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Conference Abstract

An Attempt to Evaluate the Lighting Quantity Indexes of Museum Lighting for Specimen Protection

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Abstract

Museums need to meet the visual comfort of and ensure the exhibition performance for the visitors. Meanwhile, illumination of the collections needs to be carefully managed from the risk management and preventive conservation perspective. Illumination from light-emitting diode (LED) outshines traditional lamps because LED is more sustainable and cost-effective, it also generally gives off less infrared and ultraviolet radiation, thus causing less radiation-induced damage to the collections. Museums have multiple choices for professional practical references on lighting, published by institutions and commissions on illumination at the international or national level.

In many of the lighting guidelines, specimens are only roughly classified by light sensitivity categories—either "low responsivity" or nothing—despite the fact that specimens are very different in material and construction. For conservation, it is common to keep the light intensity under 50 lux (lux is the unit for illuminance and the symbol is lx) for low-responsivity exhibited materials. However, this standard could be disputed or even contrary to curators' expertise and career experience: some specimens fade suddenly and faster within a shorter time while others don't appear to fade at all. For instance, specimens with structural colour are theoretically less prone to fading than those with pigment colour.

Few research cases and research data on specimen samples have demonstrated this theoretical difference in light sensitivity. This means it can be difficult for curators to decide the exhibition time for specimens, or even whether to bring them to the public at all. Thus lacking research and well-developed methodologies about natural history collections in conservation science in Japan, the management of exhibited collections in many natural history exhibition cases tends to be based on standards of cultural collections, especially in small-scale museums and those without natural history curators.

The focus of this work is an attempt to evaluate the photon-induced damage and lighting quantity indexes for natural history specimens based on experimental data. Further, interviews with three major natural history museums were conducted to generate collective ideas about lighting management.

Experimental specimens

The experiment used specimens representing four insect species: *Colias eratey, Ruspolia dubia, Favonius orientalis* and *Phelotrupes laevistriatus.* Five specimens of each species with similar initial conditions were selected from Hokkaido University Museum collections for experimental groups and one control group. *Colias eratey* and *Ruspolia dubia* represent the pigment colour group while *Phelotrupes laevistriatus* and *Favonius orientalis* represent the structural colour group.

Illumination parameters

The light source was a typical intensity-adjustable LED designed for museums and galleries. Illumination for the experimental groups was set at 50 lx, 100 lx, 150 lx and 200 lx, separately. The control group was set in a completely dark environment. The spectral distribution under each illumination showed no significant differences.

Time and evaluation parameters

The specimens were irradiated consistently over 180 days for a total of 4320 hours on a measurement cycle of 30 days. A total of seven measurements of the colour space defined by the International Commission on Illumination (CIE L*a*b*Commission Internationale de l'Eclairage 2004), including the initial state, were taken using a colourimeter (3nh NR100). The magnitude of the color difference was measured and compared according to these three values using the following equation:

Multiple measuring points were selected for each type of specimen and the average value was calculated. Colour differences with respect to the initial state of each specimen were calculated. These differences were evaluated based on the numerical value: <5 as unnoticeable change; 5<15 as noticeable change; and 15<30 as significant change. In addition, for the structural group, data was also collected with a polarizing filter attached to the colourimeter in an attempt to evaluate the colour difference of the pigment colour layers underlying the structural layer.

Data analysis

According to CIE (Commission Internationale de l'Eclairage 2004), the limiting annual exposure (illuminance × time) for natural history objects is 150,000 lx·h per year in the museum exhibits. In this experiment, the total exposure for four of the experimental groups reached 1.44, 2.88, 4.32 and 5.76 times the recommended limit, simulating the exhibited equivalent exhibition period. Greater illumination resulted in great changes in CIE L*a*b* colour for all experimental groups. Changes in CIE L*a*b* space colour for the control group were also observed. This suggests the potential for the systematic measurement errors, fading due to non-lighting factors and applicability of the measurement method for unevenly coloured natural objects. *Colias eratey* showed noticeable changes in CIE L*a*b* for all four groups, and the colour difference reached 16 under 200 lx irradiation conditions, while *Favonius orientalis* showed noticeable changes with all colour differences under three. However, *Ruspolia dubia* showed no noticeable changes during the experiment, likely because they fade sooner once made into specimens. Data collected from *Phelotrupes laevistriatus* were not statistically significant because of the colourimeter is designed for measuring flat surfaces, large measuring errors occurred when measuring the semicircular surface of Coleoptera.

It is necessary to establish an appropriate experiment methodology for irradiation experiments according to the material characteristics of each natural history object. Doing so enables curators to make accurate conservation plans, especially for precious specimens. In addition, well-designed experiments provide evidence that can be generalized into convenient operational guidelines for museums to use on a daily management basis, and within a limited budget.

From the interview research, curators showed a proactive attitude towards carefully considering the aesthetic and conservation aspects of LED as a new light source and growing interest in the conservation and deterioration of exhibited specimens. The management of lighting for natural history materials lacks systematic and unified standards. Curators rely on their own knowledge and experience, sometimes including intuitive sense. In some cases, natural history objects are considered to be expendable, thus less important for keeping long-term conservation in mind. On the other hand, some precious collections are being stored permanently without scientifically proven safe exposure limits. In addition, lack of standards also leads to complex problems. Some museums failed to predict how fast their specimens would fade in the permanent exhibition and failed to prepare replacement for the unsatisfying faded exhibition. On the other hand, some museums prepared a large amount of specimens with strong fading resistance for the replacement, resulting in budget waste and a storage burden.

Keywords

annual exposure, natural history collections, lighting management

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Conflicts of interest

The authors have declared that no competing interests exist.

References

- Commission Internationale de l'Eclairage (2004) CIE 157-2004:Control of Damage to Museum Objects by Optical Radiation. CIE, Vienna, Austria. [ISBN 978 3 901906 27 5].