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Conservation measures in the entomology collection of Țării Crișurilor Museum

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Abstract. The entomology collection includes 5024 specimens collected since 1952 from Romanian fauna, as well as from Europe, North and South America, Africa, Asia and Australia. To avoid conservation problems several preventive conservation measures have been taken, such as blocking natural light in the storeroom, monitoring RH and temperature, using insecticides. Until December, 2023, naphthalene was used as an insecticide, after which it was decided to change to camphor as it has the same effect of preventing pest attack, leaves no residue on heritage objects and has less toxic effects on people entering the collection.

Key words: entomology, conservation, naphtalene, camphor, MTC - Țării Crișurilor Museum.

Introduction

The entomology collection of Țării Crișurilor Museum includes 5024 specimens collected since 1952, belonging to more than 500 representative species of the Romanian fauna (orders Coleoptera, Orthoptera, Dictyoptera, Odonata, Hymenoptera, Diptera, Diptera, Lepidoptera, Heteroptera, Homoptera, Dermaptera, Trichoptera, Neuroptera, Plecoptera and Ephemeroptera), as well as Coleoptera and Lepidoptera from Europe, North and South America, Africa, Asia and Australia.

The collection includes rare and protected species such as *Rosalia alpina*, *Morimus funereus*, *Lucanus cervus* or *Cerambyx cerdo*, but also invasive species such as *Sceliphron caementarium* (Gagiu 2012), *Harmonia axyridis* (Gagiu 2000) and *Rhynocoris punctiventris* (Gagiu 2013).

In addition to the specimens collected over the years by museum specialists (Tiberiu Jurcsak, Mircea Ion Paina, Adrian Gagiu, Erika Posmoșanu), the entomology collection includes part of the Syrphidae collection (92 specimens belonging to 45 species) of Vladimir Brădescu (Gagiu 2009), specimens of Formicidae collected by Dinu Paraschivescu, T. Jurcsak and M.I. Paina (Tăușan & Gagiu 2023), specimens of European and exotic Coleoptera and Lepidoptera (1134 specimens) (Gagiu, 2005), some endemic or protected, acquired from the collector Adalbert Takács and specimens of Hymenoptera (531, belonging to 66 species) (Gagiu & Osten 2006).

As a conservation measure to protect entomological specimens, naphthalene has been used, either in pure form or in combination with other insecticides in moth balls. These have been used for more than a century to protect heritage assets from attack by moths and other pests (Heald & Madden 2011, Ormsby et al. 2006; Hodgkins et al. 2014; Álvarez-Martín et al. 2021). Inexpensive and readily available, naphthalene was purchased in large quantities and replenished seasonally in museum collections to provide long-lasting protection against pests (Heald & Madden 2011).

Storage and preventative conservation measures

In order to avoid conservation problems that may occur over time, several preventative measures measures have been taken to eliminate physical and biological risks as well as ensuring collection security (Golban 2010).

The entomological collection is housed in the zoology storeroom, a room with shuttered windows, where temperature and relative humidity (RH) are kept under control in the RH 45-55% and 21℃ (±1℃) ranges that do not cause damage and degradation of heritage assets (Moldoveanu 2009, Brandão et al. 2021).

The storage was done in 6 wooden cabinets, of which two cabinets are large with 60 drawers each and four smaller ones with 30 drawers each, and the collection is organized by families (Figure 1). The entomological wooden drawers (dimensions length x width x height: 45 cm x 30.5 cm x 6.5 cm) have a polystyrene bottom and a glass lid. The polystyrene, besides being inert and keeping the needled insects safely upright, quickly reveals any infestation of the material by pests, the dust resulting from the infestation being easily visible (Brandão et al. 2021). In addition, the glass lids, hermetically sealed, allow an inspection of the contents without the need to remove the lid. The hermetic sealing also ensures that mothballs placed in each of the drawers do not degrade rapidly and maintain a pest-free internal environment (Trapero & Soto Borrero 2023) (Figures 2 and 3).

Storage boxes and cabinets are positioned to minimize mechanical damage caused by mishandling or shifting during cleaning or moving furniture (Upton & Chapman 2010, Brandão et al. 2021).

Pheromone traps are fitted in the storage room to avoid bilogical attacks, and it is also important that drawer lids and storage box rims are securely fastened and that pure naphthalene or camphor is kept in the drawers or boxes (Upton & Chapman 2010). Naphthalene was used consistently in museum collections as a pesticide during the nineteenth and twentieth centuries to deter pest activity (Ormsby et al. 2006, Heald & Madden 2011, Hodgkins et al. 2014; Álvarez-Martín et al. 2021). By 2023 at MTC naphthalene mothballs were also being used, wrapped in gauze and stuck in needles fixed in the corners of storage boxes due

to the fact that it is a cheap and readily available chemical that was effective against various pests (Latif et al. 2004, Kabir et al. 2003, Ali et al. 2009, Heald & Madden 2011) (Figure 2). A drawback of using naphthalene is that after its use it can remain adsorbed on objects and can be slowly released at room temperature over the years (Heald & Madden 2011, Sudakin et al. 2011, Álvarez-Martín et al. 2021). At the same time, in recent decades, studies on the toxicity of naphthalene have shown that it brings a high degree of harm to personnel, all the more so as their use is massive and continuous over time; it's use has thus been significantly reduced and many have replaced it with camphor, which has an identical antiparasitic function (Delmastro 2008).

So far, following the recommended RH values no mold has been observed to appear on specimens in our collection.

The safety of the collections is ensured by security systems (video cameras and motion sensors connected to the alarm systems) and fire protection (fireproof metal access door, smoke detectors and inert gas extinguishing system) (Golban 2010).

Discussions

Although no insect attacks have been observed in the zoological storage, it remains a potential threat that needs to be considered. In spite of a wide variety of chemicals with repellent or exterminating effect, the fact that insects over a longer period of time develop resistance to them, as well as the toxic effect on humans that come into contact with the environment in the repository, must also be taken into account. Mothballs or naphthalene itself should be avoided because of carcinogenic properties (Walker & Crosby 1979).

Insecticides whose toxic residue gives low toxicity to humans are still being sought. One such substance is camphor.

Camphor is obtained by separating the wood and leaves of the *Cinnamommum camphora* L. (Fam. Lauraceae) tree from the distillation products. It is a white crystalline, translucent mass or white crystalline powder, oily to the

touch, with a characteristic odor and a taste that is at first pungent, slightly bitter and then refreshing. It volatilizes slowly at room temperature. It is flammable and burns with a black flame, leaving no residue. Melting point is 175-179℃. It is very easily soluble in alcohol, chloroform, ether and turpentine oil, easily soluble in liquid paraffin, fatty oils and in volatile oils, hardly soluble in water, but easily soluble in water heated to 80℃, practically insoluble in glycerol (Romanian Pharmacopoeia X, 1993). The median LD50 administered subcutaneously to mammals is 2.2 g/kg body, so it is considered safe for mammals (Abivardi & Zareh 1971). Used in medicinal preparations, camphor is eliminated hepatically (Abivardi & Zareh 1971).

In terms of preventive conservation of collections, Walker and Crosby (1979) recommended that camphor pieces be kept in a small cardboard container in the corner of an insect or drawer to protect the collection from insects and other pests. Delmastro (2008) also recommends positioning small containers of camphor in the insectary, which gradually evaporates and acts as a repellent for the various arthropods mentioned by Pinniger (1994) as pests of the collections (beetles of the genera *Anthrenus, Anobium, Attagenus, Dermestes, Lasioderma, Lyctus, Stegobium*, the lepidopteran tineidae, lepismatid tisanthids, some genera of beetles and mites).

Although as efficacy against pests, several studies (Latif et al. 2004, Siddika 2004, Kabir et al. 2003, Ali et al. 2009) show that naphthalene has stronger effect than camphor, Latif et al. (2004) show that 90% of pests were deterred by camphor, and Siddika (2004) also shows that the use of camphor is effective.

In the study carried out by Abou El-Ela (2014) who studied the mortality on small wax moth larvae (*Achroia grisella*) , camphor and naphthalene did not give satisfactory results.

Obeng-Ofori et al. (1998) shows that camphor applied topically or impregnated on filter paper was highly toxic, generating 100% mortality in 24 hours for the beetle species studied (*Sitophilus granarius*, *S. zeamais*, *Tribolium castaneum*, *Prostephanus truncatus*).

Jordan (2019) notes that he used 7g pieces of camphor for his entomologic collection, with each piece providing months of protection for the storage trays.

Regarding the entomological collection of the MTC, the curator decided to change naphthalene to camphor in December 2023. To prevent possible adverse reactions when handling camphor, the conservator worked in an airy room, wore protective gloves, mask and visor (Figure 4). Using a spatula, 5 g of camphor crystals were put into an ampoule whose mouth was closed with cotton wool so that the camphor vapors would gradually spread into the entomological drawer (Figure 5). The ampoule was fixed in the lower right corner of the insectary with needles to avoid it's rolling when handling the drawer and possible damage to the insectary specimens (Figures 7 and 8).

After 6 months, on a new inspection of the collection by the conservator, it was noticed that there was much less camphor in the vials (Fig. 6), which is why the decision to refill the ampules was taken.

Conclusions

The entomological collection of the Țării Crișurilor Museum includes 5,024 specimens collected since 1952, belonging to more than 500 representative species of Romanian fauna collected by the museum's staff, as well as specimens from Europe, North and South America, Africa, Asia and Australia, obtained through donations and acquisitions.

To avoid conservation problems that may occur over time, several preventive conservation measures have been taken to eliminate physical and biological risks, such as blocking natural light in the storage, monitoring and keeping RH and temperature within recommended limits, keeping the insects in standard cabinets and using insecticides.

Until December 2023, naphthalene was used as an insecticide, after which it was decided to change to camphor as it has the same effect of preventing pest attack, leaves no residue on heritage objects and has less toxic effects on people entering the collection. 5g of camfor was put in glass ampoules with a cotton wool stopper and topped up every 6 months to keep the amount of vapors constant inside each storage tray.

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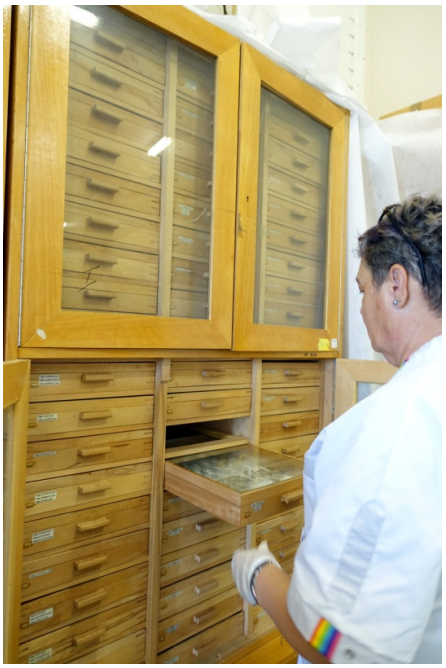

Figure 1 - Cabinets housing the entomological collection of the MTC.

Figures 2-3 - Insects with mothballs used as insecticide, and the remaining debris.

Figure 4 - The camphor vial filling process.

Figure 5 - Camphor filled vial.

Figure 6 - Camphor vial after 6 months.

Figures 7-8 - Insects with camphor vials.