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TREND EDITORIAL

Progress on bringing together raptor collections in Europe for contaminant research and monitoring in relation to chemicals regulation

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Environmental contaminants impose multi-billion Euro costs on human and wildlife health in Europe (Trasande et al. 2015). Although there are more than 60,000 chemicals marketed in Europe, so far, only 600 chemicals have been screened and identified as PBT (persistent, bioaccumulative, toxic), ED (endocrine disrupting) and/or CMR (carcinogenic, mutagenic, toxic for reproduction) (Gkotsis et al. 2019). A suite of EU chemicals legislation (EC 2001, EC 2004a, EC 2004b, EC 2004c, EC 2006, EC 2008, EC 2009a, EC 2009b, EU 2012) aims to reduce chemical risks to humans and wildlife, and the EU's Seventh Environment Action Programme (EU 2014) calls for better scientific knowledge towards achieving a non-toxic environment.

Movalli et al. (2017) noted the value of raptors as sentinels of environmental health in general, and highlighted in particular the potential value of raptor tissue collections, which can be analysed for contaminant exposure to inform risk assessment of chemicals, assess the effectiveness of chemicals risk management measures and provide early warning of emerging contaminant problems. They argued for development of a framework bringing together raptor tissue collections in Europe—including those of natural history museums (NHMs), environmental specimen banks (ESBs) and others (e.g. in research institutions)—in support of contaminant research and monitoring for better chemicals management. They suggested this framework would involve among other things identifying and digitising relevant collections and developing a searchable database of these collections to make them more visible and accessible to ecotoxicologists and competent authorities.

Here, we outline progress that has been made in this regard through the launch of two mutually reinforcing initiatives, the COST Action *European Raptor Biomonitoring Facility* (ERBFacility[1]), which was launched in October 2017 and in which 27 COST member countries are participating, and the EU LIFE project *Systematic use of contaminant data from apex predators and their prey in chemicals management* (LIFE APEX[2]), which was launched in September 2018.

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[1] www.erbfacility.eu
[2] www.lifeapex.eu

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Using raptors as particularly appropriate sentinels for PBT compounds (Movalli et al. 2018), ERBFacility will help answer what the environmental risks are for specific chemicals, whether there are emerging contaminant problems needing remedial action and whether legislation is at all effective in reducing environmental exposure to contaminants in Europe. ERBFacility builds on 10 years of work involving ecotoxicologists and ornithologists leading up to and under the European Science Foundation's research networking programme EURAPMON (Research and Monitoring for and with Raptors in Europe) (see, for example, Movalli et al. 2008, Gómez-Ramírez et al. 2014, Espín et al. 2016, Derlink et al. 2018, Duke et al. 2018).[3]

At its first General Meeting in Ciudad Real, Spain, in February 2018, ERBFacility set in motion work to bring together NHMs, ESBs and other research collections towards development of a European Raptor Specimen Bank (ERSpeB). ERBFacility has since concluded a review of raptor collections in Europe (Ramello et al. n.d.). The review, which collated data from over a hundred collections across Europe, revealed that many thousands of raptor specimens arrive annually at these collections, offering a very substantial resource of raptor tissue samples for contaminant monitoring. In the UK, specimens are processed and tissues stored by the Predatory Bird Monitoring Scheme maintained by the Centre for Ecology and Hydrology (Walker et al. 2008). In Sweden, the lead is taken by the national ESB at the Naturhistorika Rijkmuseet. A number of research collections also exist around Europe, such as that of the Leibniz-Institute for Zoo and Wildlife Research, Germany. However, such specimen banks and research collections, set up specifically for the purposes of contaminant monitoring, are the exception rather than the rule. In most countries, the main recipients of raptor specimens are NHMs. Indeed, the review found that around 75% of responding NHMs across Europe receive fresh raptor/owl specimens. Most NHMs freeze raptor carcasses on arrival and then process and freeze wet tissues; indeed, around a third of responding NHMs are already active in storing frozen raptor tissue samples suitable for contaminant monitoring

At a recent ERBFacility meeting convened at the Royal Belgian Institute of Natural Sciences in Brussels, collections came together to validate the review of raptor collections and consider how to build on this towards development of the European Raptor Specimen Bank. The meeting found that there is strong interest among collections to work together in this regard. However, many collections, particularly in eastern and southern Europe, are stretched for resources, so any new 'ask' (e.g. in terms of expanding tissue collections and/or strengthening standard operating procedures to ensure sample quality) must be tightly specified. Moreover, collections cannot be expected to build a substantial raptor tissue bank unless there is a clear regulatory demand for contaminant data and resources for the necessary analyses to be performed.

There exists here something of a Catch 22, in that regulatory demand is likely to grow only once the ability of raptor biomonitoring to provide pan-European assessments pertinent to chemicals management is proven, while proving this ability requires a substantial sample bank to be available in the first place. Overcoming this will probably involve carefully targeted proof of concept work on one or two selected species and tissue matrices for which a substantial pan-European bank of samples already exists, and for one or two priority substances of particular interest to regulators.

There are clear incentives for collections to engage in this work. These include: the opportunity to engage in a major European initiative with key regulatory applications, helping to demonstrate the societal relevance of collections; the opportunity presented by novel collaboration between NHMs, ESBs and research collections; the opportunity to expand research interests into ecotoxicology, and to expand publications output; and the opportunity to know of and exchange samples with other NHMs and thereby broaden individual collections.

Taking forward the concept of a distributed ERSpeB will involve further work under the auspices of the COST Action on a number of issues, building on relevant existing networks such as the Consortium of European Taxonomic Facilities and the network of European Bird Curators. These include: prioritising species, tissue matrices and compounds and carrying out proof of concept work; addressing legal, personnel and freezer constraints to expanding raptor tissue sample collections and shipping samples for analysis; adapting NHM standards and protocols (learning from ESBs) for the gathering, processing and storage of samples, to enhance sample quality for contaminant analysis; developing appropriate policy on access to samples to ensure valuable samples required for contaminant monitoring are not consumed for other purposes; and circumscribing the data content of the European samples database and how it will be developed, populated and updated to provide real-time information on raptor tissue samples across Europe. These issues will all be addressed by a sequence of scientific missions and meetings planned by ERBFacility for the next 12–15 months.

This paper focuses on work being done in the 'collections arena' under the auspices of ERBFacility, but it is worth noting that ERBFacility also involves work in the 'analytical arena', involving ecotoxicologists, veterinary scientists and chemists, to develop a prioritised European Raptor Biomonitoring Scheme (ERBiomS), and work in the 'field arena' involving field ornithologists and ecologists to develop a European Raptor Sampling Programme (ERSamP). Advancing work towards a comprehensive European Raptor Biomonitoring Facility, capable of delivering pan-European

[3] www.eurapmon.eu

contaminant data for chemicals management, involves collaboration across these three arenas.

While this work is progressing under ERBFacility, LIFE APEX is working to demonstrate the systematic use of contaminant data from raptors and other apex predators for chemicals management. Like ERBFacility, LIFE APEX is building collaborations between collections and analytical laboratories. But while the focus of ERBFacility is on building networks across the collections, analysis and field arenas and developing the overall Facility, the focus of LIFE APEX is on demonstrating that contaminant data from apex predators has useful regulatory applications, notably in relation to the REACH and Biocides regulations (Alygizakis et al. 2019; Gkotsis et al. 2019; Koschorreck et al. 2019).

LIFE APEX will in particular demonstrate the use of wide-scope target screening (of more than 2400 contaminants of emerging concern—CECs), wide-scope suspect screening (of more than 40,000 CECs) and non-target screening of samples from raptors (in the terrestrial environment) and other apex predators (in the freshwater and marine environments) to help the European Chemicals Agency (ECHA) prioritise substances (among the many tens of thousands currently used) for more strenuous PBT assessments and identify predominant chemical mixtures in biota. LIFE APEX will also demonstrate the power of targeted analyses of raptor matrices to assess the effectiveness of EU chemicals risk management measures. Proof of concept work on this latter demonstrator is under way by the Naturalis Biodiversity Center with the UK Centre for Ecology and Hydrology (which hosts the UK Predatory Bird Monitoring Scheme)

Taken together, the growing collaborations across the collections, analysis and field arenas under ERBFacility and LIFE APEX offer considerable promise to enhance early warning of emerging contaminant problems, for more timely identification and management of persistent and bioaccumulative substances in the environment, for putting risk management measures in place more quickly, for better understanding predominant chemical mixtures in the environment, and to ascertain whether risk management measures (and by extension chemicals regulations) are actually delivering on their purpose in reducing negative impacts on human and wildlife health. This will complement ongoing work to monitoring impacts of contaminants on human health.[4]

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[4] www.hbm4eu.eu

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