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Occurrence of organic and inorganic biocides in the museum environment

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Abstract

In the museum environment organic and inorganic chemicals can be found, which originate from both outside and inside the building. Many of the contaminants may cause adverse effects on works of art and human health, but in the past, pollution research in museums has focused on the protection of artifacts, while the risk assessment for humans has been neglected. Especially, the application of biocides leads to a conflict of interest: on the one hand cultural assets have to be protected against microorganisms, insects and rodents while on the other hand it is essential to provide healthy conditions for museum staff and visitors. It has recently been shown that the release of organic indoor pollutants from building products is one of the main reasons for deterioration of artifacts. In this work, we present the results of screening measurements on biocides in different locations of German museums. The major components that could be identified were DDT, PCP, lindane, methoxychlor, naphthalene, chlorinated naphthalenes, 1,4-dichlorobenzene, PCBs and arsenic. It is demonstrated that the application of chlorinated organic compounds and arsenic for preventive conservation is one of the prime reasons for indoor pollution in museums and provides a potential for exposure. However, the concentrations in air, dust and material are widely different and a health risk for humans has to be evaluated case by case.

Keywords: Museums; Biocides; Pesticides; Exposure; Guideline values

1. Introduction

In our modern society the problem of indoor pollution resulting from the application of biocides has been realized for decades. Inorganic compounds like arsenic trioxide (white arsenic, As_2O_3), arsenate (V) and arsenate (III) have been used for more than thousand years indoors and outdoors for the protection against rodents, insects and microorganisms. With the beginning of the 20th century, modern industrial chemical synthesis enabled the extensive distribution of organic agents. The most well-known compound is the insecticide 1,1,1-trichloro-2,2-bis(4-chlorophenyl)-ethane (DDT), which was produced

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and applied worldwide. In the Federal Republic of Germany DDT was banned by law in 1972. In the German Democratic Republic DDT was used in combination with lindane under the trade name Hylotox® until the reunion in 1990. Mono- (MCN) and dichlorinated (DCN) naphthalenes were utilized as main components for the protection of wood and wood-based materials from 1923 up to the 1960s under the trade name Xylamon® in Germany. Later, the chlorinated naphthalenes were abandoned because of their toxicity and their unpleasant smell and substituted by a combination of pentachlorophenol (PCP) and lindane, which was frequently used from the 1950s to the 1970s (Unger et al., 2001). In Germany, PCP was banned by law in 1989. Possible periods of time for the use of certain biocides are shown in Fig. 1.

In the building sector, the treatment of materials with preservatives is often well documented. In the museum environment, the treatment of artifacts with biocides occurs undefined in many cases and is furthermore only rarely documented because precise documentation of conservation and restoration treatment became an established part of conservation work not until the 1970s (Schieweck, 2005). Our inquiries have shown that arsenic (As) compounds were at least applied until the mid of the 1970s. The substitution of DDT and PCP in formulations has been regulated by law. However, it is difficult to estimate for how long oddments of PCP and DDT containing formulations were still used in museums. Lindane, 1,4-dichlorobenzene (1,4-DCB), naphthalene and camphor were distributed as pure substances and in large amounts for free evaporation in enclosed environments like cabinets. At least, we found that lindane and 1,4-DCB are utilized until today in museums. Synthetic pyrethroids were also applied for the protection of artifacts and are still in use. However, many museums have refused the application of pyrethroids because their comparatively fast degradation does not guarantee a long-time prevention. Only recently, responsible conservators have started to test non-toxic agents like diatomaceous earth (Hoffmann, 2004) for the pest control of artifacts.

It can be assumed that the comprehensive and arbitrary application of biocides for the protection of organic materials (Mills and White, 1994) in the museum environment has often caused severe contaminations of treated objects, especially in the case of zoological dissections and preventive strategies in ethnological collections. Nevertheless, only a few publications on this topic are known so far (Krooß and Stolz, 1993; Leimbrock and Wagner, 1998; Unger et al., 2001). Most work has focused on climatic parameters (Brimblecombe et al., 1999;

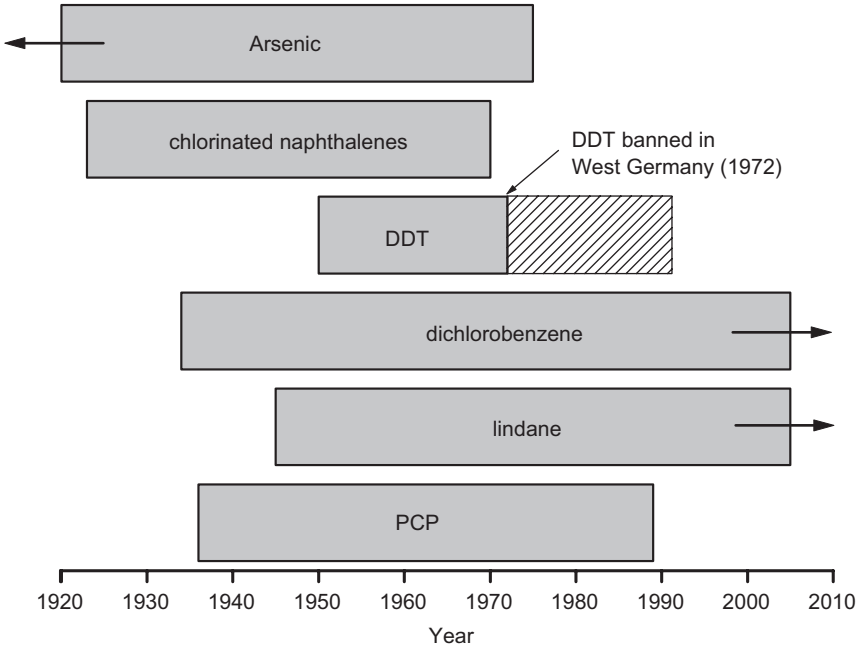

Fig. 1. Time periods of possible application of biocides in museums (MCN: monochloronaphthalene; DCN: dichloronaphthalene; PCP: pentachlorophenol; DDT: 1,1,1-trichloro-2,2-bis(4-chlorophenyl)-ethane; 1,4-DCB: 1,4-dichlorobenzene).