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Environmental Monitoring of Heavy Metals with Birds as Pollution Integrating Monitors-Practical Examples for the Goshawk *Accipiter gentilis*

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ABSTRACT

Environmental pollution by man-made chemicals requires reliable monitoring. In addition to monitoring networks already in operation for e.g. deposition of heavy metals and acids, area-integrating monitoring using living organisms is expected to be an added and valuable means for immediate as well as retrospective pollution assessment. Hence some basic definitions on bioindicators and biomonitors are given, together with an example (Goshawks) as far as birds are concerned.

INTRODUCTION

Pollution of ecosystems by man-made chemicals is still increasing in highly industrialized countries and also in the Third World. Pollution assessment by monitoring is therefore of paramount importance. Static monitoring at fixed points is commonly carried out by various networks using particular automated sampling systems, e.g. for wet precipitation (Ref. 1). However, networks of this kind are expensive to operate and cannot provide true area-integrating data without excessive costs. In addition to these systems, therefore, biological area-integrating approaches to monitoring are necessary, that can also to some extent reflect the ecological impacts of pollution. Species useful for this purpose must be representative of the area under investigation, recognised accumulators of environmental pollution (Refs. 2 and 3). e.g. metals, and suitable also for long-term storage with a view to retrospective analysis within Environmental Specimen Banking.

From this viewpoint it appears that particular approaches to Biomonitoring may prove to be a means to fulfil these requirements, since animals with known habits (and to some extent also plants) are able to integrate pollution impacts over a distinct area (home range) and/or over their whole lifespan (or at least an important part of it). This contribution thus aims at introducing one possible approach to (dynamic) pollution monitoring

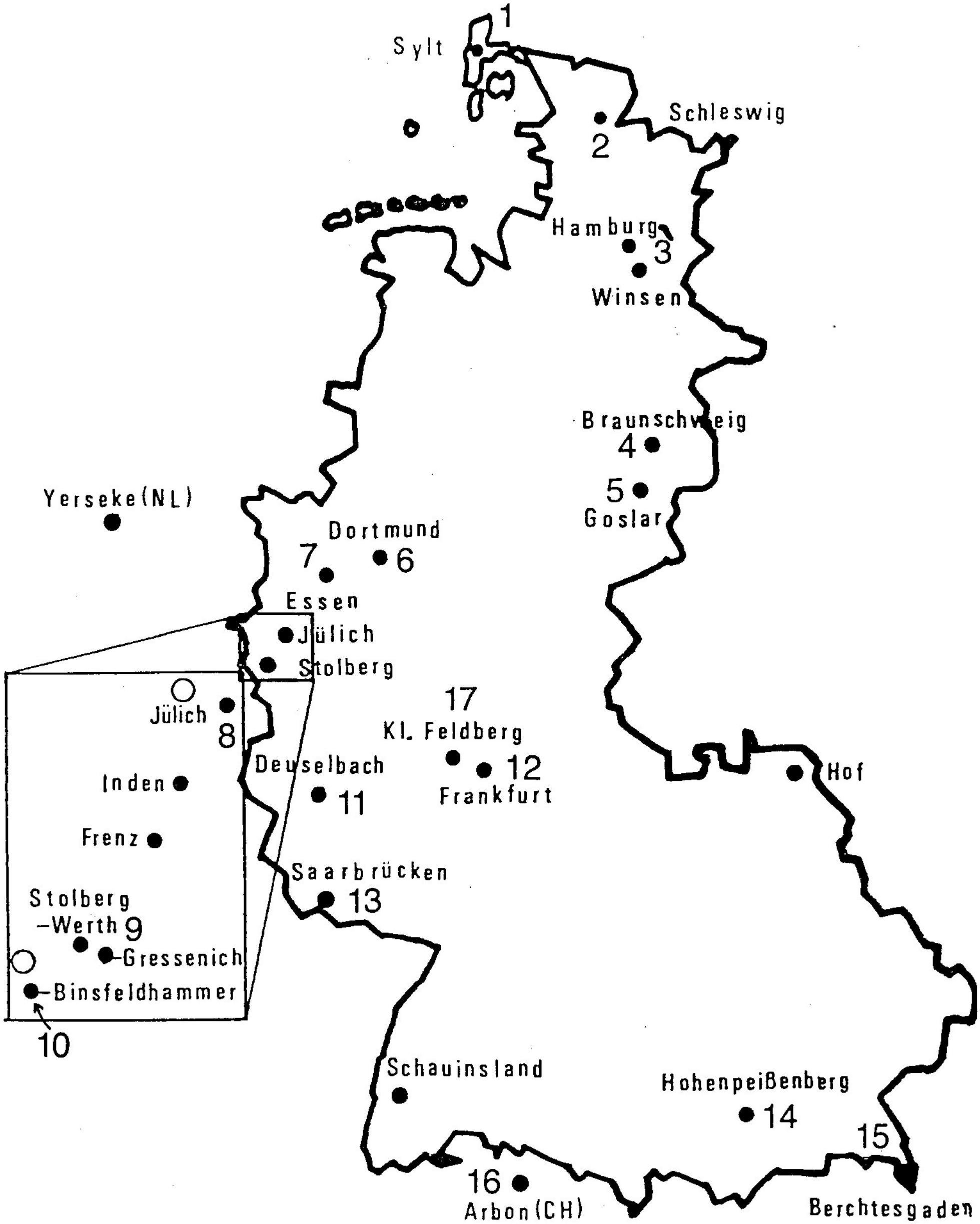

Fig 1. Map showing network of sampling stations in part of West Germany.

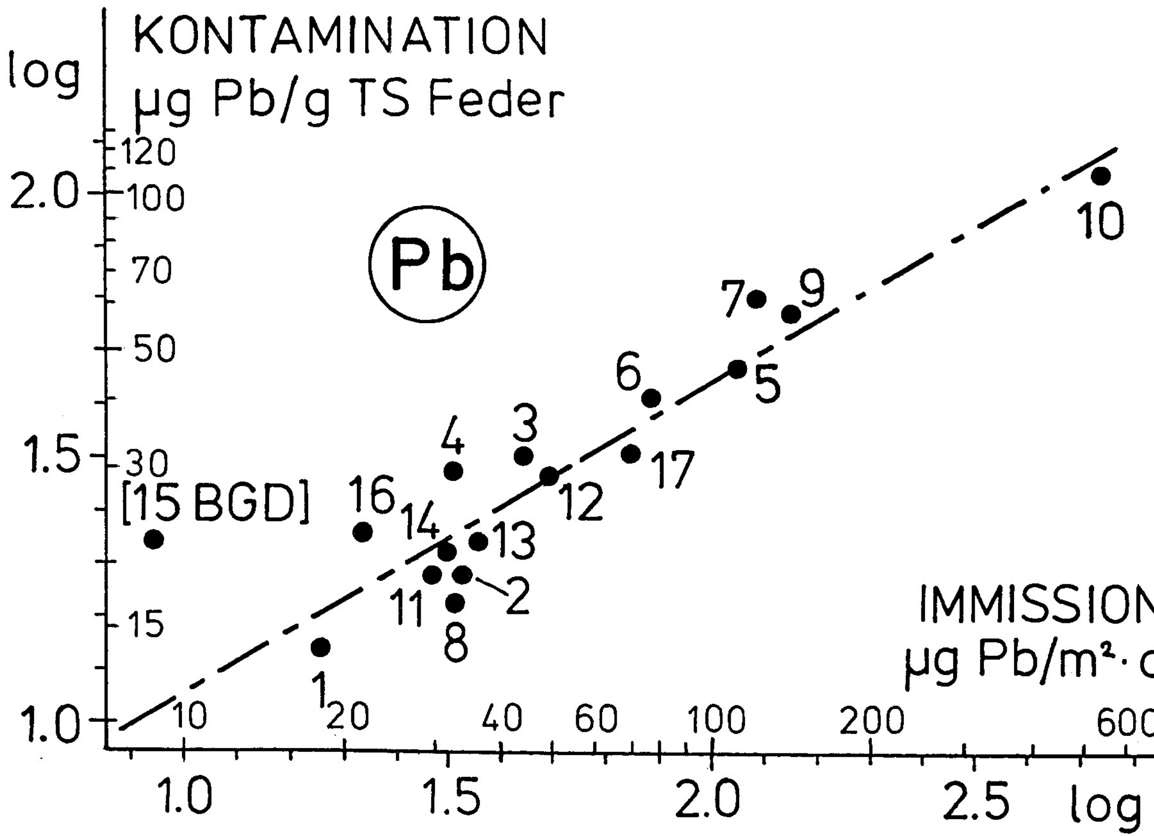

Fig 2. Pb contents in Goshawk feathers versus deposition values. - No 15: distance over 30 km in mountainous area. Not regarded for the correlation.

for heavy metals in birds, together with a few examples using Goshawks as integrators. Further data can be found in Refs. 4, 5 and 6.

DEFINITIONS

Bioindicators are organisms or communities that can be related sufficiently closely to well-defined environmental factors to indicate these, or even to be used as a quantitative test for environmental change. This may be judged by their presence or absence and/or by their easily recognizable behaviour or peculiarities.

Biomonitors are organisms that take up and sometimes accumulate particular environmental pollutants, thus indicating concentration trends in space and/or in time.

INFLUENCE OF PHYSIOLOGY AND NUTRITION

It is well known that different individuals of the same population from the same locality at the same time may show different pollution factors ranging from 10 to 100. In a field study with tits (Parus major) and sparrows (Passer montanus) the young of both species were raised together in the same nest by their parents or foster-parents respectively. Identical organs (stomach, liver) of selected individuals from different nests raised on species-specific food were found to be differently polluted (Ref. 6). This indicates that, for pollution levels, the individual food chain is of *higher importance than possible species-specific physiological interactions* with the pollutant. For the use of organisms as biomonitors, therefore, an understanding of their ecology is absolutely necessary, so that in biomonitoring ecologists and analytical chemists need to co-operate as closely as possible to achieve reliable findings.

SELECTION OF SPECIES SUITABLE FOR BIOMONITORING

Some species are better suited than others for ecological field study. Hence species appropriate for biomonitoring must be carefully selected on the basis of the following criteria at least:

- Sedentary home range behaviour
- Known food composition
- Sufficient tolerance of pollution
- Uniform distribution
- Little oscillation in population
- Known accumulation mechanisms
- Legal status
- Standardizable sampling techniques
- Sex and age characteristics
- Temporal and spatial integrating ability
- Suitability for experiment
- Easily verified food chains, etc.

There remain only a very few vertebrate species in Central Europe that meet most of these prerequisites. Among them are Goshawk (Accipiter gentilis), Magpie (Pica pica) and Roe Deer (Capreolus capreolus).

RELATION BETWEEN INTAKE AND LEVELS OF POLLUTANTS

For biomonitors a close and proven relationship between the factor to be indicated and the reaction of the indicator is of particular importance.

One example is given here. We investigated the correlation between the wet deposition of lead and cadmium measured by a network of samplers in the Federal Republic of Germany (Fig. 1) and the content of these metals in the feathers of female Goshawks standardized to the third primary. Most of these birds were breeding at a distance of less than 5 km from the sampling stations, i.e. the home ranges of their mates overlapped with these stations. In this study the correlation between the lead content (/ug/g D.W.) in the feathers and the wet deposition (/ug Pb/m^2/day) in the home range of the Goshawks was quite satisfactory (Fig. 2), i.e. for 16 localities the log feather content was 0.628 times the log deposition + (log) 0.395; r = 0.95. The same could be observed for cadmium.

CONCLUSIONS

By means of well-defined biomonitors, e.g. selected Goshawk feathers, it appears possible to assess the pollution level of distinct fractions of a landscape (Goshawk home ranges) at moderate cost and as effectively as is achieved by automated wet deposition samplers. However, bioindication and biomonitoring require calibration by the results of e.g. wet deposition and thus it can be expected that both approaches will be increasingly used in future environmental research programmes.

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