Care and Conservation of Natural History Collections

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9

Policies and procedures

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Introduction

All natural history collections should adopt clear policies and procedures governing their management. This will help in setting and achieving the best possible standards of collections care within the constraints of finance and staffing levels. As collections vary so much in their size and resources, we do not consider it feasible to make specific recommendations but, while developing this book, we have felt the need to provide some general guidelines which are presented here.

There is a wealth of published information available regarding policies and procedures for museums and other institutional collections, a great deal of which is based on the care of art and antiquities, rather than natural history collections, although natural science institutions are increasingly following this lead (see, for example, The Natural History Museum, 1998). The following guidelines are based on published policies and procedures, our own practical experience of collections management and problems and questions garnered from other colleagues and friends throughout the world. A lot will appear to be just common sense but we hope that the guidelines presented will give food for thought to experienced curators and assistance to curators who are new to natural history collections management.

Care and use of collections

Mission statement

To help establish priorities and implement decisions in any institution it is helpful to have as a foundation a clear mission statement. This is usually in the form of a broad statement which encompasses the aims and objectives of the organization and should be developed in consultation with the staff, users and the governing body. It is important that care of collections figures prominently in any such statement. As a guide we give the mission statement of The Natural History Museum, London:

To maintain and develop our collections and use them to promote the discovers'. understanding, responsible use and enjoyment of the natural world.'

Once a statement has been agreed and published it can be used as a basis for other policies, priorities and decisions. As Malaro (1979) noted: 'How can a museum proceed with confidence if there is internal confusion concerning basic policies and procedures.'

A mission statement provides a useful reference point if policies take a shift in direction or, for instance, if there is discussion or dispute over major budget priorities. Cato and Williams (1993) give detailed guidelines on

how to develop such a statement and it is modified or expanded to suit particular collections and circumstances:

recommended that this paper be consulted.

Conservation policy

The first duty of any responsible institution which holds natural history collections in its care is the prevention of their physical deterioration. The Museums and Galleries Commission (1992) have produced a set of standards for biological collections which provide good guidelines to help set up policies on various aspects of care and management, including collections conservation. A good conservation policy agreed upon by staff and management can be invaluable in promoting investment in collections care. A conservation policy should be in line with the institution's mission statement. Points to consider are:

- All institutional staff, from security guards to research staff, should be made aware of their responsibilities regarding the care and maintenance of the collections.
- Preventive strategies should be a primary objective.
- Materials used in the study, storage and display of collections should be of conservation grade.
- Objects from the collections should be stored and displayed only in conditions suitable for their preservation.
- There should be a regular programme of inspection.
- Loans of material should only be made to borrowers who can satisfy conditions for safe and secure storage, study or display.
- Conservation actions should be documented.
- A quarantine policy should be in place.
- The historical integrity of a specimen should be preserved wherever possible. This may include the retention of original mounts, labels, containers and preservation fluids.

Good practice in collections use

Following agreement of a conservation policy, it may be useful to provide an agreed set of procedures for those working with collections. A list of basic recommended procedures is provided here for guidance, but this may be

- **No eating, drinking or smoking in collection areas.**
- **Specimens brought into collection areas must be free of pests (i.e. fumigated or frozen as necessary).**
- **Specimens should be fully documented (labelled/databased) before incorporation into or removal from the collection.**
- **Delicate specimens must not be left exposed and unattended, even for short periods of time.**
- **No specimens should be left in direct sunlight or under any strong illumination.**
- **Specimens must be returned to cabinets or other secure storage at the end of each day.**
- **Dissection, restoration or any other interventive process must not be carried out without thorough consultation.**
- **Conservation grade materials must be used wherever possible.**
- **All curatorial and conservation actions must be fully recorded/documented.**
- **Visitors must be supervised at all times and must not handle or move specimens without permission.**

Collections risk assessments

Although usually associated with the insurance industry, it is recommended that risk assessments be made for natural history collections. Prevention and arrest of deterioration is fundamental to the process of collections conservation. In setting out a systematic approach to collections conservation, Michalski (1992) identified nine agents (or causes) of deterioration and suggested a method of quantifying risks as a means of addressing problems in a structured manner. Waller (1995) further developed Michalski's system with special reference to mitigation of risks to natural history collections. He recognized the following ten agents of deterioration, to which we have added examples:

- Physical forces, e.g. damage from constant vibration.
- Fire, e.g. soot contamination.

- Water, e.g. flood damage.
- Criminals, e.g. vandalism.
- Pests, e.g. museum beetles.
- Contaminants, e.g. dust.
- Light and UV radiation, e.g. high enough to cause fading.
- Incorrect temperature, e.g. high enough to cause evaporation of liquids.
- Incorrect relative humidity, e.g. high enough to promote mould growth.
- Custodial neglect, e.g. failure to record data.

These risks can be evaluated at different levels according to their severity and frequency. This provides a useful aid to prioritizing actions that will mitigate these risks. Having identified and quantified these risks, Waller proposed three approaches to control them and again we have added examples (relevant to insect pest infestation):

1. Eliminate the source of the risk, e.g. destroy birds' nests harbouring source infestation.
2. Establish a barrier to exclude the agent(s) of deterioration, e.g. seal collection in pest-tight cabinets.
3. Act on the agent of deterioration itself, e.g. treat collection with insecticide.

It should be immediately apparent that the first option provides a long-term answer to the problem while the third option may offer a tempting `quick fix'.

Each method of control can be considered at a series of levels. Waller proposed seven levels and again we provide examples (relevant to pest infestation):

1. Location, e.g. locate collection in cool climate where pests are less frequent.
2. Site, e.g. establish a vegetation-free zone around the building.
3. Building, e.g. create building without ledges that provide nesting sites for birds.
4. Room, e.g. collections store without windows.
5. Storage unit, e.g. pest-tight storage units.
6. Object, e.g. specimens frozen or heat-treated to kill pests.
7. Policy/procedure, e.g. quarantine procedures for all incoming material.

The choices here are not so obvious and often several actions should be combined for optimum effect.

Another approach is given by Proudlove (1997) who lists possible hazards under five groups, from the total loss of objects to damage likely to occur to certain collections in the longer term. Many of the above problems will seem very obvious but their solution may not be so easy to achieve due to prohibitive expense or other more practical considerations. In some cases, choices will be influenced by availability of resources

Disaster planning

Because unforeseen disasters can occur at any time it is important that there is a well devised plan to ensure that every member of staff is sufficiently informed to cope. This important topic is covered in Appendix III.

Maintenance procedures

As Yang (1989) points out, without written procedures, valuable information is likely to be inadequately transferred from person to person as changes of staff occur. Moreover, without a written record, new staff are forced to learn from trial and error rather than from the experience of their predecessors and, as a consequence, valuable time and energy are wasted. Maintenance procedures directly related to care and conservation should include:

- Basic hygiene (cleaning).
- Checks on environmental monitoring systems, including fire, flood and security warning systems.
- Checks on electrical and gas appliances.
- Checks on water, gas and electricity supply systems.
- Pest monitoring (see Chapter 8 on pest management, prevention and control).
- Checks on fluid-preserved collections to prevent drying out.

Collection managers should also ensure that any maintenance manuals and work are regularly updated and monitored. For instance, if the institution is using an integrated pest management system (see Chapter 8 on pest

Figure 9.1 A collection of large mammals languishing in a store-room

management, prevention and control), there should be a regular check that the monitoring programme is not behind schedule.

Acquisitions policy

In the past it was not considered necessary for most natural history collections to have a formal acquisition policy but, with current restraints on budgets and the consequent possibility of shrinking staffing levels, it becomes increasingly necessary that institutes and museums safeguard the collections with a clear policy on acquisitions. Moreover, some funding bodies will not consider grants to those organizations who do not have such a policy. A useful outline of the issues to be addressed in such a policy is provided by Cato and Williams (1993), while ethical guidelines are provided by the ASC (1991) and the Museums Association Ethics Committee (Museums Association, 1996a).

From a care and conservation point of view, a carefully considered acquisition policy is an important step towards controlling the quantity of incoming material at a manageable level while taking into account the importance of acquiring new material that will enhance existing collections. One of the greatest problems of older museums is the inheritance of vast quantities of poorly curated material resulting from the indiscriminate acquisition of specimens in the past. Collections were commonly accepted without any regard to the resources available for their future care and conservation, apparently on the presumption that facilities would eventually be provided. Given the fundamental presumption against the disposal of any item from a museum's permanent collection, it is a very difficult matter to deal with historic backlogs of such specimens which languish in store-rooms throughout the world (Fig. 9.1). It is therefore very important that any acquisition policy should ensure that collections are only accepted if there is the capability to care for them. Some institutions formalize the acquisitions procedure by preparing collections impact assessments when a research project involves the collection of specimens. Lee *et al.*, (1982) recommend that acquisition procedures should include criteria for accepting voucher specimens.

If consideration is being given to the acceptance of a large collection (perhaps under a will or from a researcher who can no longer care for a reference collection), it may be necessary to seek special funding to house the collection and *pay* the costs involved in assessing and curating it. There is often a fine balance between the need to acquire a collection and the cost involved in its accession and maintenance.

With the increase in awareness of the value of biodiversity and cultural heritage throughout the world, many countries have already imposed restrictions in the form of collecting and export regulations. Institutions have a legal and moral duty to ensure that all specimens have been acquired legally and special attention must be paid to establishing a legal title for all incoming material. This may include copies of collecting permits and export licences. The implications of failure to ensure that specimens have been collected legitimately has been highlighted by the Lacey Act regulating the movement, import and trade in fish and wildlife in the USA. This controversial act makes it an offence to import, export, sell, receive or acquire wildlife (including specimens for scientific study) in violation of any national or international law, treaty or State regulation. The impact of this act on entomological collections was debated in *Insect Collection News* (Johnson *et al.*, 1994).

Disposal policy

The disposal or permanent removal of an item or items from a collection is often referred to as `deaccessioning'. In the world of arts and antiquities, legislation often lays down policies for the exchange or sale of material but currently this is used to a lesser extent for natural history specimens. Cato and Williams (1993) provide a useful framework for a deaccessioning policy but it should be borne in mind that natural history collections have their own requirements in this respect. For instance, many policies refer to disposal of specimens that are duplicates — an inappropriate distinction for natural history specimens. There are good reasons for disposing of some material that is inappropriate (e.g. poor specimens without data; badly damaged and infested specimens) but, on the other hand, pressure can come from administrators to sell unfashionable collections to raise finance for other areas of activity. A disturbing instance of this in the UK was highlighted by an article in the national press (Harlow, 1997) where it was questioned whether `stuffed animals' should be displayed in public museums. The implication was that funding might be withheld from some museums because they displayed such specimens. Whilst it is true that some sections of the community consider such specimens to be `politically incorrect', there is still a flourishing market in this material so that the temptation for some museums to sell valuable resource collections must be great.

Such pressures on collections can be mitigated by a well-planned disposals policy which will protect the collection whilst making provision for the disposal or exchange of material. A good disposals policy can be a powerful tool for the protection and management of the collection, allowing removal of specimens that are inappropriate or even (in the case of badly infested or deteriorated material) a threat to the collection, whilst preventing disposal or sale of specimens for political expediency. We have learnt of one museum which makes flexible use of its disposal policy by deaccessioning very badly deteriorated specimens before submitting them to experimental conservation techniques. If these are successfully conserved, then the specimens are reaccessioned.

When devising a disposals policy, consideration should be given to possible requirements for repatriation of material or permanent transfer of material to another institute where it may be better cared for or would be more readily accessible for study and research. Weil (1987) sets this out quite clearly when he suggests that 'in some natural history museums a specimen in a collection may be deaccessioned on the grounds that the discipline itself would be better served if the object in question was transferred to another museum'. In some cases this is achieved by long-term or `permanent' loans but this does not seem a desirable alternative as there is always a danger that specimens may ultimately become lost or neglected due to staff and policy changes over a period of many years. Such arrangements should be well publicized to avoid this eventuality.

It has already been stated that there is a strong presumption against disposal of specimens from a permanent collection and any policy should reinforce this. Both the ASC (1991) and the Museums Association (1996b) provide ethical guidelines. Even when disposal is permitted, this should be clone in a responsible way and if possible the material should be relocated to an institution where it will be best used. Many institutions have agreed a

policy of advertising such material within the museum community well in advance of its disposal. Such a procedure may in future be extended through the Internet.

Policy for `care and maintenance' collections

There are many instances, especially in small provincial museums, where a collection may contribute no scientific or display value to the institution or where there are no available resources to care for it. It may be entirely inappropriate to continue to house the collection and careful consideration must be given to its long-term care and curation. A possible solution may be to amalgamate the collection with a working collection elsewhere, although this can be extremely costly and few institutions will be willing to bear such expense unless a clear benefit can be identified. If there are legal or other considerations which do not allow such a move, it may be possible to assign responsibility for the collection to a staff member on a care and maintenance basis or to employ the services of a freelance conservator/curator. However this is often impossible, in which case voluntary help may be sought.

Many members of the museum community feel a moral obligation to support orphaned collections either by carrying out voluntary work themselves or by offering support to less experienced volunteers. In the UK, the Biology Curators Group shows a strong interest in orphaned collections and monitors their situation (BCG, 1997a, 1997b).

A problem which arises frequently at a local level is that of the private collection inherited by family members who wish to donate or sell it to the local museum. Collections such as these need to be assessed in conjunction with the acquisition policy of the museum and judged accordingly. However, where such collections cannot be accepted, every effort should be made to relocate them. A procedure for this could be set up through the Internet. Already a number of Interactive Collections Availability Lists (ICAC) for orphaned and understudied collections are available as World Wide Web sites supported by the National Science Foundation.

Documentation and assessments

Documentation

Documentation is associated with many different activities and there is a growing literature associated with the subject. The *UK Museum Documentation Standard (SPECTRUMS* edited by Grant (1994) is an attempt to set standards of good practice. This lengthy tome aspires to contain `... procedures for documenting objects and the process they undergo, as well as identifying and describing the information which needs to be recorded to support the procedure'. Although directed mainly towards art and antiquities, it provides a well structured approach to documentation at all levels. On the other hand, Davis (1994) presents a more comprehensive UK point of view on the principles of documentation in natural history museums and lists important points to consider. This is an important topic and is dealt with in detail in Appendix I on documentation.

Collection assessments

Natural history specimens are by their very nature unstable objects that are vulnerable to a wide range of hazards (see risk assessments p. 178). Collections can deteriorate at an alarming rate if problems such as pest attack or chemical deterioration are not recognized and tackled at an early stage. It is therefore of prime importance to monitor the condition of a collection on a regular basis. In the UK, the Museums and Galleries Commission (1992) has set standards for the care of biological collections, which require that all specimens must be inspected by a trained and experienced biologist on a rolling programme. It suggests that `unstable material' should be checked annually or even more frequently. Many collections at risk should be checked every four months for pest attack. Collections assessments fall into four categories, each with a different purpose:

1. Condition checks — regular checks to monitor and identify local problems.
2. Condition surveys — survey collections as a whole to assess care and conservation priorities.
3. Condition reports — usually restricted to individual specimens.

4. Curatorial assessments – examine overall `health' of collections in terms of conservation and organization.

Simple condition checks, which should be carried out regularly, serve to monitor specimens and identify local problems. Condition surveys monitor the collection as a whole and help to assess care and conservation priorities. They are carried out infrequently and usually result in a report with recommendations. Condition reports generally have a much more restricted use for natural history specimens but are particularly useful for recording valuable specimens sent on loan or for exhibition. Some institutions include condition report fields in their specimen databases.

A more recent form of curatorial assessment looks at the overall `health' of the collection, both in terms of conservation and organization. Whilst this type of assessment may be seen more as a management tool, it is extremely valuable as a way of presenting the case for the importance of a collection and its care to administrators and fund-holders who may not be immediately sympathetic towards conservation issues.

In a detailed and useful discussion of monitoring collections' condition, based largely on non natural history material, Keene (1996) defines some of the above terms differently but overall objectives remain the same.

An important point to bear in mind with all forms of collections assessment is that, whilst they may highlight problems and suggest solutions, they do nothing to directly improve the collection. The minimum amount of time should be spent on these exercises so that the main effort can be put into preventive and remedial actions.

Condition checks

Checks need to be methodical and efficient in their execution. If they take too long or become tedious, they are likely to be avoided – there is always an excuse to do something more pressing. All curators (and most researchers) are subconsciously checking the condition of the collections when using them, but it is often those areas least frequently examined that are most susceptible to deterioration. If the task is split into small and manageable sections and carried out at regular intervals, it is more likely to be achieved. For large collections, such work should ideally be carried out by a team of curators and conservators. Such checks are likely to be rapid visual scans of material with a closer inspection if problems are suspected. Problems to be looked for will largely be ascertained by clay to day experience and by collections risk assessment procedures (see p. 178). It is important to keep records of these checks as they can be used to monitor problems and potential risks to collections.

Condition surveys

Keene (1994) states that `a rational and cost-effective policy for both preventive and remedial conservation relies upon accurate information about the condition of existing collections'. Collections condition surveys are undertaken to assess or audit the conditions of collections as a whole. rather than to identify individual objects requiring action. Considering the large size of many collections, statistical sampling is a practical method of providing this information. Condition surveys should:

- Provide a quantified overall assessment of the condition of objects in a collection.
- Ascertain the main causes of deterioration.
- Assess whether the collection condition is stable or deteriorating.
- Suggest procedures to slow or halt any deterioration.
- Assess the resources required to stabilize or improve the collection.
- Recommend priorities.

The data collected will depend very much on the nature of the material. Choosing the right parameters is essential for a useful survey. Parameters will usually fall into similar categories (e.g. structural damage, biological attack, chemical deterioration) but will vary according to the collection and location. Many surveys grade condition levels (Table 9.1)

Table 9.1 Condition levels

Level	*Condition*	*Response required*
A	good	no response
B	fair	response not essential
C	poor	action required
D	unacceptable	urgent action required

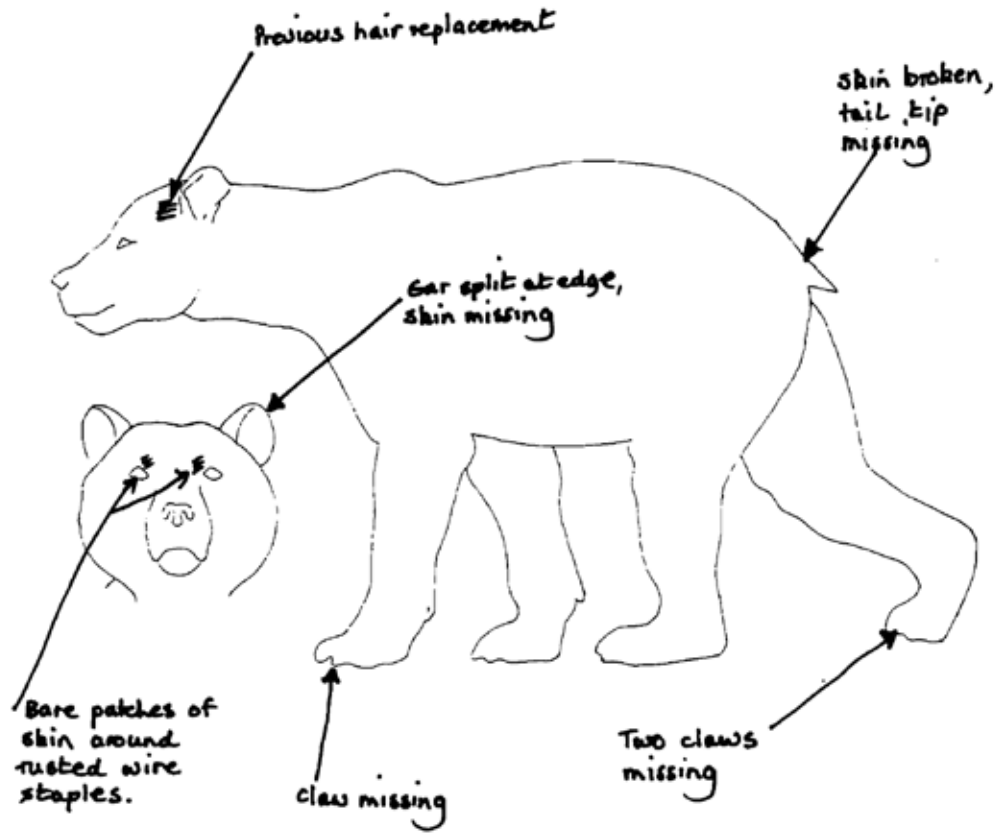
GLASGOW MUSEUMS

GLASGOW MUSEUMS

MAMMAL CONDITION REPORT

Species	Jaguar ♂	Preparator (Signature)	L. Thomas
Description	Mount on rectangular wooden base, modelled ground work	Date	8. 5. 1991.
Label Information	Rowland Ward trade label on base (good condition) NH -1913 - 34 b.		
Exhibition Loan	Claws July 1991 – Sept 1991		

Ear faded on left side.



DH/MC/CONS\FORM\MAMMAL

Figure 9.2 Mammal condition report. With kind permission from Glasgow Museums.

Many natural history collections are too large for a complete survey of all material in the collection and it is usually necessary to use a sampling method to gain an overall picture. The samples must be random to give an unbiased picture. Advantages of sampling are:

- Surveys take less time.
- Fewer objects can be examined more thoroughly.
- Data can be more rapidly analysed.

Keene (1996) provides valuable guidelines for data collection and analysis. When conducting a survey, it is important that it is appropriate to the specimens or objects under study and will produce useful results in a reasonable time. After conducting a collections condition survey of herbarium and non-herbarium material in the National Museum of Wales botany store-rooms, Purewal (1994) published a report on a diverse collection of prints, drawings, photographs, wax models, wood sections and herbarium sheets housed in three rooms. Environmental conditions were recorded in each of the three rooms prior to the survey. Although this survey was carried out on a range of different materials, a common set of parameters was devised. These parameters were: stability, insect damage. fungal damage, dust/grime. packaging, disfigurement and completeness. The parameters were assessed using the four-step system described (see Table 9.1) with the levels judged according to the materials. In this case, every ninth specimen was examined and recorded. The survey took ten weeks to complete and was used as the basis for recommendations for future storage of the collections, which have now been implemented.

Condition reports

Detailed condition reports on individual natural history specimens are the exception rather than the rule, although they can be very important for valuable material such as types or historic specimens, particularly at times when they are likely to be vulnerable, for example prior to sending them on loan or placing them on exhibition (Fig. 9.2). Forms for recording the condition of individual items have been devised for arts and antiquities collections and these may provide useful guidelines for those wishing to detail natural history specimens. The parameters for assessing specimens have already been discussed, although they are likely to be more detailed for individual specimens. In some cases it may be possible to include details of condition on specimen inventories. With increasing use of specimen-level electronic databases, the possibility of including condition fields should be considered as a convenient and efficient way of monitoring the state of the collection.

Curatorial assessments

McGinley (1992) devised a useful working system for profiling insect collections by setting a series of curation standards or levels against which collections can be assessed. This has been developed as a numerical coding system by which the curation status of individual storage units (e.g. a drawer of insects, a jar of tubes, a box of slides) can be identified. McGinley's system is based on a set of ten levels, covering issues which are common to all natural history collections:

- Level 1 — materials conservation.
- Levels 2—4 — specimen accessibility.
- Levels 5—6 — physical organization.
- Levels 7—9 — data capture.
- Level 10 — scientific voucher material.

The information gathered can be entered on to a database and used to create a profile for the whole collection. As well as indicating the current state of a collection, it is also possible to make comparisons with other collections, both within an organization or between organizations. As a management tool it can be used to plan a working strategy for collections. In order to monitor progress, the exercise can be repeated at intervals to see if targets are being achieved.

A criticism of McGinley's system from a conservation point of view, and to some degree from a management point of view, is that conservation issues are only dealt with at one level, and thus the system does not help in setting priorities for conservation needs. From a management point of view this can be misleading if the system is not fully understood. For example, if a pest is found in a category 7 drawer it immediately drops to level 1. By removing the pest and freezing the drawer it returns to level 7. On the other hand, a category 2 drawer that has cracked and allowed the entry of pests which are now eating the specimens will also drop to level 1

but will require days of painstaking work to remedy and return to level 2.

McGinley's system is now being applied to non-entomological collections, usually with some modification to accommodate their different nature and requirements. Williams *et al.* (1996) have applied a considerably modified system to collections of recent vertebrates in the Museum of Texas Tech University. The levels are categorized as follows:

1. Acquisition
2. Stabilization
3. Registration
4. Processing
5. Curation
6. Storage
7. Maintenance

Within each level, specified criteria are assessed and categorized by a series of letters. Each unit is assessed for each of twenty-six lettered criteria, which lie within the seven categories. This may seem an unnecessarily complex approach, which would be difficult to apply to a large collection, but it is a useful example of the way in which such an assessment system can be modified to produce useful data for different types of collections.

Another approach to the problem of gathering and analysing this data is to use a matrix system. Huxley (1994) devised a simple matrix system which assesses the physical state and data state of the collections separately, using the following specific criteria for a bryophyte collection:

Physical state

1. In herbarium — in new loose packet system
2. In herbarium — in packets fixed to sheets
3. In herbarium — exposed, fixed directly to sheets
4. Unincorporated specimens in sound packets
5. Unincorporated specimens in poor packets
6. Unincorporated specimens loose in open covers.

Data state

A. Specimens with full data, identified

B. Specimens with full data, unidentified

C. Specimens with adequate data, identified

D. Specimens with inadequate data, unidentified

By recording each unit for both states it is possible to create an assessment matrix which may give a more detailed picture of the overall state of the collection. Such a system could be modified and expanded to assess different types of natural history collection.

Special considerations

Loans and transportation of specimens

The interchange of specimens between institutions in the form of loans is an essential way of disseminating information and enabling researchers to examine and compare a wide range of material at one time in one place. However, such loans carry considerable risks and these must be weighed carefully against expected benefits before undertaking them. Some material is either too fragile or too rare to risk transportation but this will be up to the individual institution to decide.

Loans policy

All institutions and museums should have a carefully formulated loans policy. Points to consider are:

- A specified time for which the specimens can be borrowed.
- A more restricted time limit on primary type material. Often museums will only allow a few types to be borrowed at one time and will not loan any more until the first loan has been returned. They should usually be returned separately. Very delicate type material should not be loaned.
- Prior permission to be necessary before any use of interventive techniques, for example restoration of damage, genitalia dissection, SEM examination or molecular studies (see Conservation policy, p. 178 and Destructive or analytical use of collections, p. 188).
- Acknowledgements need to be made if the material is used in publication.
- It is advisable to add an ownership label to the specimens (p. 188).
- Loans are usually made to a researcher working in an institution, not a private address, and loans for students are usually to their supervisor.

- The loan should not be forwarded on by the borrower to another person.
- No documentation connected with the specimen should be destroyed. for instance collecting and old identification labels should remain on the specimens (see Destructive or analytical use of collections, p. 188).
- Specimens must be kept in correct environmental conditions.

Loan forms

All loans should be accompanied by a dispatch form, which should include the recommendations listed below. Walker and Crosby (1988) give an example of the form used in the New Zealand National Arthropod Collection. Consideration should be given to keeping records on a computer database. In designing a dispatch form or loan form, the following should be considered:

- Usually a form should have several copies, one of which can be signed on receipt and returned to the lender. One copy or a letter should be sent by separate mail, to notify the borrower that the material is on its way.
- The form should specify the number of specimens, their general description and their form of preservation, for example dry, in spirit etc.
- The form should provide a concise set of conditions (see above) to which the borrower agrees to by way of a signature.
- The form should have a tracking number.
- In some countries, specimens, particularly primary types, require export certification information. Provision should be made for this.
- There should be an entry on the form to record that the specimens have ultimately been returned and, very importantly, placed back in the collections.
- Instructions should be given on how to pack and return the specimens. For instance, what sort of packaging material to use, or how to fasten down the platform on which the object is mounted.

Transporting specimens

Great care is needed when packing specimens for transport and this operation should be handled by a skilled person with experience of dealing with delicate specimens. Natural history specimens vary so much in structure and size it is difficult to make general recommendations here. Specific recommendations are given in the appropriate chapters of this book. Important points to consider are:

- All specimens should be handled as delicate and unique objects and should be packed with the utmost care.
- Copies of all necessary documentation must be included with the specimens (the dispatch form, permits etc.).
- Usually specimens should be sent by airmail or express services. Courier services should be used if sending a parcel from, or to, a country which has an unreliable postal service.
- Avoid using very attractive stamps on parcels. These are an open invitation to some postal workers to interfere with the parcel, perhaps even removing it from the system altogether.
- Remember that customs officials and agricultural officers have a professional interest in the parcels entering and leaving a country. It is important to ensure that the specimens are packed in such a way that the officials can see the object easily and not destroy the specimens in the process of performing their duty. Many entomologists, for instance, have adopted the practice of covering a box of pinned insects with clear plastic film before adding the lid.
- Ensure that the outside of any packaging is labelled with some form of notice such as `fragile' or `handle with care'.
- If material is to be hand carried, make sure that the courier is aware of the delicate nature of the specimen(s). Material carried in hand baggage should be as well protected as that sent through the post.

Returned loans

Equal care and attention is necessary on the receipt of returned loans. Too often there are horror stories of long-lost loans being found in cupboards or basement stores. It is recommended that a regular check is kept on returned loans to ensure that parcels are not left neglected on a person's desk. In spite of

an instruction on the form stating to whom the loan should be returned, a borrower will often address the returned parcel to a colleague, especially if there has been a considerable interval between the dispatch and return of the specimens. There is little one can do to prevent this except to include a self-addressed adhesive label with the form which provides a quick and easy method for the borrower to use. In some institutions, especially those adopting an integrated pest management system, incoming parcels are subjected to a quarantine procedure before entering the collection area (see Chapter 8 on pest management, prevention and control). Warnings should be given if the material is likely to be damaged by freezing.

Borrowed specimens

While the institutional responsibility of caring for borrowed material should be quite clear, there have been many instances where only the sudden death or retirement of a researcher has led to the discovery of loans from other institutions tucked away in a room. Checks and balances at this level are seldom carried out. Moreover, the specimens are often incorporated into the researcher's own collection. It is clearly the responsibility of the institution that loans the material to ensure that all specimens have ownership labels attached before they are dispatched. This should ensure the eventual return of material, even if other systems break down. For instance, when an orphaned collection was presented to the New Zealand Arthropod Collection, one of the authors of this chapter was able to return important specimens to two institutions in Australia after a gap of almost forty years solely on the basis of their ownership labels.

Some institutions make it a policy that all documentation relating to borrowed material is kept in a central file but this becomes very cumbersome with large institutions who often consider it the responsibility of the individual researcher.

Destructive or analytical use of collections

The detailed examination of natural history specimens often involves invasive techniques such as dissection. Moreover, the preparation technique itself may also be regarded as invasive and subsequent treatments should always be subject to careful consideration. Techniques such as cleaning, staining and sectioning are regularly carried out on natural history specimens, often with very little regulation. With the advent of modern techniques, such as molecular studies, specimens are subject to an increasing range of processes, some of which involve the destruction of part or all of the specimen. Although these techniques should not be actively discouraged, it is important to justify any treatments.

When considering specimens for destructive or analytical purposes, the following points should be considered:

- Can the same objective be achieved by a less invasive technique?
- Are the results likely to justify destruction of part or all of the specimen?
- Is the specimen to be studied expendable or replaceable? If possible select one of a series of specimens with the same data.
- If parts of the specimen are to be removed, ensure that these are adequately cross-referenced with the remainder of the specimen.
- Where possible, removed parts must be preserved using archival materials (e.g. slide mounts of dissected parts).

Health and safety

In many parts of the world there is an increasing awareness of health and safety issues and the observance of rules and regulations. Often regulations may seem unnecessary to the person who has to comply with or enforce them but it must be borne in mind that, although regulations are laid down for the protection of personnel, there is often an indirect benefit to the collections. For instance, in the UK some fumigants have been restricted in use and this has forced institutions to reassess their pest control procedures. Instead of the routine replacement of a fumigant such as naphthalene (which is only partially effective against pests and may have damaging side-effects on specimens — see comment p. 189), integrated pest management systems have been put in place, including monitoring and quarantine

procedures, which will ultimately provide much greater protection for collections. In other cases the benefit to the collection is even more direct. For instance, adherence to health and safety procedures may avoid a major disaster such as a fire or explosion. In some countries, particularly those where health and safety procedures are a legal requirement, there have been considerable shifts in budget priorities to the point where new and safer storage facilities have priority over other institutional spending. In some cases, money has even been reallocated to provide for new buildings.

Many aspects of health and safety are referred to throughout this hook but the following problems and procedures are common to all natural history collections. When health and safety issues and procedures are being considered, Richards (1994) presents a useful overview of the subject.

Problems

Many problems are related to the control of pest attack by way of insecticides and fungicides, or the preparation, handling and storage of collections in fluid. Herbarium collections, for example, often utilize a very wide range of potentially dangerous chemicals. Bridson and Forman (1992) list carbon tetrachloride, carbon disulphide, para-dichlorobenzene, naphthalene, mercuric chloride, methyl bromide, cyanide, DDT, pyrethrum, Guardite gas mix, phenol, camphor, lauryl pentachlorophenate in xylene or white spirit, and lindane. In many other areas of natural history preservation, early techniques involved the use of highly toxic materials such as arsenical and mercuric compounds and residues of some of these substances may persist for centuries. For this reason, older specimens must be handled with caution, using protective gloves where necessary. Those who suffer from allergies should also be aware that certain plant and insect hairs or scales can still cause allergic reactions long after the specimens have been collected.

Para-dichlorobenzene has been widely used as an insect repellent in collections and was often applied in solution and soaked into insect store-boxes and cabinets. However, by the 1960s this chemical was recognized as a dangerous substance (although its carcinogenic properties may have been overestimated) and it was largely replaced by naphthalene. Now naphthalene is banned or restricted in some countries and its use is not recommended. Both of these substances are liable to crystallize on specimens and may dissolve fats (Furth, 1995).

Before their harmful side-effects were recognized the organochlorines, DDT and lindane. were used in collections. They were used as a powder and liberally scattered about in drawers and containers and sometimes even on open shelves. Large residues of these substances still remain in some collections and caution needs to be exercised when opening old containers or cleaning old and dusty collections. Removal of such substances using ordinary vacuum cleaners is not recommended unless special filters are used to trap fine particles which will otherwise be released into the atmosphere. Levels of lindane and pentachlorphenol (PCP) have been significantly reduced using the Thermo Lignum heating and extraction system (Von Rotberg *at al.,* 1997).

Methyl bromide, probably the most widely used fumigant in collections, is highly toxic to humans and is now considered to be an occupational carcinogen. Its use is already restricted in some countries and is likely to be banned in many more in the near future. This fumigant also causes damage to collections by degrading materials containing sulphur. Other fumigants have also been banned or called into question for similar reasons, so that anoxic treatments (carbon dioxide and nitrogen atmospheres) are becoming a viable alternative (see Chapter 8 on Pest management, prevention and control). Walker and Crosby (1988) caution against leaving any plastic insect-rearing containers where fumigation is taking place as some vapours react with the plastic and the fumes given off over subsequent weeks can kill insects being reared in the containers.

In collections that are being actively curated and researched, it is important to set aside isolated areas or laboratories where potentially hazardous operations can be carried out with maximum safety. For example, whenever curatorial procedures such as sealing jars and preparing microscope slides involve the use of hazardous solvents they must be carried out under a fume hood.

Fluid collections present many hazards, not least of which are heavy glass specimen jars which may be over a metre tall (Plate 31). These are often stood on the floor where they may be broken or knocked over and are at even greater risk when being moved (Clarke *et al.,* 1994) (Plates 32 and 33). When handling such large glass containers, protective aprons and leather wrist and forearm guards should be worn. Only experienced personnel should be allowed to handle such material. Suitable clothing such as laboratory coats or overalls should always be worn when dealing with fluid collections and protective goggles are recommended when specimens are being handled or fluids changed. The dangers of formaldehyde are well known (Pabst, 1987).

Ultrasonic cleaners are often used to clean specimens and these machines must be used with caution. The high intensity vibrations produced are capable of destroying human tissue, and repeated exposure can lead to permanent loss of hearing. Machines should be covered or suitable ear protectors worn to comply with health and safety regulations.

Examples of other health and safety issues common to many natural history collections are those associated with the use of cryogenic liquids, gas cylinders, autoclaves, hazardous chemicals, radiological equipment and ultraviolet radiation. These, and any other health and safety issues, including those involved in field work, must be carefully considered and procedures must comply with national regulations. In countries where there is no health and safety legislation or where legislation appears to be inadequate, advice on appropriate procedures should be sought (see Policy below).

Caution must also be exercised when handling incoming material, particularly when opening incoming crates and parcels. Staff must be aware that pesticides might be present, glass vials may be broken and unknown fluids leaking, or biohazards in the form of infected material (Irvin *et al.,* 1972) or even venomous livestock may be present. A staff member at The Natural History Museum in London recalls what could have been a particularly serious incident when he opened a badly packed parcel containing a broken glass vial. This seemingly everyday event transformed itself into a crisis when the accompanying letter revealed that the vial had contained a living scorpion for identification! Fortunately the escapee had tucked itself into a corner where the franking machine had conveniently squashed it.

Policy

All institutions should have a carefully thought out health and safety policy for the protection of those working with collections, taking into account all of the problems referred to above. This should include the issuing of health and safety instructions and recommendations in the form of manuals, information sheets, notices and posters, drawing attention to hazards and setting out procedures. It is important to ensure that staff and visitors alike are aware of these procedures. Training courses should be provided in both general and specific (e.g. lifting heavy objects or dealing with hazardous substances) aspects of health and safety. Every effort should be made to identify hazards so that accidents can be avoided.

A number of countries have legislation in force which will form the basis of health and safety policies. In the UK, the Control of Substances Hazardous to Health Regulations (COSHH) came into force in 1989 (HMSO, 1988). These regulations require risk assessments for exposure to any substances potentially harmful to human health. Written risk assessments may also be required for any procedure that is considered to be hazardous.

Many day to day occupational hazards may seem trivial in the context of collections, but tiredness and lack of concentration due to poor working conditions can lead to mistakes and accidents. A good working environment with correct lighting and with work benches and seating at correct levels will not only contribute to more efficient work but will also help to avoid eye-strain and other physical problems. This applies particularly to those who spend long hours working with computers, microscopes and similar equipment. Eating and drinking and smoking in collection areas should not be permitted.

However effective the policy, accidents will happen and it is important that emergency procedures are in place to deal with them. Telephone numbers for local first aiders and emergency services should be easily available. First aid kits should be held by those trained

in their use and laboratories should have their own emergency stations, including such facilities as those for emergency washing of eyes. The details of all incidents should be logged in an accident book.

Security

Most of the major risks associated with the security of collections are documented above under Collections risk assessments and Disaster planning (see pp. 178-179). However, all personnel associated with natural history collections ought to be aware that there is often a monetary value attached to 'collectable' items in natural history collections, from rare mammals to birdwing butterflies and birds eggs. Although stories of insects being smuggled out under the top hat of a visitor and a coat specially adapted to conceal birds' eggs may sound amusing, serious thought should be given to the security of specimens.

Many institutions, particularly museums, have a policy which discourages staff from keeping their own personal collections, thus eliminating the temptation for staff to acquire specimens surreptitiously for their own purposes.

Visitors should be carefully supervised, a record kept of their visit and guidelines on collection handling issued (see Good practice in collections use, p. 178). No matter who is working on the collection, whether visitor, researcher, curator or consery ator, a procedure should be in place and one person should be responsible for a final check at the end of the day. Points to consider are:

- All specimens should be returned to a secure place.
- Cabinets should all be locked.
- Blinds should be drawn.
- Windows should be closed
- Ensure unessential electrical plugs are removed.
- All lights should be turned out.
- Doors should be closed and locked.
- The security system should be set in place.

As a matter of course, all computer systems should have pass codes and accession registers and other archival documentation should be securely locked away at the end of the day.

Routine gallery security measures should play a major part in preventing deliberate damage to collections, but accidental damage is more of a problem. Extra vigilance and security should be in place when contractors are working near collections. The temptation to open cupboards or drawers to peek at specimens is sometimes overwhelming for a worker and extra liaison should be set in place between the security staff and curators. Where specimens may be at risk from accidental damage by contractors or other workers, it is advisable to have a security officer present. For example, it was brought to our notice shortly after photographing the giraffes covered in Tyvek in the basement of The Natural History Museum (Fig. 1.8, p. 17) that contractors, thinking the Tyvek was a spare piece of material, removed the covers from the giraffes to use as a protective measure on some other job.

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