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Movers, not shakers: challenges and solutions for relocating an entomology collection

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Abstract

Collections moves can pose significant challenges for the care and conservation of the objects contained therein, but they also offer opportunities to improve conditions. Here we discuss our experiences of dealing with the movement of approximately 1 million dry entomological specimens held by the National Museum of Ireland – Natural History from an historic building to a modern offsite location. Protocols for the movement of specimens were devised, implemented, reviewed and improved upon in an effort to minimise the impact of agents of deterioration during the move. We raise concerns about the use of very low temperatures when treating entomology collections for pests, and conclude with recommendations on freezing protocols for Plastazote®-lined entomology drawers and carded specimens.

Keywords: IPM, integrated pest management, collections moves, entomology, protocols, freezing, insect cabinets, insect boxes, pesticide

Introduction

The National Museum of Ireland – Natural History (NMINH) has a globally significant entomology collection, with over a million specimens including thousands of scientifically and historically important figured and type specimens. For over 150 years, this collection has been housed behind the scenes in the NMINH exhibition building on Merrion Street in central Dublin (also known as the 'Dead Zoo' by locals). As part of an ongoing move of stored collections to an offsite Collections Resource Centre (CRC), and with a timetable determined by a major national development plan (Project Ireland 2040, 2018) in which the Dead Zoo is due to have a roof replacement and extension building, the dry insect collections needed to be relocated. Moving objects carries inherent risks (Waller, 1995), but it can also provide opportunities to improve collections management and address existing problems (Hall, 2012). Here we discuss the challenges faced during the move, the solutions we came up with, and the lessons learned from the process.

Challenges

Collections storage

The dry entomology collection was stored in 134 standard 10-drawer Hills-type cabinets, 41 historic cabinets ranging in capacity from 6 to 60 drawers (most with 30), and 650 insect boxes. The cabinets were stacked two or three units high in two densely packed rooms in the upper floors of the building, creating a crowded space that was difficult to access (see Figure 1). The largest room was at the very top of the building, open to the glass ceiling and roof and prone to large environmental fluctuations as it received significant solar gain during the day, especially during the summer, and extremely cold conditions during the winter (Monaghan, 2004). These diurnal and seasonal fluctuations in temperature and humidity caused the wooden furniture, drawers, and boxes housing the collection to warp and split, and the cork pinning substrate in historic drawers and boxes to shrink, posing a challenge for storage following the move. The second room was a better space for collections, located a floor below and therefore somewhat buffered from more extreme changes in climate.

Physical logistics

It was a significant challenge working within the physical constraints imposed by an historic building. The lack of lifts, old stairs, uneven floors, and the restricted exit (84cm wide, with a steep ramp) that was only accessible by passing through a public space, made moving the collection difficult. Access to the private road adjacent to the building, that leads on to the public highway, is also extremely limited since it is located within the security cordon for the Houses of the Oireachtas (Irish government buildings).

The furniture housing the collection was heavy due to the solid wood and glass construction (e.g. a 10-drawer Hills-type cabinet weighs around 56 kg), but it was also fragile due to damage caused by the poor environment. Desiccated cork in old drawers meant that many of the pinned specimens had become loose, and so drawers had to be kept level when carried. The insect boxes had similar issues with shrinkage, but it was more difficult to assess and monitor as they were sealed in plastic bags. These factors combined to exacerbate issues with manual handling.

Pest management

In the top floor room, various insect pests were able to access the collections from the roof void, including psocid booklice, *Reesa vespulae* (Milliron, 1939) and *Tineola bisselliella* (Hummel, 1823) (see Figure 2). The second room was a better space for collections, with reduced access for pests, although the presence of small numbers of *T. bisselliella* did become apparent during the move. One of the main challenges we faced in moving these collections was therefore avoiding transfer of insect pests to the CRC site.

Residual pesticides

Historic pest management for the insect collection in the NMINH relied on three main approaches: barriers, repellents, and active treatments. The barriers comprised plastic bags or flypaper and sticky plastic strips pinned around cabinets, leaving sticky residues that were a minor inconvenience to remove. Repellents included naphthalene and paradichlorobenzene, which impregnated the furniture with a pervasive sublimate that readily vaporises, causing respiratory irritation at low concentrations (National Pesticide Information

Figure 1. The top floor insect room in the NMINH Merrion Street building. Image © Paolo Viscardi, 2018

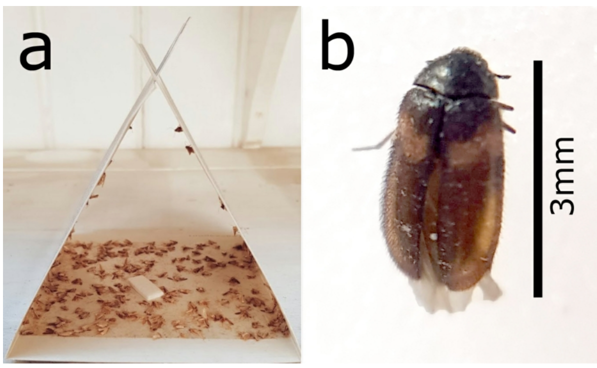

Figure 2. a) sticky trap with pheromone lure from top floor insect room containing T. bisselliella; b) specimen of Reesa vespulae found in the entomology room. Images © Paolo Viscardi, 2018

Center, 2010a; National Pesticide Information Centre, 2010b) and damage to microscope slides (Flanagan, White and Viscardi, 2018). The air quality in the room was tested on 3rd July 2013 and found to have naphthalene levels of <0.01 parts per million (ppm), well below the Occupational Exposure Limit of 10ppm (Dromgoole, 2013). As such, respiratory equipment was not deemed necessary when working in the space, although it was available if wanted. No naphthalene crystals remained in the drawers due to either prior removal or sublimation, but nitrile gloves were used when handling drawers. Active treatment with various insecticides had no doubt been in use in the past, but the most obvious was Vapona™, a brand of dichlorvos (2,2-dichlorovinyl dimethyl phosphate, also known as DDVP) dispersed from a yellow polyvinylchloride resin strip. While Vapona™ could be cut into appropriately sized blocks (Goldberg, 1996; Richter and Corcoran, 1997), it was often applied excessively in collections (Ryckman, 1969) and this was true at the NMINH (see Figure 3). Dichlorvos was banned for agricultural use in the EU in 1998 (PAN, 2008), but stockpiled supplies continued to be used in museums for many years afterwards, despite it interfering with the extraction and amplification of DNA from specimens (Espeland et al., 2010). We discovered large amounts of Vapona in parts of the NMINH insect collection, causing staining of wood, leaving residues on glass and putty, and discolouring and warping acetate mounts with specimens attached (Figure 3).

Staffing

In order to conduct the move it was essential to train a team of people physically able to carry several thousand drawers and hundreds of cabinets down multiple flights of stairs, without damaging themselves or the specimens. The NMINH has a long history of chronic understaffing (Moriarty et al., 2005) and at the time of the move the Keeper and two Assistant Keepers were the only staff in the Division. The insect move had to happen alongside normal day-to-day duties and other projects in the NMINH, including the ongoing moves of other parts of the NMINH collections.

Solutions

Staffing

In order to accommodate a move of this scale alongside a heavy workload, and to keep the physical demands of each move within reasonable limits, the project was broken into 11 moves over the course of

Figure 3. a) Large block of Vapona found in a drawer during move – note beads of fluid on the surface of the block – presumably from the breakdown of the polyvinylchloride strip; b) lid of the drawer in contact with the Vapona block – note staining of wood, reaction with putty and residue on glass; c) drawer with Vapona removed – note staining of wood and discolouration of acetate mounts; d) deformation of acetate insect mounts in close proximity to Vapona block. Images © Paolo Viscardi, 2018

a year. The Assistant Keeper for Zoology and Entomology (author PV) planned and managed the moves, facilitated by volunteers (authors AEH and KC and others mentioned in the Acknowledgements below) who played an active role in preparing sections of the collection for each move and packing the drawers on move days. To undertake the physical carrying and road transport of the collection, contracted movers William Tracey & Sons were used, a company with extensive experience of transporting objects for the National Museum of Ireland (NMI) with their own in-house Manual Handling training. Registration and security staff based at the CRC played an important role in providing access, coordinating contractors, and managing freezing protocols. The team involved in the moves received instructions in advance and the curator showed the contents of representative drawers prior to each move to explain the issues posed by particular types of specimens. The importance of minimising shocks and shakes during transport was emphasised and reinforced during moves, and all members of the moving team were instructed on how to minimise risks to themselves by using appropriate lifting techniques.

Physical logistics

When devising a moving protocol, we considered techniques implemented by other museums for moving insect collections, such as use of steel roll cages with Plastazote® cushioning between drawers and polyethylene wrap around the cage (Nicholls, 2017). However, the lack of lifts, level floors, or suitable doorways meant that wheeled solutions were impractical. Instead, we opted to use plastic crates with internal padding. For insect boxes we used our standard 80 litre (710mm x 360mm x 460mm) crates, but the insect drawers were too large so we selected 165 litre (745mm x 545mm x 425mm) crates normally used for moving computer equipment.

The smaller crates could be packed with bagged insect boxes in the insect storage room and hand-carried down the stairs, but the drawers were too large and heavy to move in this manner. Instead, they were hand-carried down the stairs by the movers, no more than three at a time (depending on the contents as assessed by the curator), and placed on tables (Figure 4a-c) for volunteers to transfer into the large crates. The crates had a 30 mm Plastazote® base layer, and a 10 mm-thick Plastazote® sheet (with a small pre-cut notch at each end) was added between each drawer to protect the glass (Figure 4d-e). Each crate was loaded with five drawers, before two 30 mm-thick Plastazote® strips were pushed vertically through the pre-cut notches in the stack of Plastazote® sheets to brace everything in position (see Figure 4f), and the crates closed.

Initially, each drawer had been sealed in polyethylene before the move, but issues arising from this (see below) led us to change our approach and the filled crates were instead covered with premade polyethylene lids, which were secured in place using polyethylene film (Figure 4g). The crates were carefully hand-carried out of the building between two contractors, loaded using a tail-lift into a truck with an air-ride suspension system (Figure 4h), and transported by road to the CRC where they were transferred directly into walk-in freezers for pest control (Figure 4i), using the freezing protocols discussed below. This process could only take place on Mondays, when Merrion Street was closed to the public and Dáil Éireann was not in session. Only a limited number of crates were available and so they were reused, meaning that the drawers had to be unloaded onto longspan shelving at the CRC (Figure 4j-k) and the crates transported back to Merrion Street for each subsequent move.

Collections storage

The CRC is an ex-electronics factory with an area of approximately 20,000 m^2, intended to house the reserve collections for all of the curatorial divisions of the NMI without relying on compression storage. The building has significant benefits when compared to the Merrion Street building: the light levels are tightly controlled, temperature and humidity fluctuate less, it is better sealed against pests, and it has zones with air handling. It also has loading bays equipped with large walk-in freezers for pest control, wide corridors and doorways, and it is built on a single storey, with no stairs or changes in level, all of which facilitates movement of collections.

The collections storage furniture used in the CRC is preferentially powdercoated or galvanised steel, in order to reduce fire risk and minimise issues with off-gassing. For storage of the entomology dry collection, there was some compromise required on this point, since the entire collection was pinned in wooden drawers and boxes and there was insufficient skilled staff available to re-pin specimens into more appropriate containers such as unit trays (Lane, 2011). We assessed the furniture and concluded that the more recent Hills-type cabinets were in good enough condition to retain, but the more historic furniture

Figure 4. Process of moving collections – see text for explanation. Images © Nigel Monaghan, 2018

was unfit for purpose due to warping and cracking of the wooden cabinet carcasses. To keep cabinets, drawers, and boxes off the ground in case of flooding and to reduce access for pests, we used steel longspan shelving. This was to permanently support the Hills-type cabinets and provide temporary storage for the historic drawers and boxes while 15 bespoke steel cabinets (with capacity for 900 drawers) were commissioned from metal fabricators Flexitech Ltd. (see Figure 5 for units and Appendix 1 for the specifications and design).

Residual pesticides

To reduce risks to human health and limit damage to the collections from volatile repellents and pesticides, the room allocated for the insect collection at the CRC had its own air extraction system, creating a small negative pressure in the room to minimise dispersal of vapour. Historic repellents or pesticides were removed prior to the collections moves by the curator wearing appropriate PPE, and sealed in plastic for later chemical disposal. The new cabinets also provided a mechanism for containing naphthalene and paradichlorobenzene vapours emitted by historic drawers.

Pest management

As part of the NMI integrated pest management (IPM) approach, all moves into the CRC follow a strict quarantine procedure. Objects unsuitable for freezing undergo a confinement process in a holding area, where they are cleaned, securely wrapped in polyethylene sheeting, and inspected after an isolation period of several months (actual duration dependent on conditions) to ensure they are pest-free before entering the main CRC collections areas. Objects that can be safely frozen are kept at -30^{0}C for at least 72 hours prior to entry to the building (although see below). When freezing objects, they should be sealed in plastic in order to prevent damage from changing humidity, condensation, frost formation and meltwater (Florian, 1990; Pinniger and Harmon, 1999). Our initial approach was to bag individual drawers prior to the moves, using polyethylene tubing and a heat sealer. This method had the advantage of being fast and allowing signs of existing damage in the drawers to be marked up on the polyethylene using a permanent pen, making it possible to assess subsequent damage occurring as a result of the move.

Figure 5. a) Hills-type cabinets on steel longspan shelving; b) bespoke steel furniture, with gaskets and compression locks for housing historic entomology drawers and boxes. Images © Paolo Viscardi, 2018

It became clear after the first move that specimens in some drawers saw significant damage, including detachment of carded specimens and loss of wings, legs, and antennae in directly pinned specimens – in some cases, even the internal wooden beading of the drawer was displaced (Figure 6). This damage was at first thought to be the result of vibration, but closer inspection revealed bent pins that could not be caused simply by vibration. We noted that this damage only occurred in drawers from Hills-type cabinets and, after consideration, we deduced that the contraction of the air volume inside the sealed drawers during freezing at -30^{0}C caused a partial vacuum that displaced beading and lifted the Plastazote® lining of the drawer, pushing the pins against the glass lid.

We tested this by using Blu Tack™ and pins to replicate specimens in a drawer, bagging it and using a vacuum cleaner to remove air. The Plastazote® lifted, pushing pins in the centre of the drawer against the lid where they bent and rotated, resulting in similar damage to that seen in the Hills drawers (Figure 7). A second experiment tested bagged drawers frozen at -18^{0}C and -30^{0}C. We found no signs of damage in the drawer frozen at -18^{0}C, but flattening of the Blu Tack and bending of pins in the drawer frozen at -30^{0}C indicated that the Plastazote® was pushing the pins against the glass. It seems likely that sealing the drawers using a heat sealer created conditions that allowed the vacuum to form at very low temperatures.

We also considered the failure of adhesive in carded specimens to be due to freezing at temperatures below those recommended in some early literature, which suggests -20^{0}C (Florian, 1990). Freezing can affect the thermoplastic properties of adhesives, causing them to “unlace” (Moore, 2007) – this was seen most often where a large amount of adhesive (probably Seccotine fish glue) had been used to attach a specimen to a card. To solve these issues, we raised the freezing temperature to -18^{0}C and extended the freezing cycle to four weeks. This allowed a minimum of two weeks at the necessary temperature to kill any pests (Florian, 1990; Pinniger and Harmon, 1999; Strang, 1992), while factoring in the time taken to fully cool down and warm up at the start and end of the process. By adapting the approach to wrapping crates for freezing (as shown in Figure 4g-i) rather than the individual drawers as we did at first, we lessened the risk of a vacuum forming and significantly reduced the time and materials used to prepare each load for transport.

Figure 6. Damage to specimens and beading in Hills-type drawer and specimen detached from card in historic drawer. Images © Paolo Viscardi, 2018

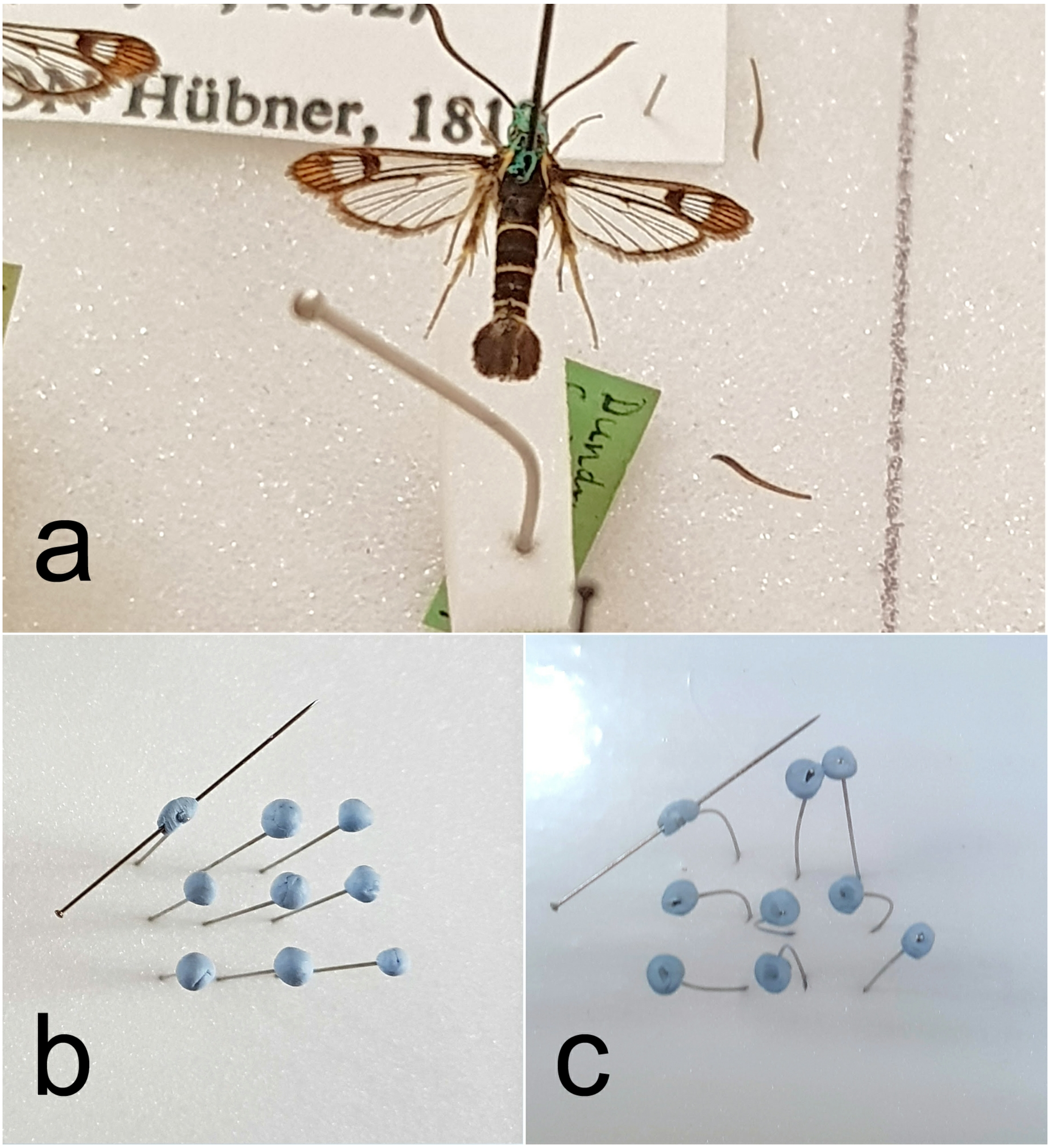

Figure 7. a) Example of pin bent during freezing process; b-c) experimental set-up using Blu Tack on pins to investigate cause of pin bending with b) prior to experiment and c) during experiment. Images © Paolo Viscardi, 2018

Lessons learned

Clear communication is essential during collections moves. We found that when communication failed, logistical problems tended to occur that increased the potential for risk to the objects – such as drawers continuing to be carried down stairs after the supply of crates had run out, meaning that the remaining drawers had to be carried back up the stairs, doubling their handling. Having a single person in charge of the process, ensuring that everyone knew what was expected and how the move was progressing, was vital.

Learning from the experience of other museum staff involved in similar moves was valuable, but it was important to tailor the lessons learned to the specific challenges of our physical spaces and resources. This sometimes meant that compromises had to be made, with best solutions not necessarily being practicable and good-enough solutions being adopted. For example, re-pinning specimens from old drawers into unit trays would be preferred, but lack of staff resources meant that transferring old drawers into new cabinets was the best available solution.

Collections moves offer significant long-term improvements in storage conditions, but they do present risks. Despite freezing being widely accepted as a suitable mechanism for controlling pests in entomology collections, it is important to note that freezing at temperatures significantly below -20^{0}C can cause problems. Besides the issue with low air pressure causing Plastazote® to lift in drawers tightly sealed with plastic, some specimens also dissociated from the cards to which they were attached, due to failure of adhesives at very low temperatures. However, after changing our freezing protocol we encountered no further problems with damage to specimens or their detachment during the move. Our experiences demonstrate the value of monitoring specimens for damage during a move and highlight the importance of changing protocols when they prove to be unfit for purpose.

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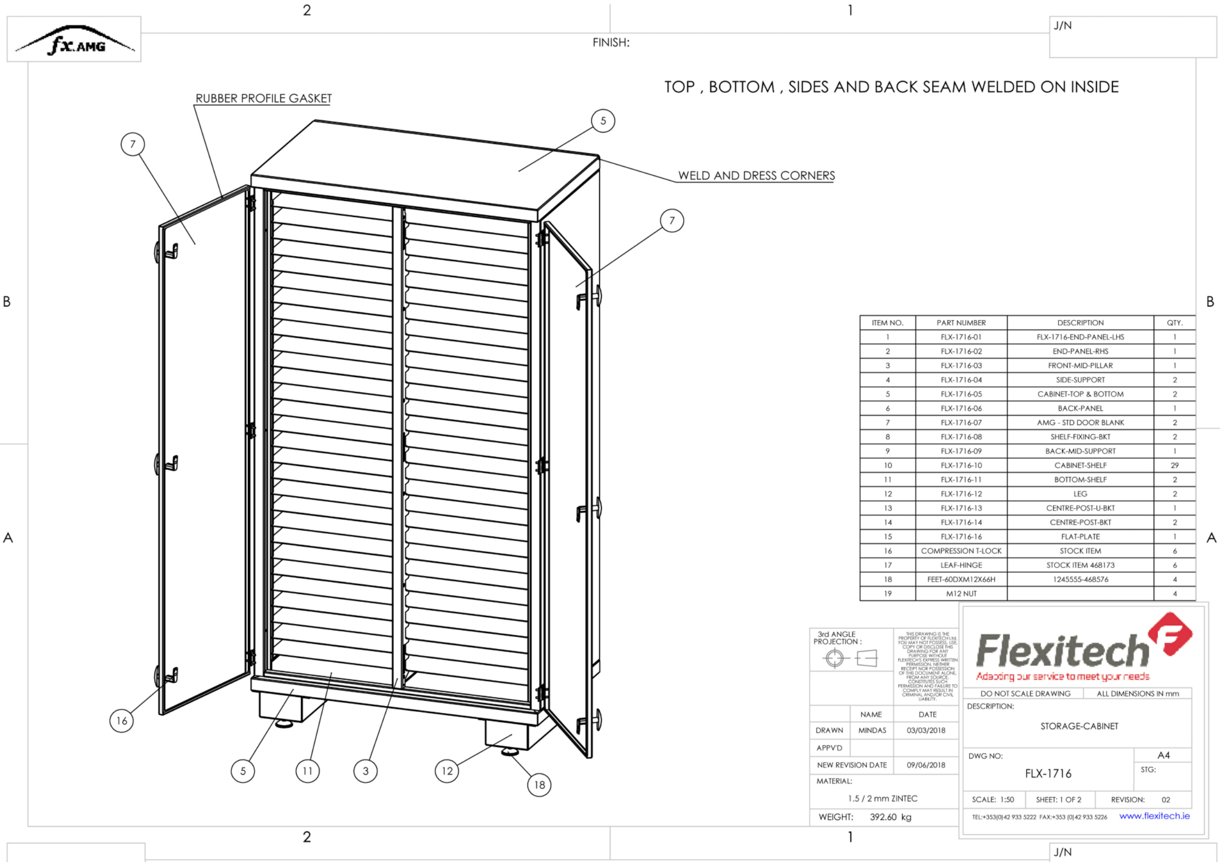
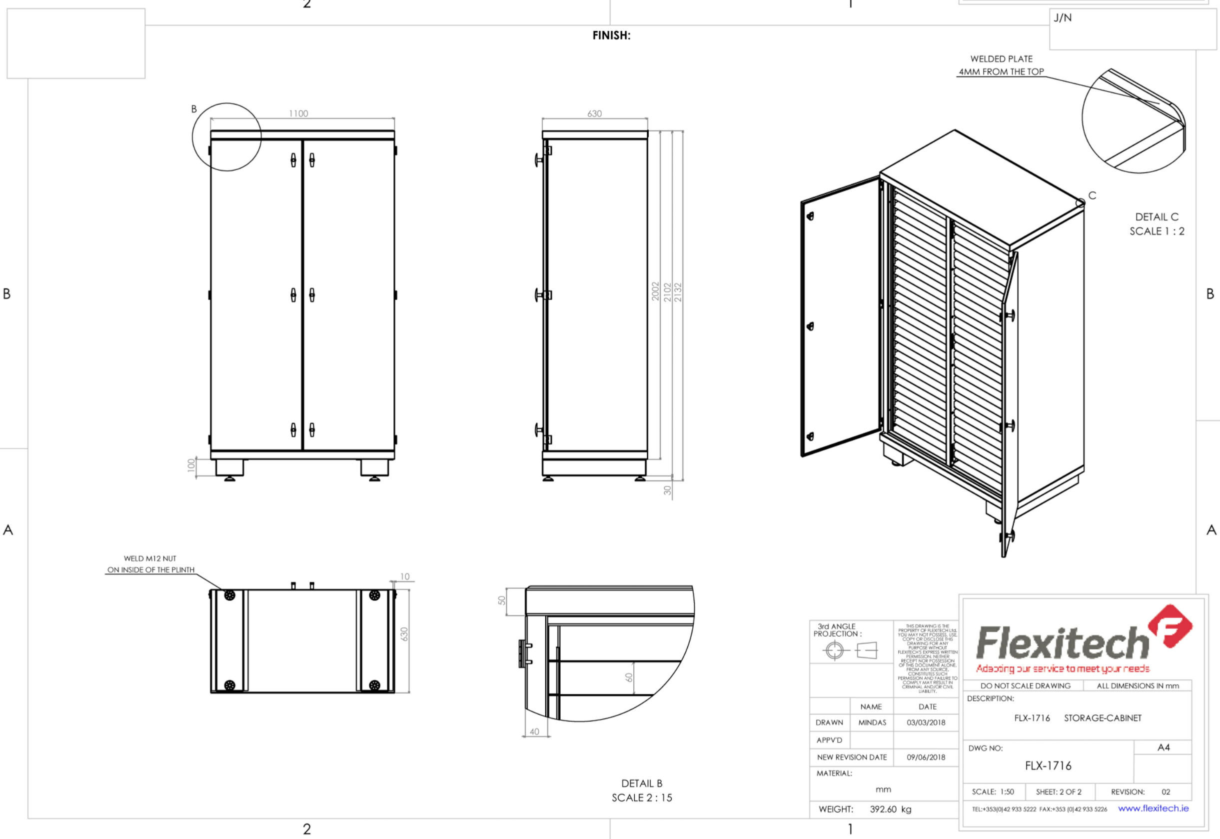
Appendix 1. Specifications for insect cabinets

The specification for the cabinets was as follows:

- Powder coated 1.5 / 2mm Zintec (mild steel with zinc incorporated using electrolysis);
- Seam-welded on five sides to ensure a secure seal;
- Double doors with three compression locks and gaskets around the internal frame to reduce the risk of pests getting inside, or volatile compounds from the historic drawers escaping.
- 1100mm wide (to take widest drawers or two, or three Historic drawers side-by-side, depending on their dimensions) x 630mm deep (to accommodate deepest historic drawer) x 2102mm high (to maximise vertical storage space while still fitting through internal doors when on a pallet truck);
- Internal Zintec shelves spaced 60mm apart (to accommodate most historic drawer heights) with removable front brace to allow shelves to be removed to accommodate oversize drawers and insect boxes);
- Two 100mm raised box supports with space between to allow movement using a pallet truck;
- Adjustable feet to enable levelling of the cabinet once in situ;
- 4mm lip at back of top of unit to act as a stop for empty insect boxes stored on the top of the cabinets.



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	FLX-1716-01	FLX-1716-END-PANEL-LHS	1
2	FLX-1716-02	END-PANEL-RHS	1
3	FLX-1716-03	FRONT-MID-PILLAR	1
4	FLX-1716-04	SIDE-SUPPORT	2
5	FLX-1716-05	CABINET-TOP & BOTTOM	2
6	FLX-1716-06	BACK-PANEL	1
7	FLX-1716-07	AMG - STD DOOR BLANK	2
8	FLX-1716-08	SHELF-FIXING-BKT	2
9	FLX-1716-09	BACK-MID-SUPPORT	1
10	FLX-1716-10	CABINET-SHELF	29
11	FLX-1716-11	BOTTOM-SHELF	2
12	FLX-1716-12	LEG	2
13	FLX-1716-13	CENTRE-POST-U-BKT	1
14	FLX-1716-14	CENTRE-POST-BKT	2
15	FLX-1716-16	FLAT-PLATE	1
16	COMPRESSION T-LOCK	STOCK ITEM	6
17	LEAF-HINGE	STOCK ITEM 468173	6
18	FEET-60DXM12X66H	1245555-468576	4
19	M12 NUT		4



Appendix 1. Plans for steel cabinet, designed in discussion with Mindas Petrosius. Copyright Flexitech Ltd. 2018. Reproduced with permission.