Museum Management from an Environmental Perspective : Undertakings at the National Museum of Ethnology

メタデータ	言語: eng	
	出版者:	
	公開日: 2020-12-10	
	キーワード (Ja):	
	キーワード (En):	
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	所属:	
URL	https://doi.org/10.15021/00009627	

Senri Ethnological Studies 103: 137–164 ©2020
Environmental Teachings for the Anthropocene: Indigenous Peoples and Museums in the Western Pacific
Edited by Atsushi Nobayashi and Scott Simon

Museum Management from an Environmental Perspective: Undertakings at the National Museum of Ethnology

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Abstract

More than 340,000 objects are stored at the National Museum of Ethnology (Minpaku), with many containing organic materials; this includes the Taiwan collection, specifically. Minpaku has developed theories and methods that protect materials from biological damage, including insect damage. It is essential to properly preserve and manage the collection in order to pass it on as future research material or valuable cultural resources.

I. Introduction

Japanese museums are highly susceptible to invasion from insects and fungi due to the country's hot and humid climate; finding measures for preserving collections in this environment is a challenge that must be addressed. The National Museum of Ethnology (hereafter referred to as Minpaku), where the author of this article is based, is no exception. In considering this challenge, this article focuses on the particular qualities of the materials housed at ethnic museums such as Minpaku.

Since 1981, condition check cards developed at Minpaku have been utilized to assess specimen conditions (Figure 1); to date, we have inspected 230,000 items. When conducting the assessments, we select the relevant 'Material Classification' for the specimen in question and perform a visual examination to determine if the condition of the material corresponds to any of the listed 'Inspection Results'. The precise procedures are outlined in a materials condition check manual to ensure there is no variation among inspectors, and the condition check card and manual are revised as necessary in response to changes in work procedures, as well as any newly confirmed materials or problems. The condition check card and manual we are currently using were last revised in June 2015 and September 2010, respectively.

All items on the condition check card have been assigned a two-digit code, which is centrally managed by the specimen materials management system. If you were to search the system for collection materials containing plant-based matter, for example, which is the organic material most susceptible to damage from pest outbreaks, the results would include a total of 96,636 hits (search items include general plant material; straw; palm

Registration No.	Name of object	Storage location	Inspector	Date

＜Complexity＞
10 "Simple" artifact made of one material
20 "Complex" artifact made of more than two materials

(Material and Technique)
10 Metal (in general) 11 Iron 12 Copper and its alloys 13 Aluminium
＊16 Plate ＊17 Metal wire and mesh 18 Enamel ＊19 Machinery
20 Stone and minerals (in general) 21 Glass 22 Terra-Cotta 23 Ceramics and earthenwares
24 Clay and its products ＊29 Jewels and precious stones
30 Plants (in general) 31 Straw and its products 32 Palm and palm leaves
＊33 Mats 34 Raw leaves 35 Nuts 36 Coconut 37 Calabash
38 Bamboo, cane, vine ＊39 Baskets
40 Wood (in general) 41 Bark 42 Bark rope 46 Wood shavings ＊47 Boxes
＊48 Plywood ＊49 Tub and cask
50 Fibers 51 Yarn, thread, twine etc. ＊52 Rope, net etc
53 Lace 54 Cloth and textiles 55 Non-woven cloth and felt ＊56 Knitted works
＊57 Embroidery 58 Cloth elastic ＊59 Accessories of cloth
60 Paints, ink or other coloring matters 61 Lacquerware 63 Metal leaf
65 Paper and paper works 66 Paper with waterproof coating ＊69 Papier-mache
70 Animals (in general) 71 Fur 72 Leather 73 Feather, wool and hair
75 Nail, horn, tortoise shell, etc. 76 Ivory, tooth, bone, etc. 77 Shell ＊78 Marquetry
80 Synthetic resins, plastics 81 Natural resins
83 Rubber products (except Cloth elastic) 84 Oil, fats and waxes ＊85 Tape and sheet
89 Processed foods
90 Miscellaneous 91 Unknown materials
92 General or whole (use for "cobwebs" "spot marks or dirt" and "thick dust") 93 Others
(Additional Codes)
01 Replica 02 Fine art, Archives
04 Japanese ink inscription 05 Burned stamp 06 Stamp 07 Label

Results

Storage
00 Unknown
10 General
20 Large size objects
30 Weapons
40 Lacquerware
50 Clothing
60 Fur
70 Carpet

＜Results of the condition check＞
00 Good condition
10 Heavy crack
11 Breakage
12 Missing
13 Deterioration
14 Separation
15 Deformation
20 Decomposition (or corrosion)
30 Mould attack
31 Insect attack
32 Missing by insect attack
33 Cobwebs
40 Discoloration, fading
41 Sticker attached
42 Spot marks or dirt
43 Used mark or mark of usage
44 water stains
50 Loose joint
51 Broken thread
60 Serious hardening
61 Oil spot
70 Thick dust
71 Dull and hazy looking
80 Others

＜Photograph or sketch of the object＞

Restoration
1 required
2 unnecessary

Fumigation
1 required
2 unnecessary

Additional note
1 yes
2 no

Cleaning
1 required
2 unnecessary

Access regulation
00 unlimited
10 not for loan
11 not for exhibition
20 do not take out of storage
30 not for perusal

Previous checking dates

Cycle of checking
year

＊Next checking
year / month

＜Checking points＞

National Museum of Ethnology　　Inspection Card　　2012.12

Figure 1 Condition check card (2019, The National Museum of Ethnology)

leaves; matting; grass in its original form; nuts and berries; coconut shells; gourds; bamboo, wisteria, and reed; baskets; trees; tree bark; tree bark tape; plywood; tubs, barrels and cylindrical objects). This figure includes duplicated items and therefore is not necessarily the actual number. Rather, the result demonstrates how the majority of folk materials, which tend to be made up of composite materials, include organic matter; thus, it is fair to say that this museum facility houses numerous materials susceptible to pest damage. As this symposium compares examples from Taiwan and Japan, I have also examined the Taiwanese materials; the search revealed around 5,000 items, of which around 1,300 include organic matter. Therefore, for the Taiwan-related materials stored at Minpaku, implementing pest control measures, such as those targeting insect damage, is an important undertaking.

Next, I would like to consider the importance of pest control measures at Minpaku from a different perspective. Carbon dioxide treatment is pivotal in our pest control measures. This method was used 16 times in 2015, 13 times in 2016, and 12 times in 2017 at Minpaku. In addition to instances where carbon dioxide treatment was performed in response to pest outbreaks, these figures also include instances in which carbon dioxide treatment was performed on materials that had been previously loaned out to other museums and were being returned to storage. This indicates that we perform carbon dioxide treatment approximately once per month, demonstrating just how important insecticidal treatment and pest control measures are in the preservation of materials at Minpaku.

However, in consideration of environmental problems such as global warming, we have recently been reflecting on our practices at Minpaku from an environmental protection perspective. This article will discuss Minpaku's environmentally conscious insecticidal treatment initiatives, focusing on pest control measures.

II. Changes in the Management of Materials at Minpaku

1. Outline of Minpaku's materials management activities from 1980 to present

The fully-fledged system for preserving materials through pest control measures was implemented as far back as 1979, when Professor Emeritus Tsuneyuki Morita began working at Minpaku. The sequence of activities is detailed in the Minpaku Tsushin issue 107 (Morita 2004: 8–10). The following overview of pest control measures from Minpaku's early days through the present is based on this report.

Minpaku first encountered large-scale pest damage in the spring of 1980 with a mass outbreak of felt and fur-eating moths in the exhibition area. At this point, Minpaku already had the largest fumigation chamber in the country and had incorporated regular pest control measures including storehouse fumigation. Despite such precautions, the damage at the museum was considerable. The use of an open exhibition style in areas subject to a large volume of visitor traffic was identified as the root cause. The majority of the materials included organic matter; thus, once the pest outbreak began, the environment enabled the damage to rapidly spread through the exhibition area.

For this reason, employing methods such as fumigation to deal with the pest damage after it had occurred was not a fundamental solution to the problem. To this end, a technique was developed for museums to vaporize and diffuse pyrethroid insecticide at room temperature, and a program of regular diffusion was introduced as a method of pest damage prevention (Kawagoe and Kikuchi 2008: 113–124). In the Montreal Protocol, an international treaty that Japan ratified in 1988, methyl bromide was designated as an ozone-depleting substance, and a decision was made in 1995 to abolish all use of it by 2005. Minpaku's main pest control measure relied on the use of methyl bromide, so this decision demanded reconsideration of our approach. As a result, we developed techniques for implementing various methods of insecticidal treatment that did not rely on chemical agents, such as carbon dioxide treatment, low oxygen concentration treatment, and heat treatment. A system was thereby created where the appropriate method of treatment could be selected based on the component materials of the museum specimens being treated, the period of insecticidal treatment, and the conditions of the area in which the treatment was to be performed.

In addition, surveys on insects were conducted from the middle of the 1980s to improve efficiency in our response to pest damage. Beginning in 1992, this task was incorporated as one of the official material management duties. The results obtained from this enabled us to understand which places were most susceptible to pest outbreaks and were useful in identifying the locations in which pyrethroid insecticide could be diffused and which materials could be subjected to insecticidal treatment. Since 2004, we have been performing comprehensive computer analyses of the survey results. Thus, our practices are even more effective in early response to pest damage and identifying the locations of outbreaks; this has become a central pillar of Minpaku's pest control measures.

2. Montreal Protocol and the trend in insecticidal treatment in Japan

The official name of the Montreal Protocol is the Montreal Protocol on Substances that Deplete the Ozone Layer, and it was adopted in Montreal, Canada, in 1987. The Protocol is based on the Vienna Convention, whose official name is the Vienna Convention for the Protection of the Ozone Layer. This Convention is a framework for international measures for the protection of the ozone layer; it was adopted in 1985 and came into force in 1988. The esignation by the Montreal Protocol of methyl bromide as an ozone-depleting substance had a large impact on the insecticidal treatment methods not only at Minpaku but also at all national museums in Japan. Next, I would like to discuss the trend of insecticidal treatment in Japanese museums at that time.

Following the Montreal Protocol, the field of museums and preservation of cultural properties research experienced a drive to develop new techniques for insecticidal treatment in anticipation of the ban on methyl bromide that would take effect in 2005. However, before the development of these new techniques was undertaken in earnest, the Agency for Cultural Affairs conducted a survey to determine whether the use of methyl bromide was essential to the pest management of cultural properties. The survey was conducted in 2002 in the form of a questionnaire, which was sent to the heads of the Cultural Properties Protection Departments in the boards of education for each prefectural and city government nationwide. It enquired whether insecticidal treatment using methyl bromide was an indispensable activity. The results of the survey suggested that it would be possible to find alternative methods for insecticidal treatment, and a decision was made not to apply for an exemption to the ban on methyl bromide for use in the field of cultural properties. With this decision came a genuine impetus to develop new techniques for insecticidal treatment.

In seeking alternative techniques, a new chemical agent was developed to replace methyl bromide (Kigawa et al. 1999: 12–21); at the same time, techniques for non-chemical insecticidal treatment were developed (Kigawa et al. 2002: 52–69), and a survey was conducted to determine the non-chemical insecticidal treatment methods already in use at museums in the West (Kigawa et al. 2003: 76–95). The methods that attracted particular attention were carbon dioxide treatment, low oxygen concentration treatment, heat treatment, and low temperature treatment. Of these, carbon dioxide treatment could be used with a variety of materials and implemented through a relatively easy system; therefore, this was the method Minpaku chose to introduce in 2004.

III. Outline and Development of Carbon Dioxide Treatment Introduced at Minpaku

1. Outline of carbon dioxide treatment

The source gas for carbon dioxide treatment is the carbon dioxide produced and collected as a by-product from oil refineries, chemical plants, and the manufacturing process of dry ice. In other words, the production method recycles carbon dioxide that has already been discharged as waste, so no new carbon dioxide is produced. This is important, as carbon dioxide contributes to global warming.

In order to develop a carbon dioxide treatment system for use on folk cultural assets, the current I performed four experiments on actual folk cultural assets (Hidaka et al. 2002: 76−102).

For the carbon dioxide treatment experiment, a gas barrier cloth sheet laminated with a layer of ethylene-vinyl alcohol copolymer (EVOH) between the polyethylene layers was used. The thick blue sheet, which has polyethylene as its main component and is commercially available, can be used to contain the compound agent of methyl bromide and ethylene oxide commonly used in fumigation at museums in Japan; however, it cannot be used with carbon dioxide due to its high level of permeability. In order to prevent carbon dioxide from permeating, a gas barrier cloth sheet with a permeability of 4 ml/ (m^2/days/atm) is required.

The experiment assessed the level of carbon dioxide concentration required for the treatment process, the adsorption amount of the carbon dioxide by the folk artefacts, and the effect on the artefacts' pigments. We also verified the airtightness of the gas barrier cloth sheet, the safety check procedure during treatment, and the points of caution during the evacuation of carbon dioxide. As a result, I was able to complete an instruction manual so that museum curators could independently perform insecticidal treatment using carbon dioxide treatment.

A brief outline of the carbon dioxide treatment process is as follows, and a schematic diagram of the carbon dioxide treatment system is shown in Figure 2. The conditions required for carbon dioxide treatment to be effective as an insecticidal treatment include the following: treatment temperature of 25℃, carbon dioxide concentration of between 60 and 75%, and treatment period of 14 days. One of the key aspects of carbon dioxide treatment is that it can be deployed using a simple system. For example, the treatment process can be performed inside a tent of any size constructed with a gas barrier cloth sheet. If you use a portable inlet and exhaust port for the carbon dioxide, and as long as you are in a space where you can maintain a temperature of 25℃, you can essentially perform the treatment anywhere.

In building off the results of the experiments described above, we successfully carried out carbon dioxide treatment using a large fastener bag made from gas barrier cloth sheets. This method was incorporated into the museum's pest control measures beginning in 2004, and currently the museum staff is responsible for carrying out this treatment (Photo 1). We later succeeded in carrying out carbon dioxide treatment on a much larger scale.

2. Example of large-scale carbon dioxide treatment performed on wooden boats

In 2013, the large tents (Photo 2) were withdrawn from use and a new storage area was constructed (Photo 3). The new, multi-functional storage facility housed a large wooden boat and cultural properties affected by disasters. It was equipped with a washing area

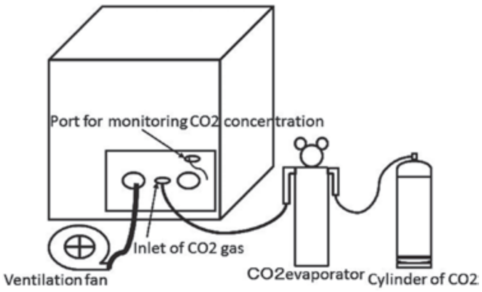

Figure 2 The system of carbon dioxide treatment

Photo 1 Minpaku staff input carbon dioxide (2020, Hidaka)

Photo 2 Large tents (2015, Hidaka)

Photo 3 Multi-functional storage (2019, Hidaka)

Photo 4 Washing area for cleaning disaster-affected items (2019, Hidaka)

for cleaning the disaster-affected items (Photo 4) before moving them to temporary storage.

We performed carbon dioxide treatment on the boats to prepare them for permanent storage. For this treatment, we used a permanently set up, large fastener bag measuring

Photo 5 Large Fastener bag (2014, Hidaka)

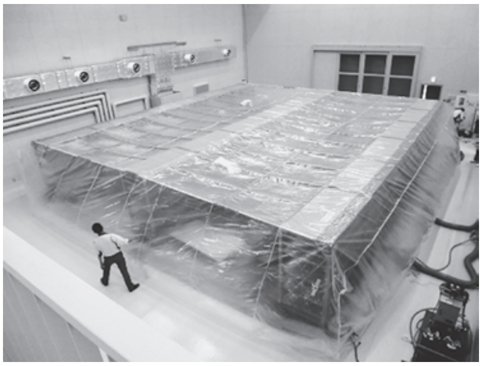

Photo 6 Large-scale carbon dioxide treatment of large wooden ships (2014, Hidaka)

6.9 m in length, 2.8 m in width, and 2.2 m in height (Photo 5). The size of the bag was determined such that it would be large enough for 80% of the wooden boats in storage. Boats that did not fit into this bag were treated with carbon dioxide in an enclosure-type insecticidal treatment bag measuring 11.5 m in length, 10 m in width, and 2 m in height (Photo 6). This large-scale carbon dioxide treatment was carried out on 35 large wooden boats over two periods of two weeks, with 17 boats in the first batch and 18 boats in the second batch. Due to the large scale of the treatment, we did not use the steel pipe struts used for the large fastener bag, but instead supported the enclosure with rows of mobile shelving used for storing materials (length 1.8 m × width 0.9 m × height 1.9 m). To measure the concentration of the carbon dioxide, we set sampling hoses at a diagonal angle in three places above and below the carbon dioxide inlet (so six hoses in total). The changes in temperature/ relative humidity and the concentration of carbon dioxide during the second treatment carried out from 4 to 23 October, 2014 can be seen in Figures 3 and 4, respectively. This was the first experience for us in carrying out such a large-scale operation, but we were able to create the conditions required for effective insecticidal treatment. In addition, we confirmed the total extermination of the red flour beetles we were using as test insects and thus concluded that we had achieved sufficient insecticidal effect.

3. Carbon dioxide treatment technology transfer following the Great East Japan Earthquake

Having gained operational experience with carbon dioxide treatment at Minpaku, we then passed our knowledge through technology transfer following the Great East Japan Earthquake.

First, I would like to briefly review the Great East Japan Earthquake. At 14:46 on 11 March 2011, an earthquake occurred in the Pacific Ocean off the coast of the Tohoku region. Following the earthquake, a huge tsunami struck the coast of Japan, causing unprecedented damage and precipitating the accident at the Fukushima Daiichi nuclear reactor (Photo 7). In the wake of the earthquake, there was a nationwide effort to save

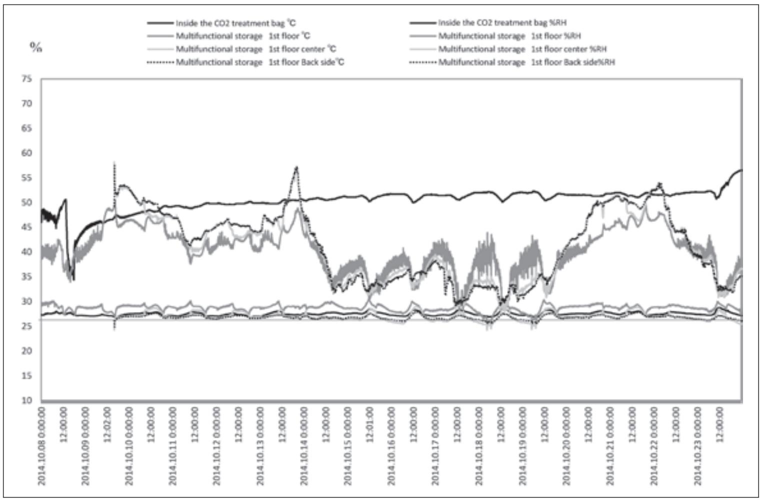

Figure 3 Transition of temperature and relative humidity during the second treatment

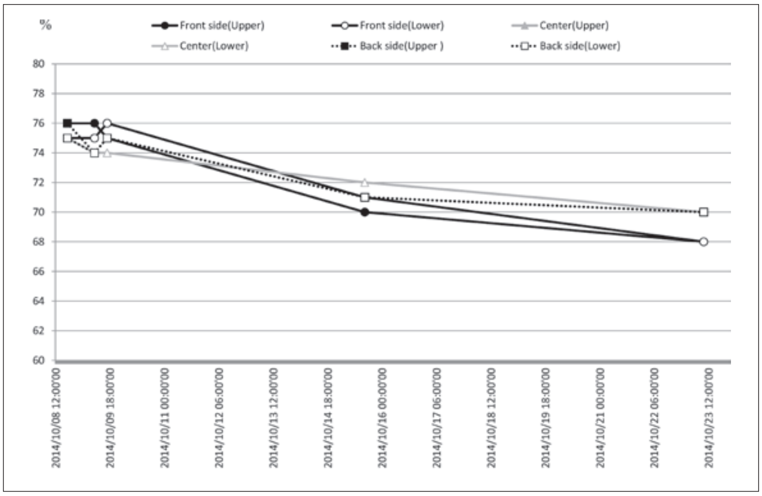

Figure 4 Transition of Co2 concentration during the second treatment

the cultural properties affected by the disaster. The current I participated in the rescue of folk artefacts in six regions of Miyagi Prefecture and two regions of Iwate Prefecture. The first task in rescuing these cultural properties was to search for the artefacts buried in the rubble and retrieve them (Photo 8). The next task was to move these rescued artefacts to a safe location where they could be stored temporarily (Photo 9). These storage locations, which were secured at the time of the disaster to house the disaster-affected cultural properties, were never intended to be anything more than temporary. They were not museum facilities; for the most part they were simply spaces to keep the items secure and dry. In addition, the majority of the spaces could be easily permeated

Photo 7 Destruction from the Great East Japan Earthquake (2011, Hidaka)

Photo 8 Search and retrieve (2011, Hidaka)

Photo 9 Temporary storage (2011, Hidaka)

by insects. When a disaster occurs, efforts are made to ensure that cultural artefacts are quickly moved from these kinds of temporary storage locations to more suitable environments. However, due to the sheer scale of damage following the Great East Japan Earthquake, it was difficult to find suitable storage locations for the cultural properties and the temporary storage facilities became long term–in some cases being used for over a year; as such, concerns over pest damage grew. To this end, I held a carbon dioxide treatment workshop for disaster-affected cultural properties in Kakuda City, Miyagi Prefecture.

Fukuoji temple in Kakuda City had sustained damage in the disaster, so the Kakuda City facility was temporarily storing the *Fukuoji Bishamondo Hono Yosan Shinko Ema* (hereafter referred to as *Ema*). These *Ema* are a collection of wooden tablets which are enshrined at the *Bishamondo* temple building on the Fukuoji temple grounds and are offered as prayers for the safety and prosperity of the local silk-worm industry. The collection mostly includes small wooden tablets inscribed with the Chinese characters for the word ‘centipede’ and features depictions of *Mukade* centipedes which are said to be the servants of Vaisravana. The custom was to pray at the *Bishamondo* and borrow one of these *Ema* tablets to display in the home as a prayer for the safe raising of silkworms.

Photo 10 Lecture on carbon dioxide treatment (2012, Hidaka)

Photo 11 Carbon dioxide treatment training (2012, Hidaka)

Once the silkworms had been safely raised, a new *Ema* was added to the previous one and both were returned to be enshrined at the *Bishamondo* temple building. The result was an enormous collection of 23,477 tablets, and in 2012 they were designated as an important tangible folk cultural asset. However, the facility where they were temporarily stored in was itself a disaster-affected building, and in the year that elapsed after the items had been moved there for temporary storage, concerns grew over a potential pest outbreak. The technology transfer performed by the author ensured that carbon dioxide treatment could be carried out in Kakuda City.

In performing the technology transfer, I first examined the condition of the *Fukuoji Bishamondo Hono Yosan Shinko Ema*, which were being temporarily stored in Kakuda City. Then, I selected the materials in need of carbon dioxide treatment, completing the treatment in several batches.

The first part of the technology transfer workshop included a classroom lecture, during which I provided an overview of insecticidal treatment for cultural properties and explained the safety aspects of carbon dioxide. I then discussed the procedure for carbon dioxide treatment (Photo 10). In a practical session, the students assembled the treatment bag, handled disaster-affected cultural properties, administered and released the carbon dioxide, and measured the carbon dioxide concentration (Photo 11). After the workshop, an official from Kakuda City was appointed to continue teaching the carbon dioxide treatment method and perform technology transfer to the museums in Miyagi Prefecture, while continuing to treat the remaining *Ema*. Ultimately, all the carbon dioxide treatment was performed successfully and without incident. The *Ema* which underwent insecticidal treatment have since been moved to a newly prepared storage facility where they are currently being managed.

IV. Development of New Techniques for Insecticidal Treatment

1. Heat treatment using sunlight

Since 2005, efforts have been made to develop new insecticidal treatment methods for use in museums in hot and humid regions, such as Taiwan. One such method that is safe, is of low cost, and does not require any special facilities is heat treatment using sunlight (Hidaka et al. 2016: 134–135). We performed two experiments of varying scales which would be achievable in Japan's climactic conditions. The heat treatment conditions were set at four retention times of 50℃/8hrs, 53℃/6hrs, 55℃/5hrs, and 60℃/3hrs; this was based on Strang's graph, which indicates the insecticidal effect over a range of temperatures (Strang 1992: 41–67). One experiment was conducted inside of a car to test the efficacy of the treatment within a small-scale space. The other was conducted inside a freight container (hereafter container) to test the treatment within a medium- to large-scale space. The following section presents the results of these experiments.

2. Heat treatment experiment inside a car

The heat treatment experiment inside the car occurred on a day when the outside temperature was expected to rise above 33°C. In the experiment, we used wooden carvings as the subject of treatment based on the fact that most folk cultural assets are made from wood. We placed a wooden carving inside of a polyethylene bag to ensure it did not become excessively dried-out during the treatment. We expelled the air from inside the bag and hermetically sealed it. We then put the materials on the passenger seat, which was the area that received the most amount of sunlight. To ensure the underside was also heated, the wooden carving was placed on a grill (Photo 12). In the preliminary experiments (Kawamura 2008: 77–81), we found that it took 2–3 hours from the beginning of the treatment for the top side of the wooden carving to reach a temperature of 55°C; therefore, about two and a half hours into the treatment, we turned the wooden carving over so that the top side (which had been exposed to sunlight) was now underneath and the underside (which had been in shade) was on top. We measured the changes in temperature during the experiment using data loggers (Veriteq, Spectrum SP2000 and T&D, Ondotori TR72-U) placed inside the car on the top and underside of

Photo 12 The high temperature treatment experiment inside a car (2010, Hidaka)

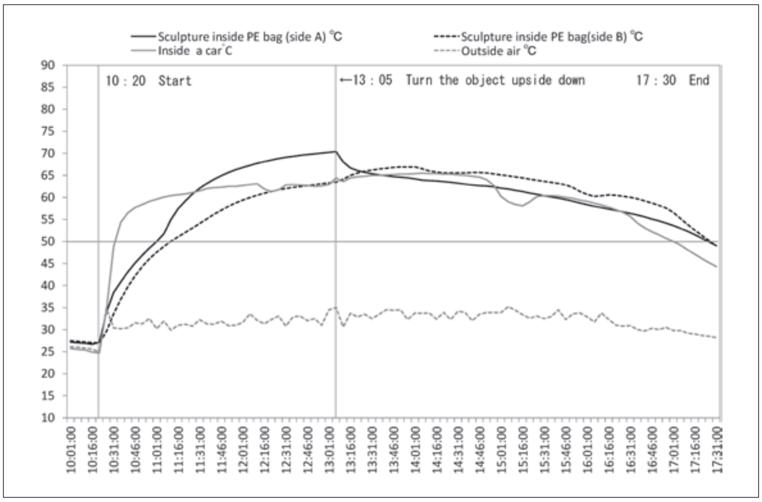

Figure 5 Experiment of heat treatment using a car: Transition of temperature

the wooden carving, as well as outside of the car (external temperature).

During the heat treatment (Figure 5), the outside temperature fluctuated between 30 and 35°C, and the temperature inside the car rose above 50°C, 15 minutes after initiating the treatment. We measured the area of direct exposure to sunlight and found that the temperature of the wooden carving reached 50°C after 45 and 50 minutes from the start of the treatment for the top and underside, respectively. The final retention times were as follows: 50°C, 6hrs 15 mins for the top and underside; 53°C, 5hrs 50 mins for the top and 5hrs 45 mins for the underside; 55°C, 5hrs 30 mins for the top and 5hrs 30 mins for the underside; and 60°C, 4hrs 10 mins for the top and 4hrs 20 mins for the underside. The highest temperatures reached were between 65 and 70°C. From this, we can gather that when performing heat treatment in a car, it is important to consider the conditions relating to the positioning of the materials in the car and not just the outside temperature.

The humidity inside the car during the heat treatment (Figure 6) decreased from 48% RH to 12% RH within 10 minutes of beginning the treatment and averaged 18% RH throughout the course of the treatment. However, inside the polyethylene bag, both the top and underside of the wooden carving rose from 76 to 84% RH within five minutes, before gradually decreasing again. Humidity of over 50% RH was maintained throughout the treatment, indicating that the polyethylene bag helped minimize the moisture content of the materials. From this, we can conclude that it is necessary to care for the materials by placing them in a polyethylene bag when carrying out heat treatment.

3. Heat treatment experiment inside a container

For the heat treatment experiment inside a container, we conducted preliminary experiments with a combination of configurations to verify effective methods for retaining the heat produced by sunlight. First, in order to prevent loss of heat through the ground, we laid an aluminium insulation sheet (Wako, industrial use aluminium thermal

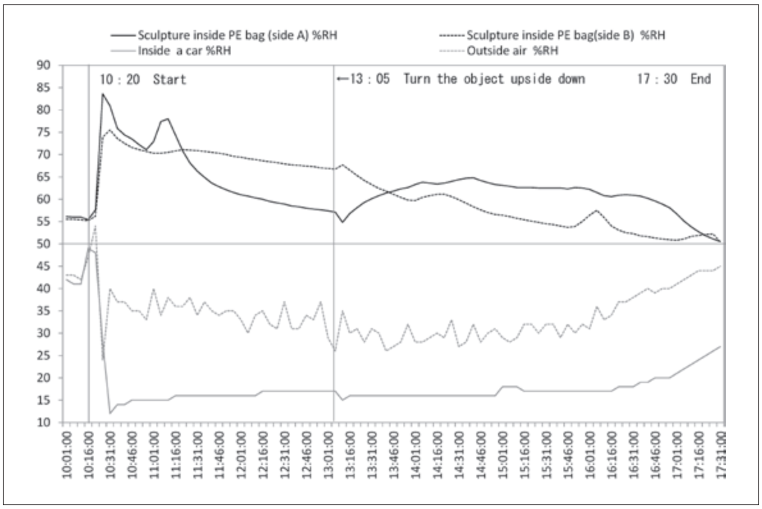

Figure 6 Experiment of heat treatment using car: Transition of relative humidity

insulation sheet) on a coated plywood panel and placed the container on top of it. We further enhanced the heat retention capability by inserting fibreglass insulation material (Asahi Fiberglass, Aclear Mat) wrapped in a gas barrier sheet (Ikari Shodoku, Ecomua Barrier Film) in the space between the underside of the container and the aluminium insulation sheet. For the experimental sample, we used a piece of wood (85 mm wooden block) and a data logger (Earth Watch Corp., high heat use wireless data logger) to measure the temperature and humidity at the wood's core. The upper area of the container interior reaches the highest temperatures; therefore, in order to position the experimental sample closer to the hottest area of the container, we raised the level of the floor using two wooden pallets which covered the entire floor area. We laid another pallet on top and placed the experimental sample on top, at a height of 590 mm from the container floor. Foam was packed around the sample to preserve heat. We also wrapped the entire container (Photo 13) in an insulation sheet (Fuji Engei, Sunny Coat) to further enhance the overall level of heat retention.

The experiment was conducted over a period of about two months between 27 July and 23 September 2015. We focused in particular on the retention times of the target temperature. The seven days during which the target conditions were met and the retention times are shown in Table 1.

When we compared the results of the main experiment with those of the preliminary experiments, we found that the time taken to reach a temperature of over 50°C was 1−2 hours quicker than in the preliminary experiments, and the heat retention time in the evening was up to one hour longer. This was because the configuration of heat retention and other measures introduced for the main experiment helped to quicken the rise in temperature by not allowing the air heated by sunlight to escape and also helped to retain the heat for longer, even when the outside temperature dropped in the evening. Looking in detail at the treatment target conditions that were achieved, we can see that the most

Photo 13 High temperature treatment experiment inside a container (2015, Hidaka)

Table 1 Target Conditions and Holding Times

	Outside air(℃)		Keep above 50℃ for more than 8 hours		Keep above 53℃ for more than 6 hours		Keep above 55℃ for more than 5 hours		Keep above 60℃ for more than 3 hours	
	average	maximum	Achieved ○ Not achieved ×	Holding time	Achieved ○ Not achieved ×	Holding time	Achieved ○ Not achieved ×	Holding time	Achieved ○ Not achieved ×	Holding time
2015/8/1	31.54	38.43	×	11:20~18:20 (7hours)	○	12:00~18:00 (6hours)	△ shortage within 30 minutes	13:00~17:40 (4hours 40minutes)	△ shortage within 30 minutes	13:40~16:20 (2hours 40minutes)
2015/8/2	31.46	38.09	×	11:10~18:30 (7hours 20minutes)	○	11:40~17:50 (6hours 10minutes)	○	12:00~17:30 (5hours 30minutes)	○	13:20~16:20 (3hours)
2015/8/3	31.84	38.09	×	11:40~18:30 (6hours 50minutes)	○	11:40~17:40 (6hours)	○	12:00~17:10 (5hours 10minutes)	△ shortage within 30 minutes	13:20~16:10 (2hours50minutes)
2015/8/5	32.50	39.68	○	10:30~18:40 (8hours 10minutes)	○	11:00~18:20 (7hours 20minutes)	○	11:20~18:00 (6hours 40minutes)	○	12:10~17:10 (5hours)
2015/8/7	31.60	39.03	△ shortage within 30 minutes	10:30~18:20 (7hours 50minutes)	○	11:00~17:50 (6hours 50minutes)	○	11:40~17:20 (5hours 40minutes)	○	12:20~16:40 (4hours 20minutes)
2015/8/8	30.33	39.88	×	10:30~17:20 (6hours 50minutes)	×	11:20~16:40 (5hours 20minutes)	○	11:20~16:40 (5hours 20minutes)	×	15:40~16:10 (30minutes)
2015/8/10	31.29	39.53	×	12:00~17:20 (5hours 20minutes)	×	12:00~16:40 (4hours 40minutes)	×	12:00~16:20 (4hours 20minutes)	○	12:40~15:50 (3hours 10minutes)

frequently achieved conditions were 53°/6hrs, 55°/5hrs, and 60°/3hrs, in that order. These results indicate that while a temperature of 50°C is reached, it is difficult to sustain for a period of eight hours. The highest temperature achieved was 67°C on 10 August. We can thus conclude that with heat treatment inside a container, retaining heat for a long period is a greater challenge than raising the temperature. However, we can also conclude that, with the right weather conditions, it is possible to create a space where heat treatment meets the requirements for lethal effect.

V. Preventative Measures against Pest Damage at Minpaku

1. Outline of museum IPM and operation at Minpaku

As described above, we have embraced the global movement towards environmental protection and developed and implemented methods for insecticidal treatment that do not rely on chemical agents. Additionally, we have sought to manage materials in such a way as to prevent pest outbreaks that are the target of insecticidal treatment. To this end, we decided to manage our materials according to the principles of Integrated Pest Management, or IPM. Originally developed by the agricultural sector, it is a method of pest management carried out by museum staff with no special budgetary provision. I will provide a brief overview of how IPM principles were developed.

During the 1950s and 60s, large amounts of chemical agents were used to enhance the production of agricultural crops. Several consequences surfaced, including problems related to the toxicity of the agricultural chemicals on the crops as well as the emergence of pests resistant to the chemicals. This spurred a movement to re-examine this form of pest control which relied on agricultural chemicals, and the resulting concept was IPM. Museums in the West began to take a keen interest in the idea of managing their facilities according to IPM principles. The following three points were established as key principles in the implementation of IPM at museums.

1. Several different control methods should be integrated in a rational way.
2. The level of pest infestation should be reduced to below the institution's (museum's) acceptable damage threshold.
3. System management of the ecosystem surrounding the museum should be employed.

The following two implementation steps are proposed as a way of realizing these three principles.

1. A survey of the current situation should be carried out in order to fully understand the circumstances of pest damage outbreaks at the museum.
2. The factors behind outbreaks of pest infestation should be identified in order to fully understand the causes.

When implementing IPM at a museum, it is important to have a clear understanding of IPM principles and, having followed the steps for implementation, mobilize all of the museum staff in identifying the areas most urgently in need of improvement and those where remedial action can be immediately implemented.

Minpaku has managed collection materials based on these IPM principles since 2004. The main tenets of this include inspections of exhibition spaces, sanitization of storage rooms, and surveys of insects. Minpaku's IPM activities are explained below.

2. Inspections of exhibition spaces

As previously mentioned, Minpaku first encountered a large-scale outbreak of pest damage in the exhibition area; this was attributed to large volumes of visitor traffic through the exhibition space, which had been arranged in an open style. This meant that once an outbreak occurred, the exhibition environment facilitated the rapid spread of the damage. The museum staff responsible for managing the materials now conduct inspections of the exhibition spaces prior to the museum's opening time in order to ensure early discovery of and a swift response to damaging pest outbreaks.

The inspection is carried out monthly according to an exhibition area inspection map (Figure 7). This is based on a plan for each of the exhibition halls and illustrates where there are materials which have experienced previous outbreaks, as well as the location of materials susceptible to outbreaks. It is also mandatory for several staff members to inspect the same areas (Photo 14). If anything out of the ordinary, such as pest damage, is discovered during an inspection, the staff member responsible for managing the materials is contacted immediately; having determined the best method for dealing with the situation, the group in charge of managing the exhibition area is informed, and appropriate measures are taken. If an outbreak of pest damage is discovered in a location not marked on the exhibition area inspection map, the map is revised ahead of the next inspection the following month to indicate the location of the latest outbreak.

3. Sanitization of storage rooms

Museum staff have cleaned the storage rooms regularly since 2007 (Photo 15). The dust is first cleared from the top of the shelves, then swept into the walkways where it is removed using a vacuum cleaner fitted with a HEPA filter. By removing the dust and other matter that pests feed on, we aim to create an environment in which it is difficult for pests to survive. Over the course of a year, we clean each of the storage rooms once. To demonstrate the effects of storage room sanitization, I will present a case study from the Old Tsukidate Junior High School in Sennuma City in Miyagi Prefecture, which was used as a temporary storage location for disaster-affected cultural properties following the Great East Japan Earthquake.

The Old Tsukidate Junior High School is a wooden school building which was provided as a temporary storage location for disaster-affected cultural properties in Kesennuma City, Miyagi Prefecture (Photo 16). A significant amount of time had passed since it was first put into use in this manner, and it could no longer be considered a temporary measure; therefore, in 2013, IPM methods were implemented in the management of its storerooms. Specifically, people entering the school building were required to change into indoor shoes, regular cleaning was performed before closing time, a sticky mat was placed at the entrance to the storerooms (Photo 17), and there were visual inspections of the materials.

In order to assess the efficacy of these activities, surveys of insects caught in traps (set once a month), surveys of airborne bacteria (air sample quantity of 100ℓ) using a Handy-Type Biosampler (Midori Anzen, MBS-1000: Potato dextrose agar, 25°C, 7 days), and dust quantity surveys (dust 5μm) using a Particle Counter (Rion, KM-02) were carried out before and after the introduction of IMP activities in 2012 and 2014, respectively, and the results were compared. The insect trap results are shown in Figure 8, the airborne

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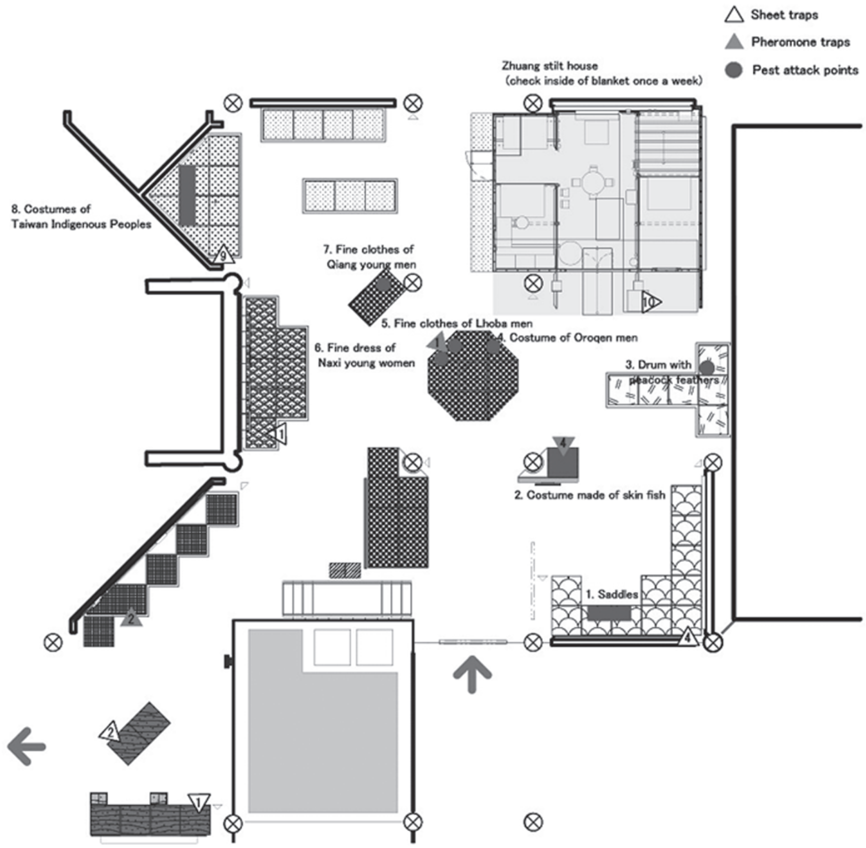
year/month



＊Check after the inspection

No.	Registration No.	Name of object	Note	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	H101408 H101476 H101564	Saddles	Pest attack																															
2	H130194 ～130197	Costume made of skin fish	Pest attack																															
3	H268317 H268318	Drum with peacock feather	Pest attack (peacock feathers)																															
4	H129684 etc.	Costume of Oroqen men	Pest attack																															
5	H87159 etc.	Fine clothes of Lhoba men	Pest attack																															
6	H237808 etc.	Fine dress of Naxi young woman	Pest attack																															
7	H100729 etc.	Fine clothes of Qiang young woman	Pest attack																															
8	H274459 etc.	Costumes of Taiwan Indigenous Peoples	Pest attack (bird's feathers)																															
9	—	Whole area	Frass and dead body of pest																															

2004.05.24. edition
2007.06.19. edition
2012.10.31. edition
2014.04.01. edition

Figure 7 Inspection map of the exhibition area

Photo 14 State of inspection of exhibition area (2012, Hidaka)

Photo 15 Cleaning the storage rooms (2019, Hidaka)

Photo 16 The Old Tsukidate Junior High School (2017, Hidaka)

Photo 17 A sticky mat (2013, Hidaka)

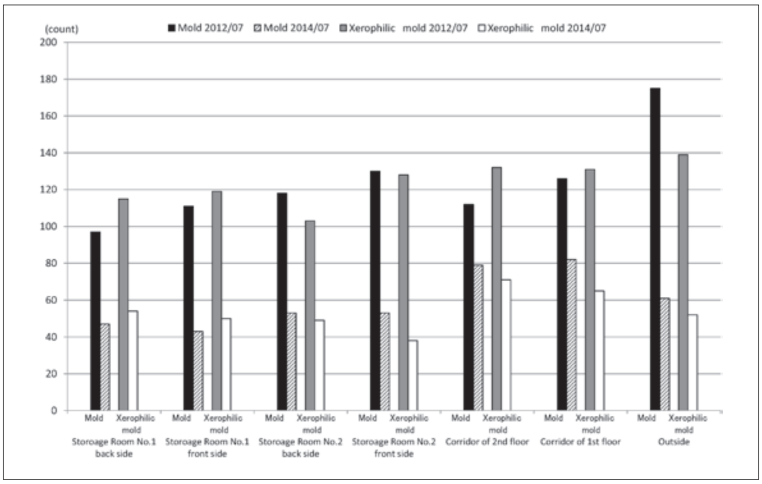


Figure 8 Transition of the number of captured insects at the old Tsukidate Junior High school, Kesennuma-City

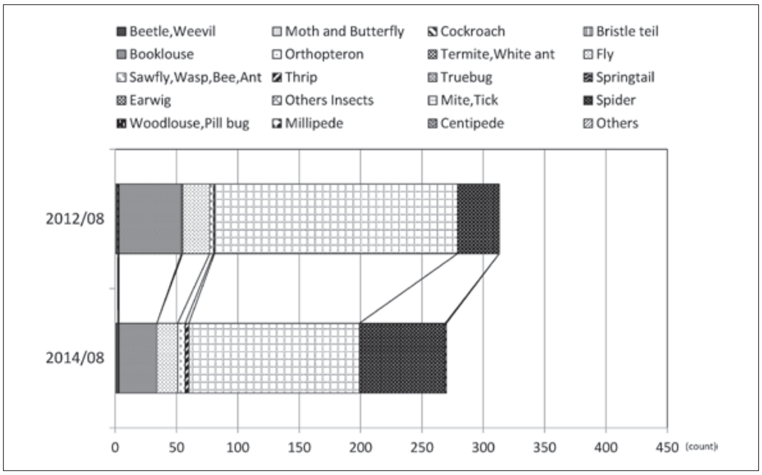


Figure 9 Transition of the number of airborne bacteria at the old Tsukidate Junior High school, Kesennuma-City

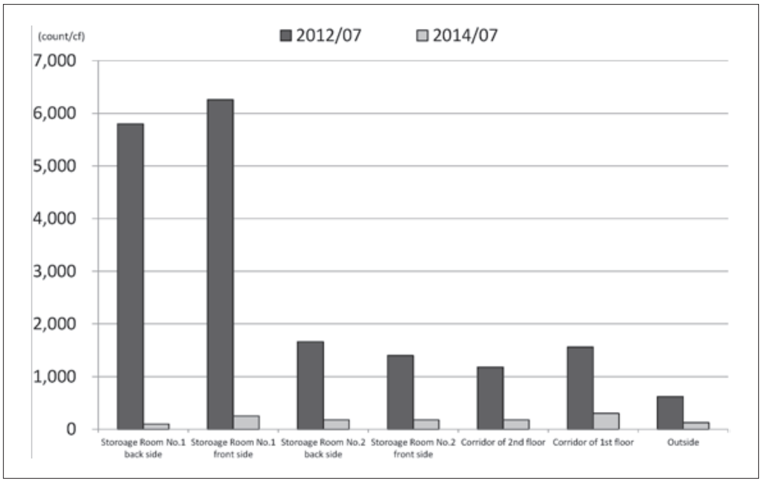


Figure 10 Transition of the amount of dust at the old Tsukidate Junior High school, Kesennuma-City

bacteria survey results in Figure 9, and the dust quantity survey results in Figure 10. From these results, we can see that the total number of insects captured after the introduction of IPM decreased. As for airborne bacteria, we can see that both general mold and good consistency mold had decreased by around half in 2014 compared to 2012. It is also evident that the quantity of dust had greatly decreased in 2014. From this, we can conclude that the sanitization of storage rooms is a highly effective IMP method.

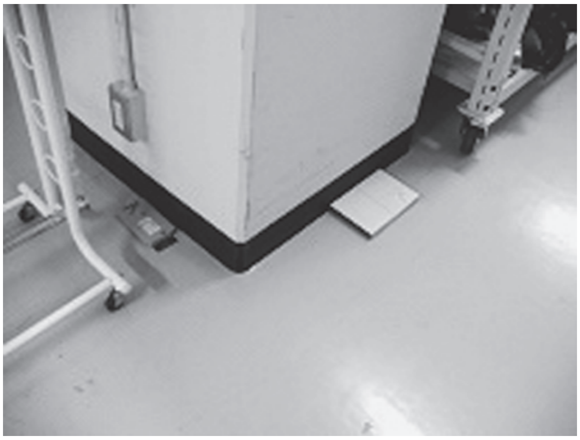


Photo 18 Trap installation (2005, Hidaka)

4. Insect surveys

Surveys of insects caught in traps have been conducted at Minpaku since 1992. As previously mentioned, this was done to understand which places were most susceptible to pest outbreaks and to determine locations for fumigation and the diffusion of pyrethroid insecticide.

The traps are placed in the exhibition galleries, storage rooms, and office rooms adjacent to storage rooms for 14 days (Photo 18). Then, the pests captured in each trap are counted and identified. Prior to 2003, the insect species identified varied depending on the survey company used; however, since the spring of 2003, we have unified the system of species identification, and since 2004 we have used a system developed by Minpaku to analyse the results of the surveys (Wadaka 2015: 646–670).

The insect survey analysis system currently in use operates with Microsoft Access and Excel. It is comprised of six functions which are displayed on the start-up menu screen: ‘Import Data’ for importing the results of the insect surveys; ‘Set graph and mapping parameters’ for setting the parameters for displaying the results in graph form or dropping them into the building plan; ‘Master Maintenance’ for registering or editing the basic database information; ‘Backup’ for backing up the insect survey analysis system; ‘Delete Function’ for deleting past data; and ‘Close’ for shutting down the system.

The insect survey analysis system enables us to determine the types of insects that have been caught in various locations, to evaluate whether we are maintaining the cleanliness of the building, and to confirm whether the situation has improved in locations which fared poorly in previous surveys. At the same time, these checks lead to the early detection of pest damage outbreaks.

VI. Conclusion

In considering museum management from an environmental perspective, this article has discussed the carbon dioxide insecticidal treatment activities at Minpaku, as well as IPM as a method for preventing damaging pest outbreaks.

As previously mentioned, carbon dioxide treatment can be performed using a simple system and is effective for a variety of materials; thus, it represents a highly versatile form of insecticidal treatment for museums. However, there are several issues with this type of treatment: carbon dioxide does not permeate through wood with a diameter of 10 cm or more, and there are pests such as longicorn beetles for which the treatment is largely ineffective. If carbon dioxide treatment is to be introduced at a museum, it is important to be aware of and understand these advantages and disadvantages. The same could, of course, be said when introducing any other method of insecticidal treatment at a museum.

Through the heat treatment experiments we are currently conducting, we have demonstrated that it is possible to create a treatment space in both a passenger car and container where temperatures of over 50℃ are reached without any cold spots. However, it has also become clear that, because the treatment is administered outdoors, it is necessary to consider the external temperature and impact of other meteorological conditions, such as clouds and wind.

In examining the heat treatment experiments in the car and container, we can see that in the case of the car, the smaller space meant the temperature rose quickly and adequately fulfilled the conditions for a 100% extermination rate, as identified by Strang. However, the temperature in the car rose to 70℃, so we can see that care is also required to not allow the temperature to get too high.

In the case of the medium- to large-scale experiment conducted in the container, we demonstrated that it is possible to create a space where the heat treatment meets the requirements for insecticidal effect, as long as the weather conditions are right. However, if the weather conditions are not favourable, then the treatment conditions are not achieved. To this end we are currently conducting verification experiments for condition settings that will achieve a 100% extermination rate at a relatively low temperature of 45–50℃ (for example, short bouts of treatment repeated several times) as a more practical method for heat treatment.

IPM is a method that can be swiftly implemented by museum staff without requiring any extra resources, and which can be extremely effective as a preventative measure against biological damage. However, in order to fully maximize the benefits of IPM, it is very important to cultivate a shared awareness among all museum staff of the need to address the factors behind the occurrence of biological damage, rather than devolving responsibility to a single IPM manager. With IPM activities, it is also important to regularly review past and present data to verify their efficacy. At Minpaku, we reviewed 20 years of insect survey data (Sonoda et al. 2012: 296–297). Next, I would like to re-examine the past 25 years of insect survey data.

If we examine the number of insects caught in the storage rooms and exhibition areas over the last 25 years (Figure 11), we can see that insects were mostly caught in the storage rooms between 1992 and 2001. Upon analysing later survey results, we observe a dramatic reduction in the number of insects caught in the storage rooms since

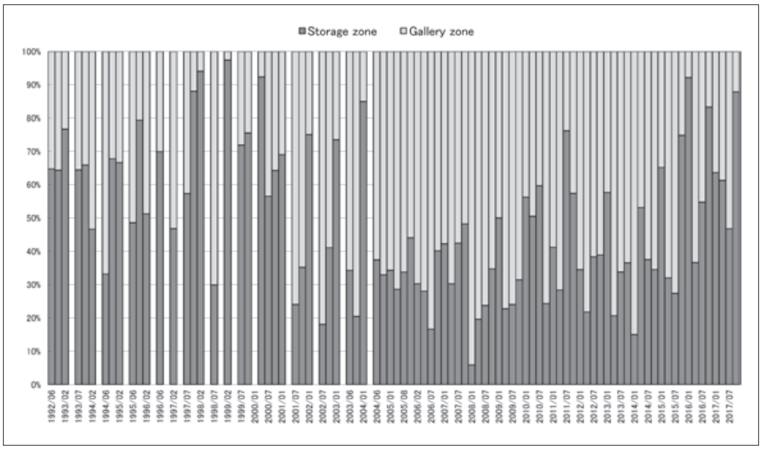


Figure 11 The number of insects caught in the storage rooms and exhibition areas over the last 25 years

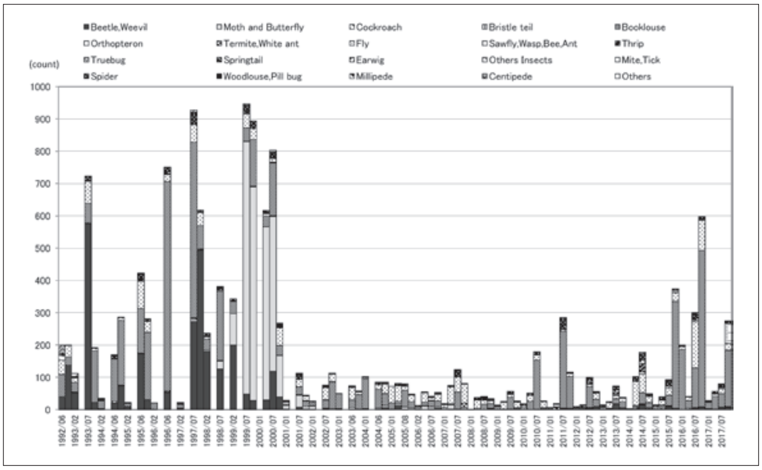


Figure 12 Transition of the number for species of captured insects in the storage rooms

2001; this is around the time we began to modify our anti-pest measures. This trend clearly demonstrates the special characteristic of IPM: by making the conscious shift towards tackling pest damage head on, you can achieve a certain effect. From 2014 onwards, however, the number of insects caught in the storage rooms has increased rapidly. This is because in 2014, we began to operate the multi-functional storage facility, which is located in an area susceptible to external conditions. This accounts for the rapid increase in the number of captured Acari and Psocoptera, which are fond of high humidity.

Next, I would like to focus on the species of insects caught in the storage rooms where the majority of Minpaku's materials are managed (Figure 12). From 1992 to 1999

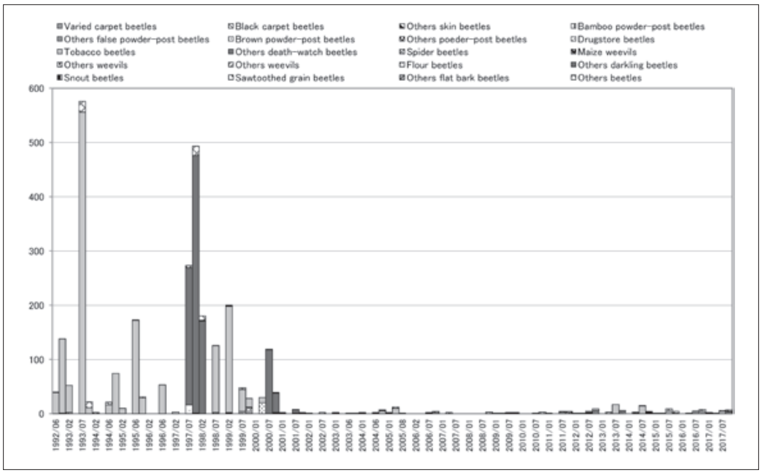


Figure 13 Transition of the number of captured Beetle and Weevil in the storage rooms

there were many Beetle, Weevil, and Booklouse; around 2000, there was a large Moth and Butterfly outbreak. This experience became a major turning point, encouraging us to revisit the survey results and implement fully fledged pest control measures beginning in 2001. As a result, the number of insects caught decreased dramatically, and the main type of insect currently caught are flies.

Of the many types of Beetle and Weevil caught between 1992 and 1999, the cigarette beetle was by far the most common. The peak of the Beetle and Weevil infestations was in the summer of 1993 and fall of 1997, but the numbers declined dramatically after 2001. If we look in even greater detail at the trend of Beetle and Weevil caught (Figure 13), we can see that, from the summer of 2010, carpet Beetle and Weevil of the skin beetle, including their larvae, were caught in some of the storage rooms. We have enhanced our level of monitoring in response to this.

In the case of identifiable Booklouse (Figure 14), they were all found to be from the Liposcelididae. What stands out in particular from recent years are the summers of 2010 and 2011, when there were mass outbreaks in storage rooms located in places susceptible to outside weather conditions. When the temperature and humidity records from 2004 (the first year recorded) onwards are compared with the number of Liposcelididae caught, it is clear that the summers of 2010 and 2011 both had humidity levels of 65% RH or less, but the temperature frequently rose above 28°C and the absolute humidity was higher than in other years. Thus, for the Liposcelididae, it is necessary to control not just the humidity but also the temperature of the environment.

The large Moth and Butterfly outbreak around 2000 (Figure 15) was an infestation of Tinea bissellinella that began in the summer of 1998 in one of the storage rooms. The infestation then spread to other storage rooms via the connecting air conditioning ducts while work was being carried out to replace them (July 1999–January 2000). The peak of the outbreak was between the summers of 1999 and 2000. Until the spring of 2000,

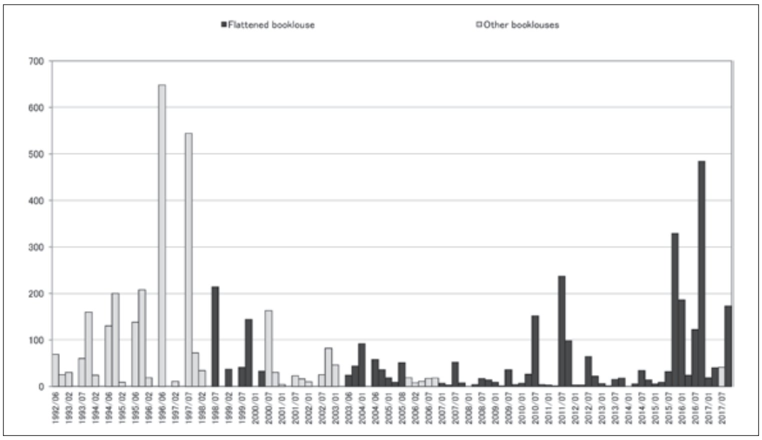


Figure 14 Transition of the number of captured Booklouse in the storage rooms

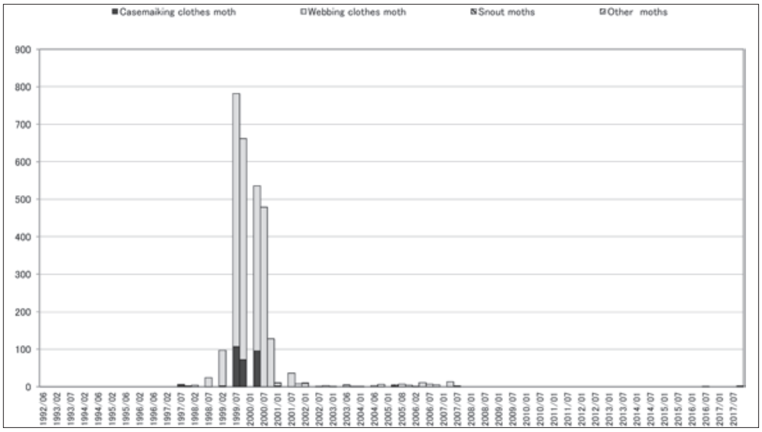


Figure 15 Transition of the number of captured insects from the Moth and Butterfly family in the storage rooms

there was a simultaneous infestation of Tinea translucens from the same Moth and Butterfly family, although the numbers were not as great as the Tinea bissellinella. To counter the infestation, we sprayed pyrethroid insecticide mist on nine different occasions between 1999 and 2002; however, this had little effect. We were finally able to completely contain the Tinea bissellinella infestation in 2007 after we identified a Mongolian *ger* as the source of the outbreak and performed insecticidal treatment on the affected materials. After that, no more Tinea translucens or Tinea bissellinella were caught in the storage rooms.

Next, I would like to focus on the exhibition areas (Figure 16). The majority of insects caught in the exhibition areas were Beetle, Weevil (mostly cigarette beetles), and Booklouse. The number of these insects caught was greatest during the summer of 1998, followed by the summers of 1997 and 2000, in that order. In the summer of 1997,

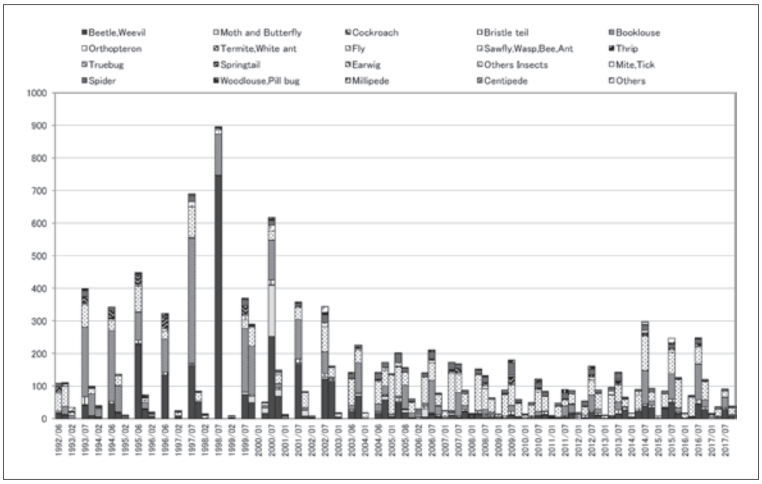


Figure 16 Transition of the number for species captured insects in the exhibition areas (2019, author)

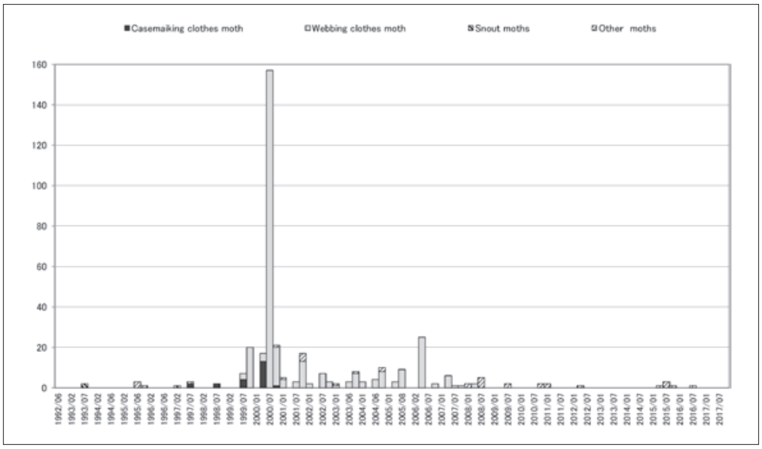


Figure 17 Transition of the number of captured insects from the Moth and Butterfly family in the exhibition areas classification (2019, author)

Booklouse were caught in a houseboat in the Southeast Asia exhibition area. In the summer of 1998, cigarette beetles were caught in a reindeer saddle in the North and Central Asia exhibition area. Finally, in the summer of 2000, Tinea bissellinella and Anobiidae were caught in a Mongolian tent. In all these cases, the damage was confined to specific materials. Since 2004, we have carried out thorough inspections of the exhibition areas, as previously described, and the numbers of insects caught has declined.

If we look at the number of insects caught from the Moth and Butterfly family (Figure 17), we can see that they caused serious damage immediately after the museum opened from 1979 to 1980, but their numbers were surpassed by Tinea bissellinella in the summer of 1999. The outbreaks of Lepitoptera settled down since the spring of 2008;

however, Moth and Butterfly cocoons continued to be discovered in the morning inspections, so we enhanced our inspection and monitoring activities.

Looking over the 25 years of insect survey results at Minpaku, it is evident that the three types of insects that require the greatest caution are Booklouse, Beetle and Weevil, and Moth and Butterfly. Due to the increased awareness of pest damage since 2001 and the introduction of IPM activities in 2004, we have been able to suppress the outbreaks of Beetle, Weevil, and Moth and Butterfly to a certain extent. However, Osaka's climate tends to be hot and humid, and this has made it difficult to control Booklouse.

Since we are increasingly required to conserve energy, an even greater level of caution will be necessary in the future. In using these results to determine when and where to spray insecticidal chemicals and carry out insecticidal treatment, it has become clear that, while spraying chemical agents is effective in pest control, for the total eradication of pests, it is essential to identify and treat the source of the outbreak. In addition, it is important for museums to effectively combine IPM as a preventative measure against pests with insecticidal treatment methods to deal with outbreaks when they occur.

This article has verified the examples of activities undertaken at Minpaku in relation to museum management from an environmental perspective. Modern society faces a variety of environmental problems, and we are required to confront these challenges in the way we run museums. In the future, I would like to use the platform the museum affords to pursue the work of preserving cultural properties with a global environmental perspective.

Acknowledgments

This database has been developed as part of the research projects below; Multidisciplinary Collaborative Projects 'Rediscovery of regional culture in the Japanese archipelago and construction of the representational system' (National Institutes for the Humanities)

The data in this article was supported by the following five people; Tomomi Wadaka, Yukako Kawamura, Sachi Hashimoto, Kaoru Suemori, and Rika Ishii.

References

Japanese

Kawagoe, K. and K. Kikuchi

2008 Minpaku ni okeru atarashii chugai boushihou he no chosen. In S. Hidaka and N. Sonoda (eds.) *Hakubutsukan heno chosen- nani ga dokomade dekitanoka*, pp. 113–124. Matsudo: Miyoshi Kikaku.

Kawamura, Y.

2008 Hakubutsukan shokuin ni yoru minzoku shiryou wo taishou to shita sacchuu shorihou: Taiyounetsu wo riyou shita kouon shori (Insecticide treatment method for ethnographic objects by museum staff-Heat treatment using solar heat). In N. Sonoda (ed.) *Yukei* *bunka shigen no kyoudouriyou wo suishin surutame no shiryou kanri kiban keisei (Formation of a management system to promote shared use of tangible cultural resources)*, pp. 77–82. Tokyo: National Institutes for the Humanities.

Kigawa, R., Y. Miyazawa, M. Koizumi, C. Sano, S. Miura, H. Nochide, H. Kimura, and B. Tomita
1999 Kakushu bouchuzai, boubaizai, kunjyouzai tou no ganryou-kinzoku ni oyobosu eikyou (Evaluation of the Effects of Various Pest Controlling Reagents on Pigments and Metals: Effects of Pesticides, Fumigants, Carbon Dioxide and Nitrogen). *Bunkazai hozon-shuhuku gakkaisi* 43: 12–21.

Kigawa, R., S. Miura, and K. Yamano
2002 Bunkazai no seibutsu higai taisaku no genjyou: Shuka metiru kunjou no daitai taiousaku nitsuite (Overview of the Present Alternative Methods of Methyl Bromide Fumigation for Controlling Pests in Museums). *Bunkazai hozon-shuhuku gakkaisi* 44: 52–69.

Kigawa, R., N. Nagaya, N. Sonoda, S. Hidaka, and T. Strang
2003 Hakubutsukan, bijutsukan, toshokan tou ni okeru IPM: Sono kihonrinen oyobi dounyu tejun nitsuite (A Review on Integrated Pest Management in Museums and Related Institutions: Basic Concepts and Practical Steps for Introduction). *Bunkazai hozon-shuhuku gakkaisi* 47: 76–102.

Hidaka, S., H. Date, H. Nochide, H. Kimura, R. Kigawa, and S. Miumra
2002 Minzoku shiryou tou no nisankatanso niyoru sachuu shori no jiturei (Practical Examples of Carbon Dioxide Treatments for Eradication of Insect Pests in Folkloric Cultural Objects). *Bunkazai hozon-shuhuku gakkaisi* 46: 76–95.

Hidaka, S., N. Sonoda, K. Suemori, M. Nishiwaza, M. Matsuda, Y. Kawamura, S. Hashimoto, T. Wadaka, R. Kigawa, and K. Kawagoe
2016 Development of Solar Disinfestation System: Preliminary Experiment for Creating Insecticidal Treatment Atmosphere to Attain Lethal Condition. *Abstracts of the 38th Annual Meeting of The Japan Society for the Conservation of Cultural Property*, pp. 134–135.

Morita, T.
2004 Minpaku deno chugai kanri 20 nen. *Minpaku tsushin* 107: 8–10.

Sonoda, N., S. Hidaka, T. Wadaka, and Y. Kawamura
2012 Kako 20 nenkan no seibutu seisoku chousa kara miru hokakuchu no suii to keikou: Kokuritu minzokugaku hakubutukan deno zoningu betu bunseki (Transitions and trends of captive insects considered from biological habitat survey in the past 20 years – Zoning analysis at National Museum of Ethnology). *Bunkazai hozon-shuhuku gakkai dai 34 kai taikai youshi shu*, pp. 296–297.

Wadaka, T.
2015 Seibutsu seisoku chousa bunseki shitutemu sumo-ru pakke-ji (shisakuban) no gaiyou to kadai. In M. Kubo (ed.) *"Ningen bunka shigen" no sougou teki kenkyu*, pp. 602–626. Tokyo: National Institutes for the Humanities.

English

Hidaka, S.
2016 Conservation Science Research at the Museum: Development of Carbon Dioxide

Treatment for Museum Collection. In N. Sonoda (ed.) *New Horizons for Asian Museums and Museology*, pp. 131–141. Singapore: Springer Open.

Sonoda, N. and S. Hidaka

2011 Integrated Pest Management at the National Museum of Ethnology, Japan: Re-evaluation of Preventive Measures and Control Strategies. In P. Winsor, D. Pinniger, L. Bacon, R. Child, K. Harris, D. Lauder, J. Phippard, and A. Xavier-Rowe (eds.) *Integrated Pest Management for Collections, Proceedings of 2011: A Pest Odyssey, 10 Years Later*, pp. 123–138. London: English Heritage.

Strang, T. J. K.

1992 A Review of Published Temperatures for the Control of Pest Insects in Museums. *Collection Forum* 8(2): 41–67.