Environmentally Friendly Pest Control Treatment Facilities at the National Museum of Ethnology, Osaka

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Naoko Sonoda
National Museum of Ethnology

1. Introduction

In recent years, the concept of Integrated Pest Management (IPM) has gained importance as a way to prevent and mitigate damage from pests. Although the concept of IPM originated in the field of agriculture, it has spread into the world of museums. This approach should prioritize increasing awareness of pest damage in daily activities. It involves placing importance on basic activities such as cleaning and maintaining facilities and paying careful attention to and inspecting objects, ensuring that an environment prone to pests and fungi is not created. If damage does occur, appropriate measures should be taken one by one or in combination with others, in accordance with the state of damage.

In Japan, methyl bromide was used as an insecticide starting in 1955; it was replaced in the late 1970s by a mixture of methyl bromide (86%) and ethylene oxide (14%), which soon became a certified drug for cultural property. However, when methyl bromide was included in the Montreal Protocol's list of substances that deplete the ozone layer, developed countries, including Japan, were obliged to phase it out by the end of 2004.

To respond to social conditions after 2005, rather than relying on a single method of insecticidal treatment by gas fumigation, the National Museum of Ethnology, Osaka (hereinafter "Minpaku") decided to use several different methods depending on the material comprising the object, the type of pests, the level of damage, the conditions under which the object is exhibited or stored, and the time and cost the treatment requires.

Pest/fungus control measures for museum collections should be safe for people, objects, and the environment. It is also our responsibility to protect the Japanese ecosystem by preventing foreign pests from entering Japan through objects collected abroad. In January 2005, it was decided at Minpaku to replace the mixture of methyl bromide and ethylene oxide with ethylene oxide and to restrict its use to objects entering Japan for the first time. Objects infested after arrival in Japan are treated by alternative methods more respectful of the environment, mainly by carbon dioxide treatment, with complementary methods such as low oxygen concentration (anoxia) treatment, heat treatment,

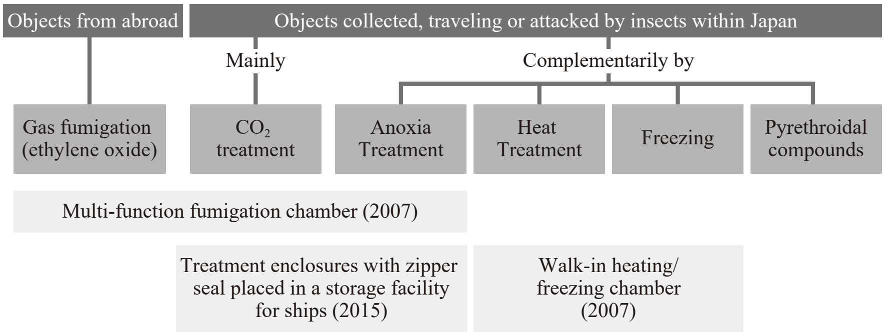

Figure 1 Pest control policies at the National Museum of Ethnology, Osaka (since 2005)

and low temperature (freezing), or the use of pyrethroidal compounds (Figure 1).

Based on Minpaku's pest control policies, environmentally friendly pest control treatment facilities were set up in consequence: a multi-function fumigation chamber; storage facility for ships equipped with carbon dioxide and anoxia treatment systems; and a walk-in heating/freezing chamber.

2. Multi-Function Fumigation Chamber

The fumigation chamber is 4300 mm in width, 5000 mm in depth, and 3615 mm in height, with a capacity of approximately 77 m^3, which makes it one of the largest fumigation chambers in Japanese museums. The fumigation chamber is made of steel pipe and iron plate. Its floor load resistance can withstand about 1 ton. However, since the floor is covered with wooden pallets, the floor loading capacity is calculated as 100 kg if the loading position is separated by more than 250 mm. If it is a mobile shelf used in Minpaku, eight units of large size (W1835 mm × D940 mm × H1970 mm) or 12 units of small size (W1540 mm × D750 mm × D1680 mm) can be brought inside at the same time.

In 2007, the existing fumigation chamber was transformed to become multifunctional, allowing not only the use of ethylene oxide gas fumigation but also the use of carbon dioxide and anoxia treatment methods (Photo 1). Before 2007, activated charcoal was used to adsorb used gaz. However, the drawback of this method is that it generates industrial waste. It was decided to add a catalytic combustion unit to the fumigation system for the detoxification of used ethylene oxide. Through combustion, the used ethylene oxide is totally decomposed and can be safely released into the air.

Carbon dioxide treatment can be applied to a wide range of materials and thus is used for ethnographic collections in general. We added a device that moisturizes gasified anhydrous carbon dioxide by passing it through a humidity control agent to avoid a sudden drop in relative humidity (RH) when the carbon dioxide is introduced. The temperature inside the chamber is kept at 25°C or higher at which carbon dioxide treatment can be efficiently performed even in winter. However, we need to keep in mind that the drawbacks of this treatment include the possibility that discoloration may occur

Photo 1 Multi-function fumigation chamber (Image by the author, July 13, 2007)

in some metals and pigments by acidity, due to the formation of carbonic acid under high humidity (Kigawa et al. 1999; Kigawa et al. 2001) and that there is no effect in controlling populations of Cerambycidae (longicorn beetles) (Valentin 1993).

For the anoxia treatment, nitrogen is provided by a nitrogen generator, and the temperature and humidity are controlled. The target condition is to maintain the oxygen concentration below 0.1% for three weeks at 25ºC (however, the treatment may need a longer period depending on the insect species). The chamber itself can be adjusted to a temperature approximately up to 40±3ºC and to an RH of approximately 30–70±10%. This is because, for the anoxia treatment, it is possible to shorten the time required for treatment by raising the temperature to the extent that it does not affect the objects while minimizing the variation of humidity (Kigawa et al. 2001). Therefore, a temperature control device was connected to the nitrogen generator, and a temperature control function was added to the fumigation chamber itself. The change in temperature and RH as well as the oxygen concentration at three different points (440 mm, 1,835 mm, and 3,355 mm from the floor) can be monitored on the display during the treatment.

3. Treatment Systems at a Storage Facility for Ships

Due to the aging of the two large tents that served to store ships, we decided to construct a new storage facility at their emplacement (Photo 2) (Figure 2). The building measures 36 m east to west, 27 m north to south, and has about 1,100 m^2 building area. In 2014–2015, a collection of ships was moved safely to the new storage facility (Photos 3 and 4)

In the light of IPM, the storage building is equipped with carbon dioxide (Photo 5)

Photo 2 Storage facility for ships (Image by the author, July 18, 2007)

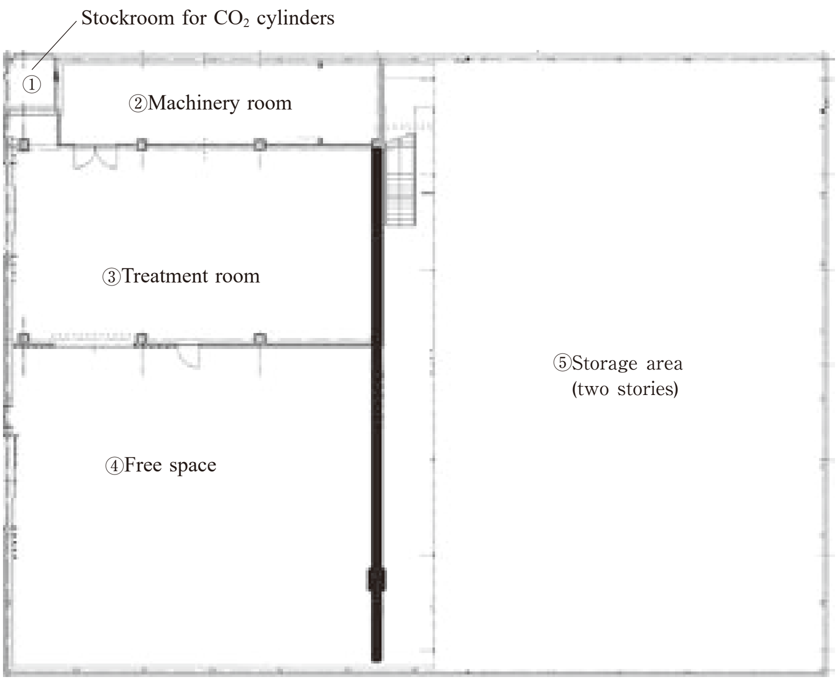

Figure 2 Schematic of a storage facility for ships

Photo 3 Transfer and installation of ships (⑤ in Figure 2) (Image courtesy of Information Planning Section, Office of Information and Documentation, Minpaku, December 9, 2014)

Photo 4 Ships reinstalled on the second floor (⑤ in Figure 2, upper part) (Image courtesy of Information Planning Section, Office of Information and Documentation, Minpaku, January 30, 2015)

Photo 5 Stock room for carbon dioxide cylinders (① in Figure 2) (Image by the author, February 14, 2014)

Photo 6 Machinery room with a nitrogen generator and a temperature/RH control system (② in Figure 2) (Image by the author, February 14, 2014)

and anoxia (Photo 6) treatment systems. Two purpose-made treatment enclosures (Nippon Ekitan) made of a polyester sheet coated with aluminum and a zipper seal (each measuring 6,900 mm in length × 2,800 mm in width × 2,200 mm in height) are installed in the treatment room, and in either enclosure, carbon dioxide treatment or anoxia treatment can be selected (Photo 7). The dimensions of the enclosures were specified to be large enough to treat as many as 80% of all ships stored in this building. A third pipeline for

Photo 7 Two purpose-made treatment enclosures in the treatment room (③ in Figure 2) (Image by the author, February 14, 2014)

carbon dioxide treatment and anoxia treatment is provided in the treatment room, and a fourth one is in the free space. This storage facility is not just to store large ethnographical objects such as ships in a safe storage environment, but part of the space, especially the treatment room, is intended to be used by related institutions in need and in case of emergency.

4. Walk-In Heating/Freezing Chamber

A walk-in heating/freezing chamber was newly constructed in 2007. It is 2,815 mm in width, 2,835 mm in depth, and 2,400 mm in height (1,750 mm on the outlet side) and has a capacity of 18.6 m^3 (Photo 8) (Figure 3). The floor loading capacity is 700 kg/m^2. The chamber is equipped inside with 33 temperature sensors (13 of which are fixed) and one humidity sensor (fixed). One temperature and one humidity sensor are attached to the outside of the compartment for comparison. Heat treatment and freezing can be carried out in the same chamber, but the changeover is done manually.

Besides materials such as plywood for display, large items made of timber are able to receive heat treatment. It is also used to kill pests located deep in wood that cannot be treated with anoxia treatment and carbon dioxide treatment. Target objects are put directly on wooden pallets, and to prevent deformation and cracks due to over-drying, these objects are sealed beforehand with an airtight film before the treatment. The treatment condition is derived by referring to the study done by Tom Strang of Canadian Conservation Institute (Strang 1992) and adding some security margins: 6 hours at 55°C or 4.5 hours at 60°C.

For freezing, since the chamber is large enough to hold two large mobile shelves at the same time, small objects are gathered in a paper box, then sealed into a polyethylene bag, while large objects are sealed in polyethylene bags individually and then put on a

Photo 8 Walk-in heating/freezing chamber (Image by the author, July 13, 2007)

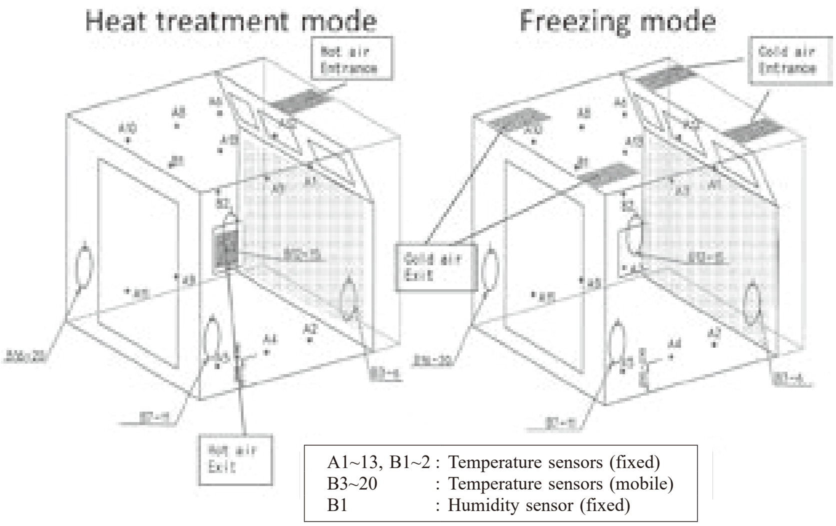

Figure 3 Schematic of a walk-in heating/freezing chamber

mobile shelf. After the freezing treatment, the chamber is designed to slowly raise the temperature to room temperature while controlling the heating, so there is no worry of dew condensation in principle. With reference to the study of Tom Strang (Strang 1992) and adding some security margins, the target conditions for effective treatment are 10 days with the core temperature of the object at −25°C or 5 days at −30°C.

References

Kigawa, R., Y. Miyazawa, M. Koizumi, C. Sano, S. Miura, H. Nochide, H. Kimura, and B. Tomita
1999 Kakusyu bōchūzai, bōkabizai, kunjōzai nado no ganryō kinzoku ni oyobosu eikyō (Evaluation of the effects of various pest controlling reagents on pigments and metals: Effects of pesticides, fumigants, carbon dioxide and nitrogen). *Bunkazai hozon syufuku gakkaishi (Bulletin of the Japan society for the conservation of cultural property)* 43: 12–21. (in Japanese)

Kigawa, R., Y. Miyazawa, K. Yamano, S. Miura, H. Nochide, H. Kimura, and B. Tomita
2001 Practical Methods of Low Oxygen Atmosphere and Carbon Dioxide Treatments for Eradication of Insect Pests in Japan. In H. Kingsley, D. Pinniger, A. Xavier-Rowe, and P. Winsor (eds.) *Integrated Pest Management for Collections: Proceedings of 2001: A Pest Odyssey*, pp. 81–88. London: James & James.

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

Valentin, N.
1993 Comparative Analysis of Insect Control by Nitrogen, Argon and Carbon Dioxide in Museum, Archive and Herbarium Collections. *International Biodeterioration & Biodegradation* 32(4): 263–278.