POLYBROMINATED DIPHENYL ETHERS IN THE BLUBBER OF MARINE MAMMALS STRANDED ON THE COASTS OF ENGLAND AND WALES

by Robin Law, Colin Allchin, Moira Bennett and Steve Morris



Introduction

Polybrominated diphenyl ethers (PBDEs) are commonly used as flame retardants. These compounds are persistent, and are now widely distributed in the environment. Following a study conducted in the UK in 1995-96 which demonstrated their presence in sediments and fish downstream of sites of both manufacture and use, concern was expressed regarding their potential for bioaccumulation in marine mammals. We have undertaken analysis of these compounds in cetaceans as marine mammal top predators. These animals were stranded or bycaught around the coasts of England and Wales in 1992-98, and both coastal and pelagic species were selected for analysis.

The species analysed from the UK included 39 common (harbour) porpoises, 2 white-beaked dolphins, 2 striped dolphins and I specimen each of the white-sided dolphin, Risso's dolphin, long-finned pilot whale, Sowerby's beaked whale, fin and minke whales. Sampling locations are shown in Figure I. Only blubber from animals which were assessed as freshly dead when subjected to post-mortem study were selected for this study.



Porpoise stranded at Bradwell, Essex.



Figure 1 Locations of collection of stranded or bycaught cetaceans.

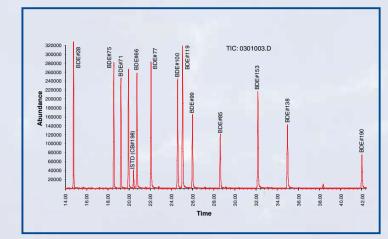


Figure 2A

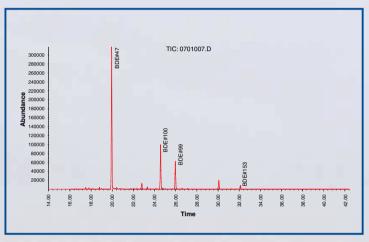


Figure 2B

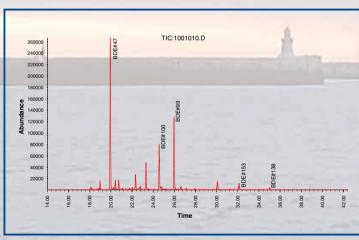


Figure 2C

Figure 2. Ion current chromatograms for (a) BDE congener standard solution, (b) SW1998/154 a white-beaked dolphin stranded at Blyth, NE England, and (c) SW1994/39 a Risso's dolphin stranded at Gunwalloe, SW England.

Blubber samples were extracted using Soxhlet extraction with *n*-hexane for 4 hours. The extracts were cleaned up and fractionated using alumina and silica, and the PBDEs were determined using gas chromatography with detection by negative ion chemical ionisation mass spectrometry (GC/NICIMS) on a congener basis, with 13 specific congeners of tribromo- to heptabromo- substitution being analysed in each sample. Using the same scheme as for chlorobiphenyls these were BDE congeners numbers 28, 47, 66, 71, 75, 77, 85, 99, 100, 119, 138, 153 and 190, and CB198 was used as a quantification standard. An annotated chromatogram of the mixed congener BDE standard solution and the chromatograms for two cetaceans exhibiting differing contamination levels are shown in Figure 2. The concentrations of BDE47 in the two cetaceans were 5,780 µg kg⁻¹ wet weight in the white-beaked dolphin, and 630 µg kg⁻¹ wet weight in the Risso's dolphin.

Earlier studies had shown concentrations of Σ BDEs in fish, as the sum of 3 BDE congeners (numbers 47, 85, & 99) from <3 µg kg⁻¹ wet weight in dab muscle from Bideford Bay, to 1,530 µg kg⁻¹ wet weight in flounder liver from Tees Bay, downstream of the major UK manufacturing site discharging to the River Skerne in NE England (Allchin et al., 1999). Detectable concentrations of BDEs 47 and 99 were also found in fish livers from offshore reference sites, remote from sources.

Porpoises were chosen as the main animal of study as they inhabit coastal waters, whilst the other mammals represent pelagic species feeding over the outer areas of the continental shelf, the continental slope, and in deep ocean waters. All are toothed whales with diets based on fish and squid except for the fin and minke whales, which are baleen whales and which feed mainly upon euphausiids.

PBDEs were detected in all animals analysed, with Σ BDE concentrations ranging from 38 and 99 µg kg¹ wet weight in the fin and minke whale, to 9,410 µg kg¹ wet weight in a white-beaked dolphin. Σ BDE concentrations above 2,000 µg kg¹ wet weight were seen in both white-beaked dolphins and in 20 of the porpoises, with lower concentrations being observed in the other species. The lowest concentrations were found in the two baleen whales. In all samples BDE47 dominated the profiles, representing 17 - 65 % of the Σ BDE concentration in the pelagic cetaceans, and 39 - 89% in the porpoises. This accords with other studies which have shown BDE47 to be the dominant congener accumulated in biota (Sellström et al., 1990), although it represents only about 37% of a typical penta-brominated formulation such as Bromkal70-5DE. There was no apparent correlation between Σ BDE concentrations and the proportion which was present as BDE47. The highest concentrations of BDE47 observed in this study were 5,780 and 6,110 µg kg¹ wet weight respectively, in a white-beaked dolphin (Figure 2b) and a porpoise, both stranded in the NE of England. Figure 3 shows Σ BDE concentrations for all the mammals analysed.

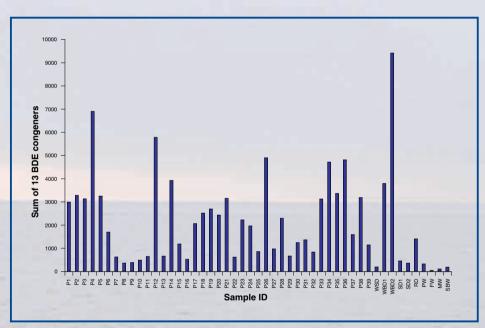


Figure 3. Sum of 13 BDE congeners in cetaceans (µg kg' wet weight)

Conclusions

It is difficult to assess the significance of the PBDE concentrations reported in this study as the mechanisms of the toxicity of individual congeners in marine mammals is poorly understood at the present time. An earlier study showed that PBDEs are accumulated by sperm whales feeding in the deep waters of the North Atlantic Ocean (de Boer et al., 1998), but these data also demonstrate the widespread distribution of PBDEs in deep offshore waters and their presence in the oceanic food chains of both toothed and baleen whales. Further studies are needed in order to elucidate the potential impact of these compounds on marine mammals if their use and discharge continues.

References

- C.R. Allchin, R.J. Law & S. Morris (1999). Polybrominated diphenylethers in sediments and biota downstream of potential sources in the UK. *Environmental Pollution*, **105**, 197-207.
- J. de Boer, P.G. Wester, H.J.C. Klamer, W.E. Lewis and J.P. Boon (1998). Do flame retardants threaten ocean life? *Nature (London)*, **394**, 28-29.
- U. Sellström, B. Jansson, K. Nylund, T. Odsjö and M. Olsson (1990). Anthropogenic brominated aromatics in the Swedish environment. *In*: O. Hutzinger and H. Fielder (Eds). Proceedings of the 10th International Symposium on Dioxins, 10-14 September, Bayreuth, Volume 2, pp. 347-350.