THE PRESERVATION OF MUSEUM SPECIMENS FROM INSECTS AND THE EFFECTS OF DAMPNESS.

By Walter Hough, A. M.

The preservation of museum specimens is of no less importance than their acquisition. Periodically the attack of some new insect, or the infesting of some new material, is brought to the notice of curators, and hitherto many specimens have been destroyed which it would be now impossible to replace. In a great museum the abundance of the material will not permit its frequent examination, so that all specimens should be thoroughly poisoned before they get out of sight. There are many things which one would not think it necessary to poison, yet all should be, for nearly all organic structures have peculiar enemies in the insect world. As instances, woodwork, basketry, textiles, botanical specimens, etc., should be poisoned with corrosive sublimate, as it coagulates the albuminoid principles in vegetation and thereby prevents decay as well as the attacks of insects.

The ravages of moths have been experienced from remote times, and though the preservation of materials from the attacks of these and other insects has been repeatedly attempted, all efforts, it seems, have so far been ineffectual. Most of the chemical substances suggested are too poisonous to be used on articles brought in contact with the person, as in every-day wear. Happily this is no objection here, for with ordinary precautions the specimens sent to the Museum can be treated with the strongest poisons, the main difficulty being to avoid damaging the material in their application.

First in rank of destructiveness are the moths, of which four species have been observed at active work in the Museum. These are *Tinea flavifrontella* Linn., the common, or clothes, moth; *T. tapetzella* Linn., or carpet moth; *T. pellionella* Linn., or fur moth, and *T. granella* Linn., or grain moth. These Tineids are night-flying insects, though the little fluttering "millers" are often seen flying in darkened rooms in the daytime. Their natural habitat is in dry animal and fibrous vegetable substances, and sometimes on the fur of living animals; in houses they infest woolens, furs, grain, etc., and the destruction caused by the larvæ is well known. They begin to fly about actively in May. I have observed them in warm rooms as early as March, and have found the larvæ all through the winter. In the stage in which this insect does

its destructive work, it is a plump white caterpillar provided with strong mandibles and sixteen legs. It nips the fiber, beginning as soon as hatched from the egg, and builds a case which is enlarged as the insect grows. These insects are known to travel in search of other quarters; they are very hard to kill, extreme cold does not affect them, and many of the domestic preventives, such as camphor, tobacco, etc., entirely fail to destroy them.

All articles subject to injury from these moths should be often examined and shaken, especially in spring and early summer, to dislodge the eggs.

Another very serious pest is the "buffalo bug" (*Anthrenus lepidus* Linn.), and its relative the "carpet bug" (*A. varius* Fabr.). The adult is a small round sluggish beetle, brown, with white or variegated scales on the wing covers. The larvæ are short, plump worms with numerous stiff, brown hairs. This insect is on the increase; its ravages seem to have attracted the notice of the public, and much was written about it a few years ago, in 1882 and 1883. Like the *tinea* larva, the buffalo-bug larva cuts leather, woolen, or fur, and builds an incoherent case from the fragments. These insects multiply very rapidly, and are also unaffected by ordinary insect preventives.

The larvæ of the "basket beetle" (*Sitodrepa panicea* Linn.) are small worm-like creatures with six minute feet. They are furnished with strong cutting-jaws by means of which they eat their way into basketry and old wood, or similar substances, boring little holes as round as if made with a fine drill. The adult insect is a little, sluggish, brown beetle which simulates death on being disturbed.

Another insect, the subject of a letter to Science, May 28, 1886, and there called "A New Museum Pest," is the "silver fish" (*Lepisma domestica*). The adult is a shining fish-shaped insect, wingless, but very quick in its movements. It prefers starch for food, and attacks everything that contains that substance, such as labels pasted or sized with starch or mucilage, cotton or linen laundered goods, etc. This insect is extremely obnoxious to librarians, being attracted by the paste used in binding books.

Other insects are often introduced into the Museum on specimens and by other means, but these are of less consequence, as they do not breed there and are usually not harmful.

It has been thought well to introduce here a paper by Mr. John B. Smith, assistant curator of entomology in the Museum, relating to the care of insect collections. It was published in the Proceedings of the Entomological Society of Washington,* under the title "Some Observations on Museum Pests."

One of the duties of a person in charge of a large collection of insects is keeping out museum pests, as the various species that feed on the dried insects are generically called. In a large collection, like that of the National Museum, no inconsiderable

*Vol. 1, No. 2, p. 113.

time is required for that purpose, as it takes at least two weeks to go through all the boxes carefully.

It has been the fashion to recommend as a certain preventive tight boxes, and quarantining all specimens before putting into the collection, and undoubtedly this is an excellent precaution, saving much future labor. It is, however, by no means the certain remedy it has been claimed to be. The boxes and cabinets in use in the Museum are as perfect, as far as safety is concerned, as it is possible to get them at present, yet withal constant care is required. *Psocidæ* will find their way into the tightest boxes, and though they do little damage ordinarily, yet in a collection of *Tineidæ*, or minute *Diptera*, they can do considerable damage. For these pests I have found naphthaline a perfect remedy. A single half-ounce cone is a perfect protection, and lasts about three months ordinarily.

Tineid larvæ are rather rarely found in the collections on the larger moths, and are not always easily discovered, since they make no dust, as do the *Anthreni*. On one occasion I found that one pair of wings of a *C. regalis* suddenly collapsed without apparent cause. Close examination showed a Tineid larva that had been feeding on the dense, long vestiture, making galleries in all directions in such a way that when I took hold of one end of the gallery, the vestiture of the under side came off in large sheets, leaving the wings almost clean, the veins broken here and there, which produced the collapse. They rarely burrow into the specimen, never in my experience. *Ptinidæ* are sometimes found, but are exceedingly rare in our collection. One box lined with corn pith was riddled by them, and a very few specimens were attacked. By all odds the most dangerous enemies are the larvæ of the *Dermestidæ*, which are pests pure and simple. The principal enemy in our collection is *Anthrenus varius*, though *Trogoderma* is not uncommon.

My experience with these is, that in the uniformly high temperature preserved in the laboratory they breed all the year around, and have no definite broods; a few larvæ appear at all times, though during the summer, when the beetles come in from the grounds, and from other parts of the Museum, exposed specimens are attacked at more regular intervals. The rule is to keep naphthaline in all boxes at all times, but, like all rules, it is not always possible to adhere strictly to it. The boxes not so protected are usually first attacked. In a cabinet not quite tight I coned a number of drawers and left the others unprotected. In the course of the summer the unprotected drawers nearly all became infested, while as a rule the others were free. The naphthaline seems to act as a repellant. I have found, however, that it does not annoy the larvæ to any very great extent, and Mr. Lugger has shown me a naphthaline cone in a hollow of which a larva had pupated. I have reason to believe, however, that it does retard the development of young larvæ. A large number of boxes, nearly one hundred, were received from North Carolina, containing a collection, principally Coleoptera. They were overhauled and found to be pretty generally infested with *Trogoderma*, this being the only species found. No *Anthrenus* larvæ were noticed. Bisulphide of carbon was freely used, and naphthaline cones were placed in all the boxes. For awhile the boxes were frequently examined and no larvæ developed. Throughout the summer the boxes were examined at intervals and remained free. With the approach of cold weather they were left for a longer period and the cones nearly all evaporated. In December this was noticed, and the boxes were again overhauled, and it was found that a very general development of larvæ had begun, all of them *Trogoderma*, and none of them more than 2 to 3 millimeters in length, most of them apparently just hatched. The entire collection was scrutinized, and an occasional *Anthrenus* larva was found, but no other *Trogoderma*, even in the most exposed boxes.

I conclude from this that the collection when received was infested, and that there were eggs everywhere ready to develop; some had begun to develop, and these were destroyed by the use of bisulphide of carbon, which also served to check the development of the eggs. The boxes were quite large, and two large cones were put in each; they were also quite secure, and the atmosphere in them was fully impregnated with

the odor of naphthaline. Throughout the summer, when under ordinary circumstances they would have developed, the eggs remained dormant, but after the naphthaline had evaporated completely, development began. I might add here that *Trogoderma* is an exceedingly rare pest in New York, and not common in Washington; farther south it seems to replace *Anthrenus*. For all these pests bisulphide of carbon is a sovereign remedy, except when they are burrowing in large Coleoptera or Lepidoptera. I have repeatedly soaked large Bombycids with chloroform or bisulphide, and a week later found them still infested. I worked for a month over some large Lucanids (*Proculejus*), and finally separated the parts so that I could fill the body cavity with chloroform. In one case, that was somewhat exposed and contained old material of little value, I found a specimen destroyed by *Microgaster*, a rare parasite for *Anthrenus*. How they got at this box is difficult to explain, since it was tight enough to prevent the entrance of the insect.

I have noticed also that boxes on the lower tier of shelves are much more liable to attack than those on upper tiers, and this leads me to believe that the parent beetle will deposit eggs outside of the boxes or on the floor of the cases, and the young larvæ will work their way into the smallest crevices. It seems difficult to account for isolated larvæ in boxes containing only old insects.

Finally I find the danger of infection comparatively greater at Washington than in New York, principally because the warm season begins earlier and lasts longer, increasing the chances of infection. I find, too, that the only real chance of safety consists in constant examination, tight boxes, and a free use of chloroform or bisulphide of carbon.

As to naphthaline, I consider that it is a good general preventive. I know that it keeps out Psocids and ants. It enhances the tendency to grease and to verdigris, and in tight boxes it seems to exercise a relaxing tendency, causing the wings to droop.

There are several classes of substances to be poisoned, in which the colors, fabric, or character of material, and therefore the kind of poison and the strength of solution, are important factors. For instance, goods not fast dyed (especially cotton), or which are dyed with colors that contain solutions, will start; also fabrics or substances which may be corroded or hardened, or otherwise injured, as feathers, fur, dressed deer-skin, etc. Too strong a solution may also cause a deposit on fur, etc., with a dulling effect. As a test for this, a black feather should be dipped in the solution, if it is of corrosive sublimate or arsenic in alcohol. If the solution be too strong, it will produce a white coating when dry. Any solution should exert its action in two ways, first to repel the adult insect, and second, to destroy the hatched larva. Pungent odors are noxious to moths and the higher orders of insects, but this is hardly true in the case of the beetles to which we have before alluded. The pungency of odor can not be made to last long, so that the poisoning quality is of prime importance. The substances used for solutions are deadly poisons, and no one who has not had experience in handling them had better undertake to apply them. Corrosive sublimate will attack the finger-nails and the skin. It is also volatile. Arsenic is prejudicial to the health; the dust, it is said, produces catarrh, both gastric and nasal, though this has not been confirmed by my observation.

Before poisoning, all objects should be treated with benzine, by put-

ting them in a close box or vessel, and pouring the benzine in, leaving them tightly closed therein for several days. This operation destroys any larvæ or eggs. They should then be hung up until the benzine evaporates before proceeding with the poisoning solutions. Bisulphide of carbon is more volatile and more quickly effective than benzine, and may be used, if preferred. There is reason to believe that both kill the eggs—quickly if the fluid comes in contact with them and less rapidly if they are directly affected only by the fumes in the vapor. Great care must be taken not to allow fire of any kind to come in contact with the vapor of bisulphide of carbon. There are several reasons why benzine is preferable, and the latter is sure to be effective when followed by the arsenic-naphtha solution. The solution found most satisfactory for poisoning nearly every kind of specimens is as follows:

Saturated solution of arsenic acid and alcohol	1 pint.
Strong carbolic acid	25 drops.
Strychnine	20 grains.
Alcohol (strong)	1 quart.
Naphtha, crude or refined	1 pint.

The use of strychnine is not absolutely necessary; but it is a very good agent and adds much to the value of the solution. Other solutions and poisons will be noticed below. It will be found advisable to apply solutions in the form of spray to delicate objects, such as feathers or specimens of similar character. In this treatment an atomizer may be used. Some small specimens may be dipped and allowed to drain, and the solution may be applied with a brush to a large class of objects, taking care to saturate every part. The specimens can then be hung up to dry or laid away as they are. They should be kept free from dust, which is exceedingly injurious to them. As soon as poisoned, they ought, if intended for exhibition, to be mounted in dust-tight cases, or carefully stowed away in close-fitting drawers or boxes. In unit or costume boxes a small packet of naphthaline may be concealed behind the specimens, and the junction of the lid should be made dust-proof by pasting on strips of paper with paste containing arsenic or corrosive sublimate.

Some specimens present problems that do not fall under any rule and have to be left to judgment and experiment. As an instance in point, we mention a fine deer-skin robe collected by Mr. Turner, beautifully tawed, with the hair on, and ornamented with a medium which will not stand wetting. It is obvious that no solution can be used in this case, since alcohol or water will harden the buck-skin and destroy the decoration. Satisfactory results might be obtained by judicious spraying, but there would be doubt as to the completeness of the poisoning. It would be better to rub into the kid surface a powder made of precipitated chalk and white arsenic. The fur side should then be well rubbed, care being taken to allow the powder to penetrate into the roots of the hair. By all means protect the hands with gloves. Powdered soap would also be a good medium for the arsenic. Great care should be

taken in applying this poison and in handling a specimen poisoned in this way. Such specimens should be at once closed up tightly and put on exhibition.

Corrosive sublimate has been much used for poisoning and is a valuable agent. Several specimens in the Museum, which were poisoned years ago with this substance, were so filled with it that they are dusty. They are made of fur-skin, and are stiff and unpresentable for exhibition. I do not know what was the condition of the articles when they were acquired; they are, however, undeniably moth-proof. I have found numerous adult moths destroyed in the act of laying their eggs. A careful use of corrosive sublimate is very effective, if it is not brought in contact with skins, as it coagulates albumen. It is also volatile, and Dr. G. H. Beyer, U. S. Navy, has proposed to take advantage of this property in preventing the growth of fungi on materia-medica specimens in jars. One objection to corrosive sublimate is that it crystallizes out very easily; this might be obviated by adding a little naphtha to the alcoholic solution.

Naphthaline is used by Mr. J. B. Smith, of the Museum, and by other entomologists, to preserve insect collections from *Acari*, *Psoci*, *Dermestes*, *Anthreni*, and other museum pests.* It destroys the two former, but only tends to repel the others. It also acts as an antiseptic, destroying schizomycetes, moulds, bacteria, etc. The salt is perfectly neutral, is not poisonous to man, and is cheap. It is customary in this department to put a small packet or cones in cases containing mounted costumes.

Vaseline may be called perfect grease, since it does not become rancid or corrosive. It is especially useful to protect iron and steel from rust, and no doubt would preserve woodwork from extraneous attack. It is also good to soften leather which has become hard. In the case of clubs, spears, and implements of hard wood, like those of Polynesia, a fine polish may be obtained by using vaseline. I regard vaseline as a good vehicle in which to apply white arsenic to skins, as is done with arsenic soap. It penetrates very well, especially if thinned a little with naphtha. Vaseline is also used on book-backs to soften them, to prevent mould, and to keep insects away.

A few recipes germane to this subject, and which may be useful in other departments of the Museum, are appended:

Mr. Hornaday has used arsenical soap prepared in the following manner:

White soap	2 pounds.
Powdered white arsenic	2 do.
Camphor	5 ounces.
Subcarbonate of potash	6 do.
Alcohol	8 do.

See p. 555.

Slice the soap, melt it, add the potash, stir in the arsenic, and add the camphor previously dissolved in the alcohol. Stir, when cooling, to prevent the arsenic from sinking to the bottom. For use, mix a small quantity with water until it resembles buttermilk, and apply with a common paint-brush. This is a mechanical mixture. Mr. Hornaday has obtained results of the highest order from its use. The following is believed to be a more correct chemical combination:

White soap	1 ounce.
Arseniate of potash	2 do.
Water	6 drachms.
Camphor	2 do.
Strychnine (ad lib.)	15 grains.

The following ingredients make an effective preservative powder:

White arsenic	1 pound.
Burnt alum	1 do.
Powdered oak bark	2 do.
Camphor	½ do.

This should be powdered well, sifted and kept in well-stoppered bottles. It should be applied to the wet surface of skin and rubbed in well. The hands should be protected with gloves. I have never tried this preparation.

The following solution has been prepared by Wickersheimer for the preservation of objects in the natural state:

Alum	500 grains.
Salt	125 do.
Saltpeter	60 do.
Potash	300 do.
Arsenic trioxide (white arsenic)	100 do.

Dissolve in 1 quart of boiling water. Cool and filter, and for 1 quart of the solution add 4 quarts of glycerine and 1 quart of alcohol. Either soak the objects in the solution, or inject them with it. This solution is said to do very well except in tropical climates.

For botanical specimens this is said to be an excellent preservative:

One ounce of corrosive sublimate to 1 quart of alcohol, diluted 50 per cent. The best plan is to dip the specimens and then carefully dry them. The poison can also be painted on with a camel's-hair brush.

For the preservation of entomological specimens, the strongest solution used should be corrosive sublimate in alcohol, 1 to 100, and the weakest 0.1 to 100. (See remarks on naphthaline, *ante.*)

For insects on plants, the following solutions are recommended:

First solution.

Salt	2½ pounds.
Saltpeter	4 ounces.
Water	1 gallon.

Filter.

Second solution.

First solution	1 quart.
Arseniate of potash	2 ounces.
Water	1 gallon.

A cheaper solution can be made by taking—

White arsenic	1 pound.
Sal soda	4 ounces.
Water	1 gallon.

Boil till a solution is made. Take 1 quart to 40 gallons of water. These solutions have been found by the Department of Agriculture to be very useful in destroying the scale-bug and the red spider, so harmful to plants.

The following method is employed by furriers in the treatment of fur skins for the purpose of rendering them pliable: The skin is steeped and scoured in a bath of alum, bran, and salt, in order to remove greasiness; then in a bath of soap and soda, to remove the oil from the fur. When thoroughly washed and dried it is found that the pelt has become tawed or kid leather.

To soften and cleanse buck-skin or chamois leather, rub plenty of castile soap into the skin and soak for two hours in a weak solution of sal soda in warm water and rub well until quite clean. Afterwards rinse in a weak solution of sal soda and soap in water; after rinsing, wring it dry in a coarse towel, and when fully dry beat it until soft and smooth.

For domestic purposes the following preventives from moth ravages are suggested: Dissolve in 200 parts of alcohol 2 parts of salicylic acid and 2 parts of thymol; perfume with oil of lemon. This is a neutral solution and will not injure colors or texture, and has a pleasant odor, but is rather expensive.

A good preparation to sprinkle among furs being packed away in a close box or drawer, is naphthaline and menthol or thymol, in proportion of 1 ounce of the former to 20 grains of either of the latter, rubbed together. The odor will disappear from the furs or goods after they have been aired for a short time. Even if moths are present and are hatched, they will not feed when closely shut up in the odor of this mixture, and in this respect it is far superior to camphor. Thymol alone is very good. Naphthaline is now on the market in a very convenient shape called "moth marbles," and seems to be going into general use.

In the following list of apparatus only those things have been mentioned that have been found necessary or very useful in the operations at the National Museum. Doubtless at other places, where such a range of subjects for poisoning is not presented, some of the articles can be dispensed with:

Gutta-percha atomizer, which may bought for one dollar. The bottle can be easily wired to a handle for convenience. (Fig. 1.)

FIG. 1. Gutta-percha atomizer.

Galvanized sheet-iron tank (Fig. 2) used for subjecting specimens to bisulphide of carbon. The lid and air-hole cap on the lid both fit into

a slot (Fig. 2*a*) that is to be filled with water to prevent escape of gas. The tank should be set out in the open air if possible. The size of the tank used here is 3 by 2 by 2 feet, and it has handles on the ends and on the lid. (Fig. 2.)

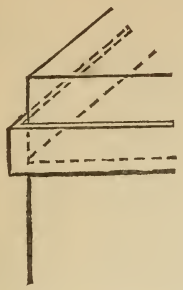

FIG. 2*a*. Showing adjustment of lid of tank.

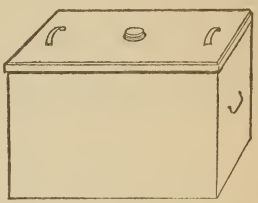

FIG. 2. Galvanized sheet-iron tank.

Shaw and Geary No. 2 air compressor (cost $15), and four-nozzle gutta-percha atomizer, cost $2.50. These are found necessary only when much spraying is to be done.

Stock solution jar, jar for mixed solution, benzine jar or jug, graduate, 1 pint; glass funnel, 3 paint brushes, not too large; several stoneware jars with closely fitting lids for smaller specimens. With good-sized jars, or even a closely-joined box, the galvanized tank may be dispensed with, especially when benzine is to be used.

The poison tags should not be large. They are convenient for showing whether specimens are poisoned or not, and when, and are sometimes a good test whether they are well poisoned. They may be printed with death's-head and word "poisoned," with space for date and museum number.

The long established "Museum standard" cases are provided with bead and groove (Figs. 3 and 4) which effectually exclude dust and insects, the two worst foes of museum collections. In putting up perish-

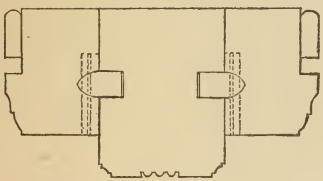

FIG. 3. Section across back of door.

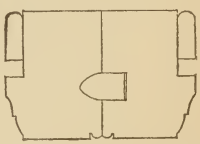

FIG. 4. Section across junction of door.

able specimens permanently in the glazed Museum unit boxes, etc., the backs are made of tin, and to guard against the minute, insinuating, newly-hatched moth larva, the junction of the lid with the sides is pasted over with strips of paper or muslin with glue, poisoned with corrosive sublimate or arsenic. This, with naphthaline cones inside, is the highest triumph of the preservation of museum specimens.

In the following table are given the approximate prices of chemicals which have been referred to in this paper:

Alcohol, 95 per cent	$2.50 per gallon.
Arsenic acid, Merck's	.40 per pound.
Arseniate of potash	..... do.
Arsenic, white	.10 do.
Benzine	.15 per gallon.
Bisulphide of carbon	.25 per pound.
Burnt alum	.10 do.
Camphor	.25 do.
Carbolic acid, Calvert's solution	.60 do.
Chloroform	.75 do.
Corrosive sublimate (mercuric chloride)	.90 do.
Ether	.85 do.
Glycerine	.30 do.
Menthol	.50 per ounce.
Naphtha	..... per gallon.
Naphthaline crystals	.25 per pound.
Naphthaline cones	1.25 per 100.
Naphthaline "moth marbles"	.10 per box.
Oak bark, powdered, or tannin	.10–.25 per pound.
Oil of lemon	.20 per ounce.
Salicylic acid	2.25 per pound.
Saltpeter	.35 do.
Sal soda	.05 do.
Strychnine	.20 per $\frac{1}{8}$-ounce.
Subcarbonate of potash	.25 per pound.
Thymol	.60 per ounce.
Vaseline, Cheeseborough's	.50 per pound.