what-was-thought-untouched-environment-worlds

http://www.dailymail.co.uk/sciencetech/article-4221796/Toxins-banned-1970s-deep-sea.html

Top story of the day on BBC Science and Environment – 1.6m views in first 24 hours
http://www.bbc.co.uk/news/science-environment-38957549

https://phys.org/news/2017-02-chemicals-70s-deepest-ocean.html

NPR - highly cited interview. Most listened to on the day
http://www.npr.org/sections/thetwo-way/2017/02/13/514997248/pollution-has-worked-its-way-down-to-the-worlds-deepest-waters

http://www.latimes.com/science/sciencenow/92565797-132.html

North scientist reveals reach of ocean pollution
The Journal (Newcastle Upon Tyne) (Main), 14/02/2017, p.4, Tony Henderson

Pollutants Are Found In Deep-Sea Animals
The Wall Street Journal (Europe) (Main), 14/02/2017, p.4, Ellie Kincaid

Found in the deep sea, toxins banned in the 1970s
Daily Mail (Main), 14/02/2017, p.12, Colin Fernandez

Newcastle University coverage
Sky News, Sky News at Nine , 13/02/2017, 21:34:16, 5:0

Newcastle University coverage
Sky News, Sky News with Kay Burley, 13/02/2017, 16:33:17, 5:0

Newcastle University coverage
Sky News, Sky News Tonight With Dermot Murnaghan, 13/02/2017, 20:24:55, 5:0

Banned chemicals persist in deep ocean
BBC (Web), 13/02/2017, Unattributed

Pollutants that have been BANNED since the SEVENTIES are still found in Pacific Ocean
Daily Express (Web), 13/02/2017, Unattributed

Chemicals banned in the 70s are found in ocean trenches
Mail Online UK (Web), 13/02/2017, Unattributed

Tyneside scientist finds evidence that man-made pollutants have reached deepest parts of the ocean
Newcastle Evening Chronicle (Web), 13/02/2017, Unattributed

Banned pollutants found in depths of Pacific
Sky News (Web), 13/02/2017, Unattributed

Deadly toxins found in darkest depths of the Pacific
The Times Online (News), 13/02/2017, p.1, Unattributed

Pollution found in Mariana Trench
i (The paper for today) (Main), 15/02/2017, p.2, Unattributed

Voyage to the bottom of the sea — where tons of toxins are
USA Today (US) (Main), 14/02/2017, p.5, Unattributed

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