Journal of Natural Science Collections

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Source: Flanagan, L., White, A. & Viscardi, P. (2018). Clean and Constrain: a pest management protocol and an overview of some collections management considerations for microscope slide collections. *Journal of Natural Science Collections*, *Volume 6*, 79 - 86.

URL: http://www.natsca.org/article/2512

Clean and Constrain: a pest management protocol and an overview of some collections management considerations for microscope slide collections

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Received: 13/08/2018

Accepted: 03/11/2018

Citation: Flanagan, L., White, A., and Viscardi, P., 2018. Clean and Constrain: a pest management protocol and an overview of some collections management considerations for microscope slide collections. *Journal of Natural Science Collections,* 6, pp.79-86.

Abstract

Integrated Pest Management is an essential tool in safeguarding museum collections, even for objects normally considered inedible, since pests may be present in and on furniture housing the collection. Here we describe an unexpected infestation in microscope slide cabinets and we outline a protocol for controlling pests in collections that cannot be frozen, while touching on additional issues relating to the use and management of microscope slide collections.

Keywords: IPM, integrated pest management, collections moves, microscope slides, protocols, freezing, storage furniture, pesticide

Introduction

Many natural science collections hold microscope slides representing specimens from every biological and geological discipline. These slides are often neglected in collections, but they may represent important scientific specimens (Justine et al., 2013) and can play a valuable role in exhibition (Tybjerg, 2018). The National Museum of Ireland – Natural History (NMINH) has in the region of 100,000 slides, including hundreds of type specimens in a range of Orders (see Appendix 1 for some of the groups represented). During the summer of 2018 a significant portion of these collections were moved from the NMINH display building on Merrion Street to the National Museum of Ireland (NMI)'s offsite Collections Resource Centre (CRC) in order to clear space for building development work, and to improve storage conditions and access to the collection (see Herrero, Chandler and Viscardi, 2018 for more details). This provided an opportunity to assess issues relating to the slide collection and address some of the more urgent problems discovered.

Microscope slides

Specimens can be mounted for microscopy in a variety of ways, depending on the type of microscope that is to be used and the size and shape of the specimen intended for examination. Three-dimensional specimens may be adhered to a card or placed in a prepared cavity (or cavities) on a slide. Generally, such specimens are examined using direct light from above or to the side of the specimen, rather than being lit from beneath. As such, the slides used for them tend to be opaque. Very small and flat specimens will tend to be viewed using light transmitted through the specimen from beneath, necessitating use of a transparent – usually glass – slide (see Figure 1).

Figure 1. Slide drawer from the NMINH collection, showing a selection of type specimens of corals mounted onto card, cavity slides, and glass slides with coverslips. Image © Paolo Viscardi, 2018

Securing specimens to slides allows manipulation during examination and helps prevent movement or loss of the specimen. For opaque slides, this will often have been achieved using whatever adhesive was at hand, but for glass slides specimens need to be secured using a method that does not interfere with the transmission of light. For short-term work, it may be enough to sandwich a specimen between a glass slide and coverslip, sometimes with a drop of water or oil to hold the coverslip in place using surface tension. However, for slides intended to be held in collections, an appropriate mounting medium is required, that will keep the specimen affixed to the slide indefinitely. Historically, a variety of mounting media have been used, including glycerine, wax, phenol, and even saliva (Allington and Sherlock, 2007). However, when keeping specimens permanently in collections it is recommended that a stable, non-aqueous mounting medium is used, such as Permount™ or Canada balsam (ibid.; see Figure 2). It is also recommended that coverslips on slides are sealed with an appropriate sealant, which can reduce issues of crystallisation and discolouration by limiting the area of exposed medium at the margins, reducing the opportunity for desiccation and chemical reaction (Allington and Sherlock, 2007).

While there is a useful body of literature discussing the aging and subsequent restoration of microscope slides (Brown, 1997; Allington and Sherlock, 2007; Neuhaus, Schmid and Riedel, 2017), there is very little written about pest management of slide collections, since they are not considered particularly vulnerable to pest attack. The main reported concern relating to slides and pests is the use of paradichlorobenzene as an insect repellent around microscope slides, due to a reaction that causes darkening and opacity of Canada balsam (see Figure 2) (Halliday, 1994; Neuhaus, Schmid and Riedel, 2017).

Figure 2. Slide drawer showing discolouration of Canada balsam mounting medium due to the presence of paradichlorobenzene in adjacent historic insect cabinets. Note that the intensity of the discolouration is greater in slides that have not been sealed. Image © Paolo Viscardi, 2018

Glass slides are typically safe from pest attack, although their paper labels are not and may be grazed by Psocidae (booklice), Oniscidea (woodlice), and Zygentoma (silverfish and firebrats). In some cases, the furniture that houses slides can provide a source of food for pests. At the NMINH, microscope slides are stored in a variety of ways, including folded card holders, bespoke wooden furniture, and steel cabinets, but there has been a move towards storage in standard cabinets. These measure 45cm high x 40cm wide x 34cm deep and are made from wood with a lockable glass-panelled door. They contain 28 wooden drawers, giving a capacity of 1000 slides per unit (see Figure 3). These cabinets allow accessible arrangement of the slides, which lie flat in shallow drawers that prevent displacement of mounting media and loss of any coverslips, labels, or specimens that become detached from slides. The drawers have

Figure 3. Standard cabinets with evidence of pest infestation. Image © Paolo Viscardi, 2018

a white plastic lining that offers contrast against which slides can be clearly seen, making it easier to see specimens and read labels. However, as with most wooden furniture, these units can warp and crack when stored in fluctuating environmental conditions, such as those experienced in Merrion Street (Monaghan, 2004; Herrero, Chandler and Viscardi, 2018). They also suffer from a design issue that we discovered has implications for pests - the cabinets each have a vertical wooden bar on the inside of the door, near the hinge, which prevents movement of the drawers when the cabinet doors are closed. This restraining bar has a strip of wool felt down the centre that acts as a buffer (see Figure 3). This wool felt is particularly attractive to the webbing clothes moth *Tineola bisselliella* (Hummel, 1823) and, on inspection, we discovered significant infestations in some of the cabinets (Figure 3). We also discovered adult brown house-moth *Hofmannophila pseudospretella* (Stainton, 1849), *Reesa vespulae* (Milliron, 1939) and some unidentified Psocidae.

The pest issue was identified during preparation for the movement of microscope slide cabinets from the entomology collections space to the CRC. The integrated pest management (IPM) protocols for these moves are described elsewhere (see Herrero, Chandler and Viscardi, 2018), but primarily they involve prophylactic treatment by freezing or cleaning, wrapping, and quarantining objects before inspecting them for signs of pest activity. However, when approaching the move of microscope slides, we were unable to use freezing as a preventative control measure, since slides can be damaged by ice formation (Florian, 1990; Brown, 1997; Allington and Sherlock, 2007). Furthermore, the materials comprising slides expand and contract at different rates, which can compromise the seal between slide, mounting medium, and coverslip (Allington and Sherlock, 2007). Therefore, we adopted an alternative approach to pest control involving manual removal of pests and treatment with a pesticide.

Materials and methods

The microscope slides in the NMINH collection are organised taxonomically, and to maintain their arrangement we drew a template of a standard slide drawer onto a sheet of 10mm thick Plastazote®, allowing the slides from one drawer to be laid out in the same sequence as they were stored. The drawer was inspected for signs of pests, with any evidence collected using a pair of fine entomology forceps and saved for further investigation. The drawer was carefully cleaned using a small nylon brush micro adapter on a Museum Vac® with HEPA filter and treated with pesticide if there was any sign of pest activity, then allowed to dry before the slides were returned in their correct sequence. The pesticide selected was Constrain™, which is a water-based permethrin formulation applied using a trigger spray, created specifically for use in a museum environment to control a wide range of insect pests (Pinniger et al., 1994). The outside of the cabinet was inspected and wiped down with paper towels; the inside of the cabinet was vacuumed and also sprayed with Constrain™, with special attention paid to the felt strip. The cabinet was allowed to air out until fully dry before the drawers were returned. Each slide was gently dusted with a small, soft paintbrush prior to re-storage (Figure 4). All work was conducted in a ventilated space using appropriate personal protective equipment (nitrile gloves and a 3M 8822 particulate respirator).

Figure 4. Slides being laid out on a Plastazote® template while empty drawer is cleaned. Image © Paolo Viscardi, 2018

Discussion

Use of pesticides is generally avoided in modern museum practice in order to reduce issues of contamination of objects with toxic residues that may impact upon the health of staff and the integrity of specimens (see Herrero, Chandler and Viscardi, 2018). When pesticides are used, pyrethroids and particularly permethrins are the usual choice because they have relatively low toxicity to mammals and birds (Imgrund, 2003) but high toxicity to invertebrates (Pinniger et al., 1994; Pinniger and Harmon, 1999). Permethrins are considered safe enough to be used in topical applications for treatment of human ectoparasites such as scabies (Rosumeck, Nast and Dressler, 2018) and present a relatively low risk to staff when used in collections, although some studies have suggested there may be some impact on male mammal reproduction when administered orally (Patrick-Iwuanyanwu, Udowelle and Okereke, 2016). Despite the toxicity of Constrain™ to target organisms, it has some limitations as a pesticide since permethrins do not readily vaporise (Imgrund, 2003). This means that it must come into direct contact with pests to be effective. Therefore, permethrin treatments such as Constrain™ may not eliminate eggs and larvae hidden inside holes and cracks in furniture that are not exposed to direct application (Querner, 2015). Permethrins also break down with exposure to sunlight and through bacterial action (Imgrund, 2003), meaning that they may not provide sufficient residual insecticidal effect to kill new adult insects as they emerge from untreated areas. Therefore, following the move of slide cabinets to the CRC they were wrapped in polyethylene, quarantined, and will be inspected at three month intervals for a year to ensure that all pests have been eradicated. In order to help prevent future infestations, we intend to replace the edible felt with a conservation-grade inedible material, such as Plastazote®, or consider alternative furniture.

Replacing the cabinets currently in use would provide the advantages of materials that are less attractive to pests and less prone to distortion, splitting, and detachment of drawer linings; all problems that we encountered. Rehousing the slides in new furniture would also present an opportunity to review the collection in a more comprehensive and systematic way than has been possible here, in what has been a time-sensitive response to a need to move. For the time being, however, the wooden cabinets have been moved onto steel shelving in a room at the CRC with no history of paradichlorobenzene use and a comparatively stable temperature and humidity, which represents a significant improvement from their previous storage environment. Fluctuating temperature and humidity is likely to have contributed to the detachment of labels and possibly to the discolouration and crystallisation of mounting media on some slides. Restoration of these may be possible with an appropriate understanding of the chemistry and causes of crystallisation and discolouration (Brown, 1997; Allington and Sherlock, 2007; Neuhaus, Schmid and Riedel, 2017), but it will require an appropriately trained member of conservation or technical staff to undertake the work.

Pests and other conservation issues are more likely to be recognised in a timely fashion in collections that are regularly used. With a collection of around 100,000 microscope slides, very few with unique museum numbers assigned, there is a real need for comprehensive curation and documentation to encourage use. It is important that a review of types, figured specimens and other important material is carried out and data made accessible if the collection is to fulfil its scientific potential (Notton, 1995). A list of putative type specimens of Acari from J. N. Halbert has previously been published (O'Connor, 1980), and many Orders with types represented in the collection are noted below (see Appendix 1), but there are a large number of zoological and geological microscope slides that have yet to be thoroughly examined. Furthermore, we have only been able to recognise type material that is labelled as such, making it important to encourage access by researchers specialising in the material, who may identify further important specimens. There are many specimens recorded as types in hard catalogues, but that information can be difficult to relate back to the specimens since many labels on slides are difficult to read due to grazing by Psocidae, fading, poor choice of writing materials (such as use of thick markers or inks that deteriorate), and poor penmanship. We found that badly faded slides were illegible when backlit or on a darker surface, but a white background greatly improved legibility and taking a photograph of the label allowed image-processing software to enhance legibility (Figure 5). With modern mobile devices and freely available software applications, this can be a quick and simple solution to deciphering faded text on labels.

Conclusion

IPM is an essential consideration even for collections not normally considered at risk of infestation. It is important that we undertake processes to prevent transmission of pests between collection spaces, and those processes should seek to minimise risks to people, collections, and the environment. We recommend that slide collections are included in IPM activity, and if wooden slide cabinets are used, we suggest removing wool felt if it is present. Slides should be stored in a stable environment away from

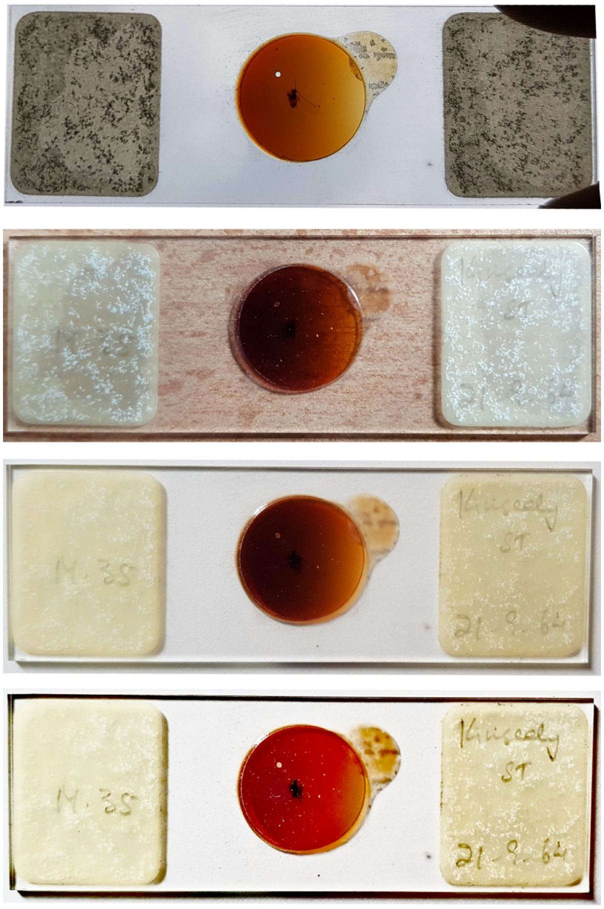

Figure 5. Top to bottom: backlit slide, slide on table, slide on sheet of white paper, slide photographed and image enhanced using image processing software. Image © Paolo Viscardi, 2018

old furniture with traces of residual paradichlorobenzene. Preferably, slides should be laid flat rather than stored on their side or end to limit the risk of displacement of labels and specimens that may become detached over time. Slide collections can hold important scientific information or have significant interest for a variety of audiences and should be appropriately curated and documented in order to make them accessible, as with any other collection.

Acknowledgements

We would like to thank Ana Esmeralda Herrero and Kim Chandler for their input to the work on this project and their input on this paper.

References

Allington, L. and Sherlock, E., 2007. Choosing a microscope slide sealant: A review of aging characteristics and the development of a new test, using low oxygen environments. *NatSCA News,* 12, pp.4–14.

Brown, P., 1997. A review of techniques used in the preparation, curation and conservation of microscope slides at the Natural History Museum, London. *The Biology Curator*, 10 (Supplement), pp.1–33.

Florian, M.L., 1990. The effects of freezing and freeze-drying on natural history specimens. *Collection Forum,* 6, pp.45–52.

Halliday, R., 1994. *Microscope slide mounting media. Results of informal survey.,* s.l.: Archives of Acarology List.

Herrero, A. E., Chandler, K., and Viscardi, P., 2018. TBC. *Journal of Natural Science Collections,* 6, pp.TBC.

Imgrund, H., 2003. *Environmental Fate of Permethrin*. Sacramento: California Department of Pesticide Regulation.

Justine, J.L., Rahmouni, C., Gey, D., Schoelinck, C., and Hoberg, E.P., 2013. The Monogenean which lost its clamps. *PLOS ONE,* 8(11), pp.1-18.

Lane, S., 2011. Re-organising the Coleoptera Collection at Leicestershire County Council Service. *NatSCA News*, 21, pp.75-88.

Monaghan, N., 2004. Victorian Natural History Galleries in the 21st Century - Keeping a Victorian Gallery Alive. *NatSCA News*, 3, pp.26-28.

Neuhaus, B., Schmid, T., and Riedel, J., 2017. Collection management and study of microscope slides: Storage, profiling, deterioration, restoration procedures, and general recommendations. *Zootaxa,* 4322(1), pp.1-173.

Notton, D.G., 1995. B.P. Beirne Microscope Slides of Ichneumonidae at the Natural History Museum, London. *The Biology Curator,* 2, pp.15-17.

O'Connor, J.P., 1980. J.N. Halbert: Notes on His Collection of Acari (Arachnida) Housed in the National Museum of Ireland, with a List of Contained Putative Types. *The Irish Naturalists' Journal,* 20(2), pp.75-76.

Patrick-Iwuanyanwu, K.C., Udowelle, N.A., and Okereke, C.J., 2016. Testicular toxicity and sperm quality. *Journal of Interdisciplinary Histopathology,* 4(1), pp.13-16.

Pinniger, D. and Harmon, J., 1999. Pest management, prevention and control. In: Carter, D. and Walker, A.K. (eds), 1999. *Care and Conservation of Natural History Collections.* Oxford: Butterworth Heinemann, pp.152-176.

Pinniger, D., Morgan, C., Child, R., and Lankford, W., 1994. *A novel microemulsion formulation of permethrin for the control of museum insect pests*. Studies in Conservation, 39(1), p.24.

Querner, P., 2015. Insect Pests and Integrated Pest Management in Museums, Libraries and Historic Buildings.. *Insects,* 6(2), pp.595-607.

Rosumeck, S., Nast, A. & Dressler, C., 2018. Ivermectin and permethrin for treating scabies (Review). *Cochrane Database of Systematic Reviews,* Issue 4, pp. 1-74.

Tybjerg, K., 2018. Exhibiting Epistemic Objects. *Museum and Society,* 15(3), pp.269-286.

Appendix 1. Some collectors and taxa with type specimens held on slides in the collections of the NMINH.

Collector	**Taxa**
Ashe, P.	Diptera, Hymenoptera
Barnes, W.V.	Phthiraptera
Bullock, E.	Acari
Cabot, D.	Parasitic worms (various)
Carpenter, G.H.	Collembola
Conroy, J.C.	Acari
Donovan, O.	Phthiraptera
Evans, G.O.	Acari
Gertrude, C. and Fr. Joseph	Collembola
Halbert, J.N.	Acari
Haliday, A.H.	Diptera, Thysanoptera, Hymenoptera
Healy, B.	Annelida
Hopkins, G.H.E.	Phthiraptera
Huxton, M.	Acari
Hyatt, K.H. and Benson, E.M.	Acari
Jackson, D.F.	Copepoda
Langton, P.H.	Diptera
Lawrence, P.N.	Collembola
Leske, N.G.	Lepidoptera
Malcomson, S.M.	Ostracoda
Melvin, A.D.	Collembola
Mitchell, M.	Diplopoda
O'Mahony, E.	Phthiraptera, Siphonaptera, Zygentoma
O'Mahony, E. and Hopkins, G.H.E.	Sternorrhyncha
Perkins, R.C.L.	Collembola
Peters , J.U.	Psocoptera
Purvis, G.	Acari
Purvis, G. and Evans, G.O.	Acari
Rousselet, C.F.	Rotifera
Schmitz, H.	Diptera
Theobold, F.V.	Sternorrhyncha
Walker, T.M.	Hymenoptera, Sternorrhyncha
Walton, G.A.	Auchenorrhyncha
Williams, C.	Diptera
Wright, E.P.	Cnidaria
Surveys (Including Challenger, BIOMAR, Royal Irish Academy)	Marine invertebrates (various)