Natural History Collections Division:

Terrestrial Invertebrate Collection

Collection Management Manual

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Compiled by

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Contents

1. Introduction and objectives

Point 9.4 of the Collections Policy for the Natural History Collections states that a Collection Management Manual must be kept for each collection. This manual provides the necessary detail on the procedures needed to comply with the Collections Policy in managing the Terrestrial Invertebrate Collection. It has also been compiled to provide sufficient detail for a new staff member to understand the collection and know what to do under particular circumstances. The manual takes a preventative conservation approach i.e. by being proactive in implementing procedures that lower the risk to the collections. However, it also covers procedures for emergency situations, should they arise.

2. History of the Terrestrial Invertebrate Collection

oIntroduction

Terrestrial invertebrates include the class Arthropoda, which includes insects, spiders, mites, and their relatives. The Arthropoda is probably the most successful group of organisms on the planet, the insects (Hexapoda) alone accounting for about 55% of all species known to science. The terrestrial arthropods inhabit every terrestrial habitat and have influenced and continue to influence the evolution and maintenance of biotic communities. They are pollinators, predators, parasites and prey. They play a vital role in the processing and recycling of organic material on the planet as they chew and suck their way

through organisms - living and dead, plant and animal. They are vital to the food chain of both vertebrates and invertebrates and therefore impact heavily on man.

The study of insects and their relatives is therefore important in mans' attempts to preserve and enhance environmental quality, enhance crop production and quality, manage human health and build commercially viable economies. Pest species can result in enormous crop losses and ill health while other species can enhance man's activities and well being. Pollinators ensure the production of crops and parasitoids and predators help control pest species. Some species are even of pharmaceutical value. While mostly regarded as pests they are the biocontrollers of the planet and play both a positive and negative role in the lives of humans.

Plants and animals easily attract more attention from the general population while the importance of insects as part of our support system is largely overlooked. Society poisons them indiscriminately, crushes them or ignores them. Each species has a function and a place in nature's intricate web - it deserves to be here, it earned its place, it survived the journey of evolution.

The arthropod collections in the entomology department are research collections, used by scientists both locally and abroad and a loan programme serves their requirements. The scientists working at the Museum are primarily taxonomists and systematists. Their business is discovering new species, species associations and ecological relationships. Their findings are then described and published and this data can be used in heritage data networks. South Africa is a signatory to the 1992 United Nations Environment Programme's Convention on Biological Diversity in Rio de Janeiro and is obliged to make a contribution to the conservation of biodiversity. Providing data from our research and collections is one way in which this can be achieved. As the planet's biodiversity is more and more threatened, so the collections and associated data, housed in natural history museums, become more important. It is vital that these collections are maintained and conserved to serve this vast and daunting task of conserving the remnants of our living heritage.

Natural history museums collect, house and conserve collections that can be used to study and discover, display and educate, and inspire and entertain within the realms of the natural world. Everything is now aimed at serving the cultural needs of society and bolstering the social fabric. New words to describe an old business. Nothing has really changed. The only difference perhaps is that the problem which has always prevailed, has grown. The gap between the informed and uninformed has widened and the only solution, as it has always been, is education.

While the above is true, natural history museums must now take on greater responsibilities of education, research and collection management. Our accountability is no longer limited to appeasing and informing the daily visitor. The scale of accountability is now global. It has been predicted that, at the current rate of habitat and species destruction resulting from human population growth, civilisation will have disappeared by the end of the next century - "not with a bang but a whimper".

To conserve what we have, we must know and understand what we have. We need to know identities, distributions, numbers, understand ecological and biological relationships and many other aspects of the natural world. Natural history museums have vast holdings of collections and data that can serve to assist with this huge task of information management for conserving the planet's heritage of biological diversity

The collections have been assembled by scientists over the decades. They originated out of research, what is gained from them is through research and they should continue to grow because of research. Physical access to the collections by the public has always served, and will continue to serve, educational and other cultural needs but the most important access to these collections is by the scientists and through the knowledge gained from research, both directly and indirectly (e.g. conservation, medicine, agriculture, etc). While drawers of dead animals can be opened and displayed by teachers and collection staff, it is through research by the scientist that opens windows of knowledge.

In the past, the entomological collections clearly suffered as a result of the absence of standardized methods and procedures to provide the continuity of care that the biological collections require. Each generation of collection staff has both solved and created collection-related problems. This manual is aimed at eliminating the latter by attempting to record the history of collection management as accurately as possible and provide some continuity thereby eliminating the possibility of errors being repeated. As new information becomes available the manual will be revised accordingly.

Conservation and collection management of natural history collections is still a developing science and collection staff should attempt to stay abreast of new developments. Iziko South African Museum is a member of the Society for the Preservation of Natural History Collections (SPNHC) and subscribes to the journal *Collection Forum* which publishes papers on the latest conservation issues.

While this manual was prepared from an entomological perspective, it can be applied to most of the biodiversity collections at Iziko. This manual does not provide information on entomological specimen collection and preparation techniques as that information is abundantly available in many other specialised publications. (Londt 1986, Smithers 1982, Uys & Urban 1996). See also http://www.ars.usda.gov/Main/site_main.htm?docid=10141&page=1&pf=1&cg_id=0.

o Staff

(Partially extracted from *Report on the Entomological Department Collections in the South African Museum and Proposed Plan for their Reorganisation* by H. G. Robertson. December 1990).

Although there were insects at the Museum from its earliest days, it was really only when Roland Trimen first became involved with the Museum in 1866 that the Museum's insect collection had its inception. Trimen laid the foundation of butterfly research in South Africa and his three volume work, *South African Butterflies*, published from 1887 to 1889, is highly regarded. Although most of his

primary type material was deposited in the British Museum (Natural History), we still have a substantial number of butterflies dating back to his period. The earliest specimen we know of in the collection is *Amauris (Amaura) echeria echeria* (Nymphalidae). SAM-LEP-A014355. Collected in Knysna, S.A. in 1858 by R. Trimen.

During Trimen's era, Louis Péringuey began work at the Museum as a clerical assistant. He worked his way up, and in 1906, became Director of the Museum. Péringuey was not a trained entomologist but had an enthusiastic interest in beetles. Just as Trimen had laid the foundation of butterfly research in South Africa, so did Péringuey for South African beetles. Although Péringuey did not deposit his type material in foreign museums, he did have a private collection that was bought by the University of Pretoria after his death and eventually donated to the National Collection of Insects. Although the Museum does not hold all of Péringuey's types, it still houses a valuable collection of beetles resulting from Péringuey's work.

During most of Péringuey's period of service at the Museum, Robert Lightfoot acted as a clerical/scientific assistant and amongst other activities, was a prolific collector of insects and other land invertebrates.

W. F. Purcell started working at the Museum in 1896, marking the beginning of the arachnid and myriapod research at the Museum. This research was continued by R. W. E. Tucker, R. F. Lawrence and R. H. N. Smithers, and ended only in 1935 when Smithers resigned.

Dr. A. J. Hesse began work at the Museum in 1924, overlapping with Péringuey by about a year. When he began the job, he was well qualified as a parasitologist but had no entomological training. Hesse holds the record as the longest serving member of staff in the Museum having worked here for 51 years. He reached retirement age in 1955 but was employed for 19 years after this, only leaving the Museum in 1974. Hesse's main research interest was flies and he published some large revisions of the bombyliids and mydids. He also did a great deal of fieldwork in conjunction with C. W. Thorne and H. Zinn who were general technicians at the Museum.

During the Hesse period, H. G. Wood worked as an honorary entomologist and produced a monograph on the crane flies of the south western Cape. K. H. Barnard, although employed as a marine biologist, made a substantial contribution to entomological research in the Museum, producing some important papers on endemic insects of the Cape, such as one on mayflies and another on *Colophon* beetles.

S. H. Skaife was a trustee during the 1940s, 50s and 60s and although well known as an entomologist, there are no records of any outstanding contribution made by him to the Entomology Department other than some specimens he donated.

H. Andreae was a beetle enthusiast who worked in an honorary capacity during the 1940s, 50s and 60s. Besides the collecting he did, he also identified huge numbers of beetles in the collection.

F. W. Gess, worked at SA Museum from 1959 to 1968 and then move to the Albany Museum in Grahamstown. Besides doing general curatorial work, he conducted an interesting study of *Protea* associated insects.

Near the end of the Hesse period, I. T. L. Pearse, C. J. Taute and T. J. D. Coates worked in the Entomology Department for brief periods.

In 1971 A. J. Prins was appointed, later to retire in 1989. His main interests were ants and forensic entomology but he also had a very good knowledge of insects that was usefully employed answering entomological queries by the public.

In 1973 Dr Vincent B. Whitehead took over as Head of Department and Dr Hesse retired the following year. Dr Whitehead retired in 1988 and continued working until 2002. His research mainly concerned ladybird beetles and bees, more specifically oil-collecting bees, Melittidae and Fideliidae.

In 1989, Dr Hamish Robertson was appointed as the new head of Entomology. The Entomology Department operated as a separate section until October 1993 when the departments of Entomology, Marine Biology, Herpetology and Ornithology amalgamated and became the Division of Life Sciences with Dr H. G. Robertson as the Head of Division. Dr Simon van Noort was appointed in 1992. The research staff complement was made up of Hymenopterists. Dr Whitehead worked on bees, Dr Robertson worked on ants, more specifically *Camponotus* and Dr van Noort worked on wasps, mostly parasitic wasps and fig pollinators. In 2005, Nokuthula Mbanyana was appointed on contract as a trainee scientist and worked with Dr Robertson on the Formicidae.

Helen Rae assisted Dr Whitehead for a few years until about 1981 and Amanda Roux assisted Dr Prins for a short time until his retirement in 1989 when they married and he retired. Mrs Cathy Carr was an arachnologist and worked for a brief period in the 1980s until she and her husband emigrated to Australia. Gerhard McShane worked as a technician fro a short period from about 1990 to about 1992. Mrs M. A. Cochrane (neé Macpherson) was employed in 1982 and became the collections manager and Mrs Dawn Larsen was employed in 1992 and became the assistant collections manager. Her husband, Norman Larsen, is an amateur arachnologist and his extensive knowledge has assisted the department over the years. Many technical assistants were employed on contract to assist with processing vast amounts of field material collected by Drs van Noort and Robertson. The longest serving is Aisha Mayekiso. Originally she worked on material collected by ant specialist, Dr Brian Fisher, of California Academy of Science while based at SA Museum.

See Annexure 7 . Chronology of the staff at the South African Museum who have been involved in Entomological activities.

oCollection history

The Entomology collections house over a million dry insect specimens, nearly 25000 bottled Insecta, Arachnida, Myriapoda, Onychophora, Acarina and about 2600 microscope slides. There are nearly 9000 type series, over 7200 of which contain primary type material. While the collection is relatively small by world

standards, it is a very valuable collection in that it is rich in type material and is representative of the threatened and unique fynbos biome.

In 1981 the South African Museum received the Hymenoptera collection of the Bulawayo Museum in exchange for their Zimbabwe birds. This was a highly contentious exchange that caused considerable ill feeling among entomologists and which resulted in the resignation of most of the entomological staff at the Bulawayo Museum. The exchange was conducted at a high level between the South African and Zimbabwean governments and entomologists had little to say in the matter. This collection has now been fully integrated with the South African Museum Hymenoptera collection and bear blue labels stating the donor.

In about 1988 it became clear that the arachnid collection was impossible to use as there were multiple vials of different accession numbers in a single jar. M. Cochrane and A. Roux commenced rebottling the collection, placing each accession number in a vial or jar of its own. In the old storage system many accessions were crammed into a single jar resulting in damage to specimens and a collection that was impossible to use. During re-bottling each sample was separated and checked and re-bottled into its own jar or vial. This re-bottling was finally completed in 1992 and the computerization of the data completed in 1996. Those involved with this task were G. McShane, M. Cochrane and D. Larsen.

Soon after he started work in 1989, Dr Robertson conducted an analysis and evaluation of the dry insect collections and listed the entire collection to genus level. This, and the restructuring of the budgeting system in 1989, marked the beginning of the major reorganisation programme. In 1992, H. Robertson, M. Cochrane and M. van der Merwe (Marine Biology collections manager) attended the International Symposium and First World Congress on the Preservation and Conservation of Natural History Collections in Madrid. Dr S. van Noort was appointed shortly afterward and all these events marked the beginning of a new era of collection management for the South African Museum Life Sciences collections.

The re-organisation of the dry collection began in earnest in 1993. Over the years the shortage of space had resulted in the collections becoming dissociated and disorganized and about 45 per cent of the dry material had been stored in old field boxes. Re-organisation of the dry collection involved sorting the material into series groups (material with the same collection data) into the unit tray system and each series was then numbered and later computerized. Those involved with the re-organisation were H. Robertson, S. van Noort, V. B. Whitehead, M. Cochrane, D. Larsen and G. McShane. In the early stages the department also had the help of voluntary workers; Mrs G. Wheeler re-organised the Bombyliidae (Diptera) and part of the Nymphalinae and Mr T. Brinkman re-organized the Hesperiidae and Charaxinae, and Mr A. Heath assisted with the Lycaenidae.

By July 1997 the Hymenoptera collection had been re-organized and all, but the Sphecidae, computerized. Other groups re-organized but not computerized were; the Diptera, of the Lepidoptera the Lycaenidae, Hesperiidae, Nymphalinae and Charaxinae; and of the Coleoptera the Carabidae to the Lucanidae, Tenebrionidae, Coccinellidae and Buprestidae and of the Scarabaeidae the Cetoniinae, Aphodiinae, Hopliini, Dynastinae and Troginae. This resulted in the

contents of 61 per cent of the field boxes being integrated back into the collections.

By August 1998 the remaining uncomputerized Hymenoptera had been computerized and M. Cochrane completed the re-organisation of the Scarabaeidae, Cossyphodidae, Clambidae, Byrrhidae, Dryopidae, Elmidae, Heteroceridae, Limnichidae, Eucnemidae, Throscidae, Elateridae, Cantharidae, Prionoceridae, Drilidae, Lampyridae, Lycidae, Dermestidae, Anobiidae, Ptinidae, Bostrychidae, Lymexylidae, Trogossitidae and Cleridae and D. Larsen had re-organised the Cicadidae (Hemiptera), Embiidina, Psocoptera, Plecoptera, Thysanoptera, Mecoptera and Neuroptera. By this time, 74 per cent of the field boxes had been integrated back into the collections.

In 1990 the collection was housed in 44 cabinets and by July 1997 they were housed in 74 cabinets (3026 drawers). By August 1998 there were a further 6 cabinets (300 drawers) that had already been filled and the department was once again needing more space for the re-organisation program. By the end of 2006 all that remained for reorganisation was the completion of the moths at which stage the collection was housed in 5028 drawers in 115 cabinets.

3. Size of collections

Collection	No. samples accessioned	No. samples unaccessioned	Year counted	Method of counting
Dry insect collection			2006	
Blattodea		541		Accession number labels
Coleoptera	25 469	65541 -25469 = 40072 + undet material		Database/accession number labels
Diptera	13 798	+ Undet material		Database
Embioptera		18		Accession number labels
Ephemeroptera		408		Accession number labels
Hemiptera – non Cicadidae	2 883	8 577 -541 Cicadas -2883 = 5133 + undet material		Accession number labels and database
Hemiptera- Cicadidae	541			Database
Hym - ants	19 405	+ Undet material		Accession number labels
Hym - Wasps	45 852			Database
Hym -Bees	8 983	+ Undet material		Database
Lepidoptera – butterflies	14 554			Database
Lepidoptera - Moths (not reorganised)		30 000		Rough estimate
Mantodea		618		Accession number labels
Mantophasmatodea		11		Accession number labels
Mecoptera		64		Accession number labels
Megaloptera		18		Accession number labels
Neuroptera	1230	150		Database/accession number labels
Odonata		1279		Accession number labels
Orthoptera		4966		Accession number labels
Phasmatodea		220		Accession number labels
Plecoptera	29			Database
Trichoptera		228		Accession number labels

Total	**132 744**	**83 726 ++**	2006	
Alcohol collection				
*Ants	**10 379**			
Arachnids	18 346	+Undet material		Database
Chilopoda	1 082	+Undet material		Database
Diplopda	830	+Undet material		Database
Onychophora	147			Database
Alcohol insect collection		2000		Rough estimate
Alcohol passive collection bulk samples		1000s		Rough estimate
Total	**30 784**	**1 000s ++**		
Grand total	**163 528**	**83 726 + 1000s**		

*(Includes: Back wall: Regina 6230, black tops 2728, 633 misc. Side wall: 788)

4. Collection areas

Room no.	Name of collection area	Contents	Floor area (m^2)
EN202	Wet/alcohol collection	Arachnida, Myriapoda, Onychophora plus insects	51.32
EN206	Dry insect collection	Hexapoda	134.14
EN209	Safe	Alcohol, arachnid type and general store	7.30

5. Acquisitions

- Aim and scope

All material placed into the collection is acquired through either donations or collections made by Iziko research staff or research staff from other institutions. The main taxonomic focus is Hymenoptera and the geographical focus area is sub-Saharan Africa although general African material that relates to the taxonomic focus is also collected/accepted. All material must bear the relevant collection data and be in a sound condition. Some overseas specialists offer exchange material but this is avoided unless what is offered complements the research focus.

- Required levels of preparation of donated material

Material accepted for the collection must be in a satisfactory condition and must be labelled clearly with all collection data. The ideal donation would be material that is in an excellent condition, bears accurate, neat data labels and is identified to species. However, most incoming material is not at this level of curation.

In some cases donors provide unidentified material with no data labels, only numbered specimens with an accompanying data list. This will only be accepted if the material is of great value as we cannot afford the time required taken to label unlabelled material.

Each sample/specimen must bear data such as locality (preferably with co-ordinates), date, collector and other relevant information such as host plant/animal, habitat and other biological associations that are known.

A specimen or sample with no data is of no research value but might be retained for educational purposes.

For preparation, see 5.3 below.

oProcessing of new acquisitions

All incoming material must be processed immediately to a level where the material and data are accessible in the future.

This manual does not include the entomological techniques for collecting, pinning and setting specimens. These methods can be found in abundance in various publications (Londt 1986, Smithers 1982, Uys & Urban 1996).
See also
http://www.ars.usda.gov/Main/site_main.htm?docid=10141&page=1&pf=1&cg_id=0.

Incoming material received for the collection could be at any of various stages of preparation.

a. Dry material that is set and labelled adequately.
b. Material that is in alcohol vials and labelled adequately.
c. Dry material that is set but not accurately/adequately labelled.
d. Material that is in alcohol but not accurately/adequately labelled.
e. Material that is freshly collected and not set and labelled. A public enquiry is usually included in this group. See public enquiries below.
f. Material that has been collected in alcohol or glycol and is acquired in bulk sample jars. This is usually material collected on field trips using passive collection methods such as Malaise traps and pan traps.

Preparation levels of incoming material

Stage of prep	Extract/ Sort into required taxa	Prepare/ mount	Place into SAM vial	Apply SAM data label	Allocate accession number	Record in accession book and number the sample	Treat for pests	Add to data-base if applicable
a					X		X	X
b			X	X	X	X		X
c				X	X		X	X
d			X	X		X		X
e		X		X	X		X	X
f *	X	X	X	X	X	X	X	X

* This material could remain in alcohol or be removed set and dried for the dry collection.

Public enquiries.
This material is usually in the form of a single specimen or sample and might be acquired as a query from a member of the public or a health department official where identification is required with some information on the biology of the animal. Once the identification has been reported, the enquiry is written into the 'Incoming Material' book where all details pertaining to the enquiry are registered (Number, date, Source, Contact Details, Reason, Taxon, Reported/Acknowledged). The sample is then treated as per the above.

6. Access

All visitors must notify collection staff in advance of an intended visit. Permission is usually granted unless the visitor has poor credentials or reputation with regard to poor collecting ethics and handling of museum material.

o Visitors

- Researchers and students from museums or universities, both local or abroad. Unknown research visitors need to send a letter bearing letterhead of their institution.

  Students from museums of universities require a letter of introduction from his/her supervisor. Sometimes, a researcher or student might arrive without prior warning and request to use the collection. This might be allowed if the person is known to collection staff. A brief conversation with the visitor will establish the authenticity and credentials.

  However, sometimes an unknown student or researcher might request access to the collection with no real objective and wanting ‘to look’ at the collection. This is not sufficient reason to grant access. It has happened that such requests facilitate indiscriminate collectors gaining access to locality data to inform a field trip to collect rare and threatened species.

- School and other groups for a Behind-the-Scenes tours. Access is usualy via the Education and Public Programmes division. Groups are limited to 10 -15 individuals as one cannot monitor their activities if the group is larger.

- Film crews, artists or photographers. Access is only if their visits do not pose a threat to the collections. Arrangements must be made in advance with collection staff and a fee agreed upon.

oVisitor supervision and care

Researchers and students with valid credentials are allowed to work unsupervised in the collection. While equipment such as microscopes are provided, visitors must provide their own pens, forceps etc.

- All other individuals or groups are supervised at all times.
- All bags must remain outside the collection.
- A register of visitors must be kept.
- Cabinet COL08 (*Colophon* beetles) is kept locked when not being used.
- Staff will be cordial, polite and helpful at all times. Research visitors will need assistance with regard to use of equipment, use of the library and other facilities.
  However, it can happen that certain visitors make continual and excessive requests, preventing collection staff from focusing on their work and this would need to be addressed appropriately.

- Collection staff should advise the director of any visitors if they think it relevant.

oCode of conduct for visitors

See Annexure 2.

7. Loan management

There are 3 aspects to loans. Loans sent, loans being returned and incoming loans made by researchers at Iziko.

oAims and objectives

Loans form an essential part of systematics research, both locally and abroad and a large portion of collection management is dedicated to loan administration. Scientists working on a specific group of insects require all the relevant material associated with their research project, and hence request loans from the institutions where the material is housed. Not only do loans facilitate the research process, but also collections are continually upgraded and their value is increased due to identifications that are done during the research process. An identified collection is an accessible collection and one that can be used to provide a service.

o Scope

Loans are to be given priority for the sake of good relations, and should be despatched promptly and according to a loan procedure.

Process the request.

- Check credentials of the borrower.
- Check if we have the material and if the institution is prepared to send it if it is valuable.
- Send the borrower the loan contract/agreement for signature
- Prepare loan package and loan documents
- Get documents signed by director and curator and include with parcel. If the borrower is visiting, the forms are signed and a copy left with the collection manager.
- Send reminders according to the schedule

oLoan agreement/policy. See Annexure 1.

In the entomology collection, the loan policy forms the basis of the loan agreement and the name of the borrower and the loan number is merely included. By using the policy as an agreement, borrowers are forced to acquaint themselves with the loan policy. This is sent to the borrower once it is decided to send a loan. The form is faxed and the borrower is requested to sign and return by fax. In the case of a student borrowing material, the supervisor is also required to sign it.

Once the borrower receives the loan (either in the post of when visiting the collection), the loan requisition forms are also signed and a copy returned to the collection manager as proof of receipt.

oTransport of loaned material

Loans are sent and returned either by hand or by a courier service and all costs are covered by the borrower. This must be clarified before the loan is made and included in the agreement. In the past, loans were sent by airmail post, usually registered. However, due to theft and losses, this was stopped in about 2002 and courier services used instead.

oManagement of loans

Before a loan is made, the borrower's credentials must be checked if the person is not known. One can enquire at other institutions or do a search on the internet. It is also useful to refer to old loan records. One must know the scope of the research for which the material has been requested. The borrower must be at a recognised institution and if a private borrower, a recognised institution must be prepared to manage and take responsibility for the material. Borrowers who are known dealers do not qualify for a loan.

Loans are usually made for a period of a year but when the loan is small and includes type material, it is reduced to 6 months. In some cases only 3 months is granted.**.1 Loans**

If a borrower requests a second loan before returning the first, this must first be authorised by the curator of the collection.

- Loan documentation

  See 7.3 Loan agreement. This is sent before the loan requisition documentation.

  A loan number is allocated (last 2 digits of the year followed by sequential numbering, eg. 97001) and the loan is recorded in the loans section of the SAM database. Three copies of the loan requisition are printed and signed by the director and/or curator and collections manager. Two copies (one with the loan policy) are sent to the borrower. One copy of the loan requisition is kept and filed and when the signed copy is returned by the borrower, the two are filed together in "loans out".

  When the loan has been returned by the borrower, it should be checked, acknowledged, treated for pests and returned to the collection without delay. One copy of the loan acknowledgement is sent to the borrower and one is filed in "loans in" file and this is used for the 6-monthly report.

  Once the loan is returned in full, the file is closed and the correspondence filed under general correspondence in alphabetical order.

  Note: Once a loan has been returned in full, the status of the database loan record must be changed from "current" to "old" otherwise one runs the risk of embarrassing oneself by sending a loan reminder for material already returned.

- Computer loan records

  - The early loans were written up in the carbon copy requisition books and are still referred to occasionally. These records were then transcribed to XYWrite, a previously used word processing programme. However, these records sometimes still need to be checked if there is a query and are kept in M. Cochrane's C:/my documents/XY. Most of these loans have been transcribed to SAM database.

  - Records on SAM database. To produce loan documents from this database is frustrating and tedious and needs to be addressed. The database was designed when Word Perfect was in use. When producing a loan document, the programme, CLARION, is only compatible with Word Perfect and first writes across to this programme. The file then needs to be re-opened in MSWord but becomes corrupted. This then requires a huge amount of editing before it can be used. Word Perfect is not a supported programme at Iziko and only the collections manager has a copy on her computer and no further copies will be purchased. This results in only one person being able to produce loan documents.

    The loan invoice is first found in C: eg. C:/lLOANS/L97001I (I for invoice) or C:/LOANS/L97001A (A for acknowledgement). FINAL EDITED LOAN INVOICES MUST BE FILED ON THE SERVER TO: NH database on 'Sam-adc' (L)/LOANS.

- Loaning dry pinned material

  When material is removed from the collection to be sent on loan, an indicator label is pinned where the material was. This indicates to collections users that material is on loan. The label is merely a small (about 10x15mm) yellow handwritten label indicating loan number and borrower's name.

  If the material bears no SAM identification, a label must be applied to eliminate the risk of the borrower confusing the material with that of other institutions. An accession number can be applied or a pre-printed, South African Museum - Cape Town.

  If the material is re-organised (that is, in unit trays), there will be an accession number allocated but in some cases, not attached to the specimen/s. EACH SPECIMEN OF RE-ORGANISED MATERIAL MUST HAVE ITS ACCESSION NUMBER ATTACHED BEFORE IT IS REMOVED FROM THE COLLECTION.

  The material is then pinned in a box with a pinning base, usually polyethylene foam. The specimens are then cross-pinned to prevent each specimen from spinning on the pin thereby damaging itself and specimens around it. Cross-pinning in the usual sense should be avoided for the more delicate winged specimens. These can be secured with pins either ahead of or behind the wings.

If the distance between the pins and the lid is greater than about 5mm, then a sheet of firm foam or card is placed over the top of the pins to fill the space. This prevents pins from coming out of the foam and falling around in the box causing damage.
Once the material is pinned, the box is taped closed or wrapped in brown paper. This is then placed in a cardboard box containing soft styrene foam packing. See Packaging and sending 7.5.7

- Loaning wet alcohol material

As with the dry material, a label is placed in the polystyrene holder in the collection to indicate that material is on loan. A yellow strip can be placed in the vial/jar holder.

Alcohol is regarded by airlines as a safety hazard and alcohol must be kept to a minimum. Most alcohol needs to be decanted from vials and if plastic sachets are used, the specimens is packed with roller towel soaked in alcohol. The reduction of alcohol also reduces the weight. When labelling the parcel a general term o 'preservative' can be used and no reference need be made to 'alcohol'.

Various methods of packing are used depending on the size of the specimens and the numbers involved and the packing method is determined by the best protection of the specimens at the lowest weight/size cost. It is important to pack so there is as little agitation of the specimens as possible. Ensure that the vial or jar is full of alcohol with cotton wool in the mouth. This reduces the air bubble agitation in the container thereby reducing the risk of damage. Some specimens are labelled with metal labels. These are a huge hazard when sent on loan and can result in a specimen literally being chopped up. These metal labels should be removed from the specimen and left behind in the vial.
ENSURE THAT THE SPECIMEN BEARS A HANDWRITTEN REPLACEMENT LABEL AND ENSURE THAT THE METAL LABEL AND SPECIMEN ARE
RE-UNITED WHEN THE LOAN IS RETURNED.

Material can either be sent in the standard glass vials/jars but if there are too many they become costly to send. For a large amount of specimens, the material is removed from the vials/jars and repacked. Smaller specimens in glass vials can be repacked into small plastic vials and larger specimens double sealed into plastic sleeving with alcohol. The sealing is done with a heat-sealer and a good seal must be ensured. This is a good method of packing as specimens are well insulated from shock.

If glass vials are used, they should first be wrapped in roller towel to insulate against shock. These are then sealed in the plastic sleeves and then grouped together securely so they do not bump against each other. The bundle is then placed in a cardboard carton as with the dry material and despatched in the same way.

- Loaning microscope slide material

These are best sent in flat cardboard slide holders. They provide better support than the holder where the slide is only supported at the ends. Many breakages have been experienced with the latter.
A label indicating loan number and borrower is placed in the slide collection when a specimen is removed. Slides are first placed in a slide holder, taped closed and packed in a box with packing and the parcel made up as for wet and dry material. See 7.5.3 Packaging and sending material.

- Loan reminders

Loan reminders are sent annually to borrowers who have had material on loan for a year or more unless the borrower has requested an extension in the interim. Depending on the number of specimens borrowed and the type status of the material, a reminder might be sent within a year. If a borrower fails to respond for 2 years, a reminder is sent to the director of the institution.

Responses to the reminders are then noted on the loan database and the email response filed for future reference. These are invaluable for managing the loans. All email communication must be filed diligently and accurately, as they are always required when the annual reminders are done. One must keep proof of all communication.

Managing loan can become frustrating when dealing with borrowers who are not working on the loaned material are borrowers who are reluctant to return material. When borrowers persist in ignoring your attempts to make contact, one has no option but to communicate with their associates or seniors.

The current SAM database cannot group borrowers by country and institution so a.8 Loaning microscope slide material useful tool is a Word file, see SAM adc (L):/Ento/loans/Loans borrowers and institutions. This is a table that includes all borrowers listed according to country and institution. Borrowers are graded according to their reliability. 0= good borrower. 2+ someone to be avoided at all costs. The table also indicates if there is more than one borrower at a certain institution. Often a defaulting borrower works with another borrower with good record and the latter can be used to get material returned.

- Packaging and sending loan material

Pinned material
The box of pinned material is placed in a box of styrene foam. The size of the box is determined by the size of the box of pinned material. The area filled with the soft styrene foam around the inner specimen box (the top as well) should be about one third to half the length of the box of pinned material. The box of specimens should ‘float’ in the foam in the outer box that should be neither underfilled or overfilled with the styrene foam. Underfilling could result in the box of specimens bumping

the outer box and overfilling will not allow a small amount of movement that acts as a shock absorber in the event of a heavy impact.

Alcohol material
Strict airways legislation now bans the inclusion of substances like alcohol in packages so the amount used must be kept to a minimum and referred to as 'preservative' if queried. Vials of smaller specimens can be plugged using cotton wool saturated in alcohol. Larger specimens such as scorpions can be gently wrapped in roller towel saturated in alcohol and sealed into plastic envelopes using a heat sealer. Enough of an air pocket must be included to prevent the specimens from being crushed under the weight of the others. Double seal in plastic as sometimes leaks develop.

Labelling the package
This box is then taped closed, wrapped in brown paper and sealed with string.

The box is clearly labelled with the sender's and receiver's name, address and telephone numbers (printed with the loan invoice). Also attach a RED label :

F R A G I L E

HANDLE WITH CARE

PRESERVED DEAD MUSEUM INSECT SPECIMENS ON LOAN FOR SCIENTIFIC USE

YIPHATHE NGONONOPHELO

AZINAMBUZANA ZEZWMFUNDISO

AZINAXABISO NGOKWENTENGISO

NO COMMERCIAL VALUE

Property of:
South African Museum - IZIKO Museums of Cape Town
PO Box 61 Cape Town
South Africa 8000
Tel) 021 4813868

NOTE:
The latter label indicates to customs officials at the receiving end that no duty is to be charged and also serves to discourage potential thieves, which is unfortunately a reality these days.

All material is sent by courier (unless hand carried by the borrower). For overseas material, the borrower is expected to pay all the courier costs. This has to be explained to the borrower in advance. The borrower then provides a courier account number against which to sent

the parcel. The tracking number is then sent to the borrower by email. Occasionally, exceptions are made and Iziko pays the courier costs. This applies to situations where the borrower is not supported by funding and the loan will substantially benefit the collection by upgrading with identification of specimens.

8. Collection Preparation and preservation

Once dead, animals and plants decompose through the effects of bacterial action, temperature and humidity. As the process continues, insects move in to complete the process, and, in the case of most animals, reduce them to bones and dust.

Fortunately, these processes can be arrested at the time of collection. However, there are many instances where this is not done and museums have dust, the end product of the process, gracing their shelves instead of fine specimens. Recent surveys of natural science collections indicate that there are about 500 million specimens actively deteriorating in museums worldwide. This can been attributed to poor preparation, incorrect storage, improper conservation techniques, and also a lack of documentation of procedures used.

This is an alarming situation considering the loss of data and the investment of time, knowledge and money. If monetary value alone is considered, the estimated cost of accumulating a collection of 1 million specimens has been calculated at R130 million.

Most collections have taken hundreds of years to accumulate, involving hundreds and thousands of man-hours of field work in areas that no longer bear any resemblance to what they were at the time of sampling.

But more importantly, the value of collections lies in their future use. In the past, collections formed the basis of taxonomic studies, a branch of systematics, in which animals are described and classified. The study of systematics has expanded to studies of speciation, phylogeny, biogeography, biodiversity, ecology and population genetics.

Furthermore, collections may be used by archaeologists and palaeontologists for comparative purposes.

Developments in conservation techniques of artworks, books and other non-biological collections have far outstripped those of biological collections. This can be attributed to the fact that those who have managed them in the past tended to think in terms of species rather than material. Modern conservators, on the other hand, think in terms of material. Although one must not lose sight of the fact that animal specimens were once living organisms and should be given the empathy they justly deserve, it is important to think of and manage these collections in terms of materials and compatibility of materials. This will then afford them the protection needed to secure them for their future use.

This manual does not include the entomological techniques for collecting, pinning and setting specimens. These methods can be found in abundance in various publications (Londt 1986, Smithers 1982, Uys & Urban 1996).

See also
http://www.ars.usda.gov/Main/site_main.htm?docid=10141&page=1&pf=1&cg_id=0.

oDry collections

.1 Dry collection

The dry pinned insect collection is housed in about 5028 drawers and some field boxes in room EN206. There is also a small display of freeze-dried scorpions in this room.

At the moment the collection is still in the process of being re-organised and being moved form the old system of storage into ABS (Acronytril buterate styrene) plastic unit trays.

The major agents of deterioration in the dry collection are pests, pollutants, handling, corroding pins and loan related damage and loss (See Loans above). Temperature and humidity have never really been a problem but must always be considered.

Drawers and field boxes are coated with heavy residues of insecticides so care must be taken and hands washed after use. (The field boxes still contain residues of poisons such as arsenic and DDT).

- Preventing pest infestation in dry collections

Where there is a collection of dead animal material, there will always be insects to consume and destroy it. A constant war is waged against pests in museums and the most common culprit for damage in our Entomological collections is the beetle *Anthrenus verbasci* (Dermestidae). For other pests see 8.1.1.

Controlling pests is not done by trying to treat infestation emergencies. Pest control is done by Integrated Pest Management (IPM). This is a strict regime of avoiding the introduction of pests to the collections, preventing them, identifying them, assessing the problems, solving the problems and reviewing procedures. It is not a ‘one-off’ process. It is an ongoing process learning and development.

- Avoiding pests. Denying them food and safe havens for reproduction. This is done by sound housekeeping procedures with routine cleaning. (Field equipment is to be kept in the marine storeroom). Eating in the collections is prohibited as food lures insects and secondly, there is always the hazard of insecticides being ingested.

- Preventing pests. Preventing access to the building. Overhanging trees and plants, blocked gutters, nesting birds and dropping are all breeding grounds for insects and they need to be eliminated. All material about to be placed in the collection must first be treated for pests. (Fumigating, freezing, heat. See below).

- Identifying pests. Traps can be set for the collections of regular pests.

- Assessing pest problems. Once identified, the source can then be investigated and as much learnt about the life cycles as possible, facilitating the effective treatment.

- Solving pest problems. Pest problems can be solved by changing and improving the environment and methods.

- Review IPM procedures. IPM methods and procedures must be constantly assessed and improved.

▪ Treating pest infestations in dry collections

Under the present conditions, pests are rarely found in the collection. There was an incidence of Psocoptera in a Neuroptera drawer in 2006. If there are pests in a drawer, they are not always easily seen. However, there is often frass in the drawer indicating their presence. The frass is removed and the drawer treated. Pests can be killed by fumigating, freezing or dehydration.

- Fumigating. See Preventing pests in 8.1.1 above.

In the past, Vapona (DDVP, dichlorvos) was used where a small piece (25x10mm) of Vapona is placed in the drawer. After about 2 weeks of fumigation the drawer is once again inspected and if there is no longer evidence of insect activity, the Vapona is removed.

Vapona is very effective but it is acidic and has been known to bleach out the colour of certain Lepidoptera and over a long period can corrode steel pins. VAPONA FUMES MUST NOT BE INHALED FOR ANY LENGTH OF TIME AND MUST BE USED ONLY IN WELL VENTILATED AREAS.

EN206 is fumigated with Doom Foggers every second week. Each time the lids of the drawers of 5 cabinets are removed and the drawer returned to the cabinet. Lids are replaced after the fumigation ensuring that lids are not mixed up.

When fumigating, switch off the extractor and the forced air into the collection. Extractor: the key switch is just outside the blue doors to the bird skin collection and the key is in the key cupboard in entomology. Forced air: The switch is on the board in the plant room which is behind the dry collection, entry from the passage to herpetology.

When fumigating the collection, cover the 6 air samplers with the specified plastic covers, switch both panels (passage and EN209) to ISOLATE

NB DOOM FOGGERS ARE POTENTIALLY FLAMMABLE. USE AS PER DIRECTIONS AND DO NOT USE MORE THAN 3 CANNISTERS IN EN206.
The fumigation programme was started in July 2006 and replaced the Lindane painting system where the entire collection was inspected annually and the top edges of the drawers were painted with Lindane solution. (Gamma Benzene hexachloride, BHC). As the collection increased in size, it became hazardous to health as too much time was required to complete the annual cycle exposing staff to a hazardous chemical for too long.

In the past Lindane was used, Naphthalene (moth balls) was used and DDT and arsenic was used in the field boxes.

- Freezing.

Place the box of specimens in a polyethylene plastic bag, ensuring that there are no punctures. Remove some of the air and seal. Place in the freezer (minus 20ºC) for about 5 days. The literature (Florian, 1990) cites 48 hours after steadily freezing to minus 20ºC and preferably cooling and warming repeatedly a few 3 times but that is impractical.

After 5 days, remove from the freezer and allow to stand at room temperature until there is no evidence of moisture in the bag.

This method is usually used for returned loans that are in smaller boxes. But whole drawers could be treated with freezing but it is not always practical and care must be exercised as it could cause damage to and delamination of materials.

- Dehydration.

To treat by drying, there is a small hot box in EN203 but this is not large enough for large numbers of specimens. Remove the lid from the container and place the specimens in the box at about 60ºC for 8 hours.

If the collection to be treated is housed in an old veneered drawer and the freezing or dehydration method is to be used, the specimens must be removed from the drawer as drying and freezing might damage the lamination of the drawers.

Controlling pollutants in dry collections

Controlling pollutants in the environment of a dry collection is done by using the correct material that come into contact with the specimens (solid or gas) and all materials must therefore be of archival quality.

- Use only stainless-steel pins. In the early times stainless steel pins were not available and nickel-coated copper pins were used. Stainless steel pins are now routinely used. Many specimens have suffered damage from pins that have corroded from the body fluids of insects and to a lesser extent, from the acid in non acid-free labels. As the pins corrode, large crusty deposits of copper oxide are formed that eventually split the specimen and also result in the pin breaking. Where possible, pins can be

replaced where the procedure will not result in damage to specimens. See removal of corroded pins in Annexure 6..

- Use only acid-free papers and card with the collections.

- No PVC (Polyvinylchloride) plastics must be used with the collection. These give of chlorine gas that damages the collection.

- Woods emit fumes that may be damaging to the collections and all wooden specimen storage space the material must be appropriately sealed. At the moment the cabinets are being manufactured by Service Products and are coated in a 2-component varnish catalytic varnish and sets on drying excluding the risk of fumes. (See cabinet specifications).

- Handling.1.d Handling

Insect drawers must be handled with care and attempting to carry more than two many at once must be avoided at all costs.

- Dry collection labels

Specimen labels are prepared on computer and printed on to Camelot cartridge acid-free paper, 135 gram per square meter. The size is about 10 x 15mm. Labels can be handwritten with Rotring ink. Labels on and in drawers are also printed on acid free paper.

Where old labels have deteriorated due to non acid-free card used in the past or because of body fluids from the insects, new labels are made and attached to the pin. The old label is retained on the pin or the pieces are glued to a piece of acid-free card.

oWet collection

.2 Wet collection

This collection is housed in EN202 and includes about 20 000 accessions of Arachnida, Acarina, Myriapoda, Onychophora which are fully computerized. There are quite a few samples missing from this collection and these records are, as yet, not computerized. The types for this collection are housed in the safe, EN209 which is adjacent to EN206.

Also in this collection is a collection of miscellaneous insects, a vast ant collection and a large collection of bulk samples from passive sampling on various field trips by S. van Noort. A large portion of the ant material still needs to be mounted for the dry collection. Most of the wasps have been removed from the bulk field samples and when researchers visit, they go through this material and often find specimens of interest.

Two types of containers are used. A 30ml glass vial (See section B, 9a) and 175ml plastic jar. Plastic is not an ideal material for storage but at the time of re-bottling, finances simply did not allow for glass jars to be bought so we standardize on the plastic. They have proved to be very reliable except one wonders if any plastic compounds might be bleaching or damaging the specimens. Vacutainers are also used for small samples.

All type material is stored in glass vials in the plastic jars and yellow tops are used to indicate the type status. Double bottling is used where the sample size allows as it provides extra protection for the types. However, there is often insufficient space in a jar to allow double bottling for the larger species.

The main agents of deterioration in the wet collection are low alcohol levels through evaporation, incorrect alcohol pH, incorrect alcohol concentrations, high temperature and high light levels.

- Alcohol levels

  All containers of alcohol preserved material must be kept topped up to the required level with the appropriate strength alcohol and the entire collection must be check annually, including the type material in EN209.

  If the alcohol level in a jar or vial has dropped drastically, the container must be investigated and possibly replaced if not up to standard. Either the lid or the container might be cracked.

  All the alcohol must also be replaced as most of the alcohol, being more volatile than water, will have evaporated leaving behind a solution with a high water content.

  In the event of alcohol having evaporated to the extent that specimens have become dry and brittle. See Annexure 6 Rehydrating dried out liquid preserved specimens.

- Alcohol pH

  A neutral pH (about 7.0) is the ideal for maintaining material in a condition for research. A low pH is acidic and can bleach and decalcify material and a high pH is alkaline and causes clearing of tissue. Factors that can affect pH are unstable water used for dilution alcohol, labels, as some types of labels (Resistall) are known to leach acid into the alcohol (Waller and Strang, 1996), differing types of specimens and the ratio of volume of alcohol to size of the specimen (Hargrave et al, 2005).

  Ideally, the preserving process should start at the ideal pH and this would be easier by using purer water for dilution. Distilled water would be ideal but at the moment, the Museum does not possess a still but this might be overcome in the near future. The collection should be sampled regularly to ascertain the degree of pH shift.

- Alcohol concentrations

  All material (except that for DNA analysis) in the wet collection is now stored in an 80% ethyl alcohol solution but up to about 1995, 75% was used in the past. De-ionised water was used for the dilution but the de-ioniser became too costly. Ideally, distilled water should be used for the dilution. See Waller and Strang, 1996 for physical and chemical properties of dilutions of ethanol.

Material for DNA analysis is kept in 96% ethyl alcohol. The holders are clearly labelled and when topping-up, only 96% must be used.

-

Keep the room temperature at 18 to 20º C.

- Light

Switch off the lights when the collection is not being used. Fluorescent lights emit high levels of ultra violet rays that can be very damaging to material over long periods of exposure. Some light strips have been removed to reduce he light levels and those remaining have been covered with UV protector sleeves.

- Cleanliness of wet collection areas.

Cleanliness. Keep shelves clean.

- Wet collection loan care

When sending loans, ensure that the vial or jar is full of alcohol with cotton wool in the mouth. This reduces the air bubble agitation in the container thereby reducing the risk of damage. Some specimens are labelled with metal labels. These are a huge hazard when sent with loan material and can result in a specimen literally being chopped up. These metal labels should be removed from the specimen and left behind in the vial. ENSURE THAT THE SPECIMEN BEARS A HANDWRITTEN REPLACEMENT LABEL AND ENSURE THAT THE METAL LABEL AND SPECIMEN ARE RE-UNITED WHEN THE LOAN IS RETURNED.

- Labelling

Wet collection labels must be written in black Rotring ink on the synthetic vegetable parchment paper and allowed to dry completely before placing in the alcohol. (If the ink runs when the label is placed in alcohol, either the ink has not dried sufficiently or the alcohol solution is below the required concentration and must be replaced with 80% alcohol). Research has shown that black Rotring 17 is the most superior ink for collections (Williams and Hawks 1986).

A more convenient option is the water/alcohol proof felt pens. To date the Unipins that are locally available seem to be fine and users have had no problems with labels for 7 years.

Laser printed labels are not long-lasting and should be used only for short-term storage or in combination with hand-written ink labels. Pencil (2h) can also be used. Do not use ballpoint pens as the ink will dissolve in alcohol.

In the past Resistall paper has been used (for a short period in Marine Biology) but the literature indicates that it leaches acid into the ethanol preservative (Andrei and Genoways, 1999). However, our own parchment that we used has not been tested.

There are ways to as produce labels for alcohol stored material but they have not really stood the test of time so hand written labels are best. Pressure is important for long-lasting print on fluid-stored labels. A successful label to date seems that of Puylaert and Jocquè (1992), using a Daisy-wheel BROTHER HR40 (Daisy-wheel Brougham 15cpi) printer with a ONETIME carbon notary ribbon. The label paper used is TYVEK 1085D, 110g/m2 supplied by Wiggins Teape Synthetics Ltd. (Du Pont). The location of the supplier is not specified in the publication but it is probably in the UK.

oDisplay collections.3 Display collections

All collections on display must be monitored and treated for pests annually. The display department will open storage cases on request. To treat, a Doom fogger can be placed in each cabinet overnight and the frame around the doors can be painted with an effective Lindane solution before closing. Vapona has been used in the past but fumes from this insecticide tend to be acidic and have been know to bleach the colours of certain lepidopterans.
(Our current display is next to the discovery room which houses live specimens. Do not use Doom foggers as this will kill any live specimens in the Discovery Room).

oMicroscope slide collection.4 Microscope slide collection

This collection is housed in room EN206 and the only care it really requires is to be kept dust-free and organised and the slides kept flat as "drifting" of the specimen can occur if stored in a vertical position.

oPhotographic slide collection.5 Photographic slide collection

This collection is housed in 2 filing cabinets in room EN206. All photographic slides must be stored in polypropylene plastic holders and not PVC (polyvinylchloride) as this will damage the slides.

oInsects in amber collection

There is a small collection of insects in amber and this is housed in the safe, EN209.

oFuture preservation goals and objectives

- The bulk mixed samples in the wet collection need to be organised and databased.

- The ant collection in the wet collection need to be rebottled and representative samples mounted for the dry collection.

- Header labels for the reorganised dry collection have been hand written and new printer generated labels are required.

- Monitoring of pH in the wet collection is required and if synthetic vegetable parchment affects it. Purchase a water still for alcohol dilutions.

- Sufficient stocks of jars should be kept in the event of existing plastic jars deteriorating simultaneously.

- Comprehensive disaster plan needs to be developed.

9. Destructive sampling

Destructive sampling is the procedure of using parts of or whole specimens for analysis such as DNA analysis, SEM imaging. Special permission to do so is required as once the material is sampled, it is lost to future researchers. Permission is only granted if there is an abundance of material available or if the research is vital to science. An application to do destructive analysis must be discussed by curator and collection manager.

Destructive analysis must never result in the destruction of all specimens with the same accession number. There must always be one or more usable specimens remaining.

10. Waste management (organic and chemical)

Occasionally, there is a need to dispose of hazardous material such as chemicals and insecticides. They may not be disposed of in the sewerage or the waste removal systems, as it would pose a threat to public health and safety. A specialised system of disposal is required and a company such as Wasteman or Waste-Tech can be contacted for assistance.SECTION B: CONSERVATION TECHNIQUES FOR BIOLOGICAL MATERIAL

11. Organisation of collections

Pinned material in EN206.
Primary type material is stored with the collection but placed in separate unit trays and paratypes are placed with the non-type material. While most of the collection is arranged systematically at the higher taxonomic levels, in most cases it is arranged alphabetically at genus and species level.

The beetle collection is stored in the original 30-drawer cabinets, the end groups overflowing into the new cabinets.

Alcohol preserved material in EN202.
Arachnid type material is stored separately in the safe EN209 (in EN206)arranged alphabetically by family and accession number.
In EN202 the spiders are separated into the Araneomorpha and Mygalomorpha and within each group, they are arranged alphabetically by family, genus and species. Other arachnids are also arranged alphabetically by family, genus and species.

There is a collection of insects in alcohol on the shelves on the right on entering the collection area. This collection includes insect larvae, malaise trap material and pitfall material. It is arranged alphabetically by order and family and is largely unidentified.

There is a large amount of bulk samples on the back island shelving, resulting from passive collecting, most from S. van Noort's research.

A large ant collection is stored on the back shelves. This collection needs to be rebottled and representative samples need to be mounted for the dry collection.

12. Collection documentation

Documenation includes accession numbering, listing material in accession books and on databases and attaching the information to specimens. It also includes record keeping. See also 11 Conservation, Poor Documentation. All records relevant to the collection, such as field notes, method and system changes, must be retained.

- Accession numbering. ACCESSION NUMBERING- wet collection.1 Wet collection

  Up until 1992/1993 it was only the wet collection that had been given accession numbers and these are registered in 3 accession books. The earliest book commences with the 150000 series, then changes to an A prefix series and then changes again to a B prefix series. The second and third books run from 1 to 14877 with no prefix. For the sake of computerisation, these were given an X prefix. All 3 of the original accession books also contain accessions of non-entomological collections.

  Because of the excessive use, it was thought that a copy might be better to use and it was attempted to photocopy the first book. However, it seems that photocopying resulted in more damage so the idea was abandoned.

  Later, in about the late 70's another accession book for the wet collection was started and this is the C series.
  The wet collection computerisation prefix is SAM-ENW- (W = wet).
  Examples, therefore, of wet collection accession numbers before and after computerisation:
  A2319 = SAM-ENW-A002319
  B6534 = SAM-ENW-B006534
  C1700 = SAM-ENW-C001700
  150041 = SAM-ENW-X150041

  Also in the late seventies an attempt was made to renumber the material already accessioned in the 3 early accession books and there is another accession book allocated to this series - the SAM-ARAN series. However, this was abandoned, as it proved unnecessary and confusing.

- Accession numbering - dry collection.2 Dry collection

The dry collection was never registered in accession books, due probably to the sheer volume of material. Also, in about the late 70s an attempt was made to accession the type material. Most of the Coleoptera types therefore bear a SAM/ENT number. In the mid-1980s, it was decided that a list of this type material should be published and part one, the Carabidae, was published (Cochrane, 1991) but it was decided not to continue with this series as it was felt that type lists could be generated at relatively little cost on the internet once the collections were plced onto databases.

From about 1993 following the start of the reorganisation programme, accessioning and computerisation of the dry insect collection began. The process started by sorting material into series, accession numbers were then allocated and each accession was then computerized. One number is applied to a series; a series being one or a group of specimens with same collector, date and locality. Sometimes there might be a need to number specimens individually (eg. for measuring them or for referring to the sex or type status of a particular specimen). In this case, an alphabetic suffix can be added to the end of the accession number, eg. SAM-ENT-001145a, SAM-ENT001145b etc. If there are more than 26 specimens requiring individual numbering, then aa, ab, ac etc. may be used.

Ideally, each specimen should have its accession number attached but in most cases only a header number precedes the series (except the Hymenoptera where a large portion of specimens is individually numbered). This was done to simplify and speed up the re-organisation process. ANY SPECIMENS REMOVED FROM THE COLLECTION MUST THEREFORE FIRST HAVE ITS ACCESSION NUMBER ATTACHED.

Sometimes this new numbering system clashes with the SAM/ENT system. For example, one series might have included more than one SAM-ENT number or the same SAM-ENT number included in more than one series. Changes were made according to the new system and then cross-referenced. (These changes were made before the Carabidae type list was published).

Currently, each group of insects has its own prefix. For example, ants are SAM-HYM-C000000, bees SAM-HYM-B000000, wasps SAM-HYM-A000000, Parasitica SAM-HYM-P000000, beetles SAM-COL-A000000, flies SAM-DIP-A000000.

oInterpreting labels

Many of the labels in the collection are more than a hundred years old. Some have faded, disintegrated or are stained from specimen leakages and some are also abbreviated. All these imperfections sometimes make labels extremely difficult to read. Unless a label can be accurately read, never be tempted to assume the label details or interpret them in any way. Inaccurate interpretation can lead to errors that will be continually perpetuated resulting in poor data credibility.

New taxa are named according to the International Code of Zoological Nomenclature. Named specimens will usually be labelled with the genus and

species followed by the author's name without intervening punctuation. Sometimes this will be followed with the year of the publication of the description and this is separated from the author's name with a comma. The author's name (and date, if cited) is placed in parentheses if a species or subspecies is transferred from its original genus to another genus.

BIOLOGICAL TYPE DEFINITIONS

. BIOLOGICAL TYPE DEFINITIONS

- HOLOTYPE A single specimen taken as the type by the original author of the species description.
- ALLOTYPE A type of the opposite sex to the holotype, the actual status being a paratype if it was included in the original type series. If the specimen of the opposite sex was described later in a different publication from the original description of the species, then it has no type status although earlier authors often labelled such specimens as allotypes.
- PARATYPE A specimen or specimens, supplementary to the holotype, used by the original author as the basis of the new species.
- SYNTYPE One of several specimens of equal rank upon which the description of a species is based.
- COTYPE An old term, generally, but not always, meaning syntype. To avoid confusion, this term is no longer used.
- LECTOTYPE A specimen, selected from a syntype series, subsequent to the original description, to serve as the new holotype.
- PARALECTOTYPE The specimen, or specimens, supplementary to the lectotype, remaining from the syntype series after the lectotype has been selected.

LATIN TERMS AND ABBREVIATIONS. LATIN TERMS AND ABBREVIATIONS

Below is a list some of the more common Latin terms that are found in the collection (Torre-Bueno, 1989).

det. (not Latin)	determined by
ex.	out of, from
comb. nov.	new combination
gen. nov.	new genus
ibidem (ib.)	in the same place, same reference
incertae sedis	of uncertain taxonomic position
idem (id.)	the same
in situ	in its natural place or normal position
lapsus calami	a slip of the pen, an error made by the author
lego (leg.)	collected by
nomen conservandum	conserved name
nomen dubium	name of unknown or doubtful application
nomen inquirendum	name subject to investigation
nomen novum (nom. nov.)	new replacement name
nomen nudum	name not available according to the Code
nomen oblitum	a forgotten name
nomina nova	new replacement names
nomina nuda	names not available according to the Code

nomina oblita	forgotten names
non viso	not seen
senso lato (s.l., s. lat.)	in the wide sense, broadly speaking
senso stricto (s.s., s. str., sens. str.)	in the strict sense, strictly speaking
sic	thus; used to indicate that data are exactly as given.
species (sp.)	one species
species (spp.)	two or more species
species nova (sp.nov.)	new species
syn. nov.	new synonym

o Future documentation goals and objectives

- Printouts of databases need to be produced.
- The current database needs to be upgraded to a programme more compatible with other database programmes and that does need to write across to word processing programmes to produce lists.
- Accession books need to be copied. Photocopying has damaged accession books in the past so an option would be to photograph them and keep a digital record. The images would need to be filed in a way that the accession numbers are readily accessible for reference purposes. That is, each image file name would indicate the range of accession numbers.

13. Health, safety, security and fire prevention

o Health and safety

A museum working environment carries potential health hazards and employees need to be aware of them. Workers are very often exposed to hazardous chemicals and insecticides over long periods and while the effects are not always felt over a short period, the accumulatory affect can result in illness later in life.

A fine balance needs to be struck between health and safety for workers and security and sustained preservation of collections. What is healthy and safe for humans is not necessarily healthy and safe for collections – and visa versa. In many cases the very substances and practices that are conducive to preserving collections are the very substances that pose a threat to humans.

Chemical risks
In the entomology department the primary health risk is from insecticides used for fumigation (Doom foggers) and insecticide residues on old specimens, drawers and field boxes (DDT, naphthalene and arsenic).

Inhalation of fumigants must be avoided and areas that have been fumigated must be vented well before entering the area.

When handling hazardous chemical such as Lindane, protective gloves must be worn as the chemical can be absorbed by the skin. Inhalation of alcohol fumes must also be avoided.

Hands must be washed after handling drawers and old field boxes as the latter especially are contaminated with DDT and Arsenic, chemicals that were freely used in the early days of collection preservation.

Formalin is not generally used in an entomology collection but it is worth mentioning that this chemical severely irritates the mucosa causing severe burning and sensitivity and is also carcinogenic. The very fact that it is used to fix tissue of dead animals, suggests that prolonged inhalation could also fix one's lungs. Protective equipment must be worn or extractors must be used when working with this chemical.

Biological risks
While the entomology material generally does not pose a disease risk, this is a serious consideration for new donations and collections of birds and certain mammals as some birds and animals can carry diseases such as Avian Flu, Plague (Cosgrove et al, 1992), Anthrax, Rabies, Bovine Tuberculosis, Brucellosis, Psittacosis (Parrot fever),Tularaemia and Tetanus. Workers are usually routinely inoculated for Rabies and Tetanus. When dead birds and animals are received, the cause of death must be known and museum workers must wear masks and gloves when preparing them.

- Security

[Classified]

- Fire prevention

There are 2 fire control systems. The gas system in the dry collection, EN206, and a water sprinkler system everywhere else.

In EN206 the fire control system is armed with a gas, FM200. This is an interesting gas in that it puts out fires and yet is not harmful to man, unlike carbon dioxide that is sometimes used in fire systems. READ INSTRUCTION SHEET NEXT TO THE CONTROL PANEL.

When the department is left at the end of the day, the system is armed by switching on to 'Automatic'. When working in the collection area, switch to 'Manual".
There are 3 zones covered by the system, 2 in the dry collection EN206 and 1 in the safe, EN209.

In the event of a fire or fault:
In ISOLATE mode, no alarms or buzzers will sound and no gas will be discharged. However, an alarm will sound in the control room on the ground floor.
In MANUAL mode, alarm bells and buzzers will sound but no gas will be discharged and an alarm will sound in the control room on the ground floor.

In AUTOMATIC mode, alarm bells and buzzers will sound and after a 'Double Knock', the gas will be emitted after about 2 mins. An alarm will sound in the control room on the ground floor. 'Double Knock' is when 2 of the 3 zones in EN206 and EN209 go into alarm mode. **The gas is very costly (about R100 000.00) and an accidental emission is to be avoided at all costs**.

So, in the event of the alarms sounding, check the area for a fire. If there no fire reset and silence buzzers and switch to isolate mode. Advise the control room and investigate further.
However, should there be a fire that cannot be controlled with the manual fire extinguishers, shut the collection room door and break the glass on the yellow Gas Release Box of the Gas Control Unit. This overrides all the settings.

Should there be a fire and should there be sufficient time, switch off:

- the extractor - the key switch is just outside the blue doors to the bird skin collection and the key is in the key cupboard in entomology.
- forced air - the switch is on the board in the plant room which is behind the dry collection, entry from the passage to herpetology.

The system can also be triggered by fumigation and smoke from fires outside the building.
If there are extreme veld fires raging outside, switch to ISOLATE.
When fumigating the collection, cover the 6 air samplers with the specified plastic covers, switch both panels (passage and EN209) to ISOLATE and advise the control room so they can isolate their switches as well in order that the alarm will not sound in the control room.

The Iziko fire system is linked to the fire department and unnecessary call-outs must be avoided.

o Disaster management.

Disaster can result from natural causes (rain, floods, insect and vermin infestations, earthquakes and volcanic action) and man-made causes (war, fires, poorly maintained buildings and equipment, explosions, chemical spills, power failures). The potential hazards for the entomological collection are fire and flooding that could result from burst pipes.

A disaster management plan is required so everyone understands what to do in the event of an emergency/disaster. This edition of the manual will only include basic information and a full plan will be developed for the next issue.

- **Emergency telephone numbers**

[Classified]

In the event of an emergency:
In the event of flooding or the fire alarms sounding after hours, a key will be needed for access through the double green doors. The key is with the site manager.

In the event of a **fire:**

- Switch off the air extraction system if there is sufficient time. The key switch is just outside the blue doors to the bird skin collection and the key is in the key cupboard in entomology.
- Switch off the forced air system if there is sufficient time. The switch is on the board in the plant room which is behind the dry collection, entry from the passage to herpetology.
- Switch the fire system on AUTOMATIC or break the glass on the gas control unit. See 13.3 Fire prevention.
- Close all windows and doors.
- Leave the building via the stairs.

In the event of **flooding** from overhead air conditioner water pipes:

- Close the isolation valves (taps). They are in H202 (Herpetology collection), above the entrance. The key is kept in the entomology key cupboard.
- Block water from entering offices and collection areas.
- Call the site manager.

14. Risk management and security

[classified]

15. Annual collection timetable/checklist

Check	Date Due	Date Done
Fumigation of dry collection. Annual cycle	Every second week. Cycle completed by December	
Top-up of wet collection. Annual cycle.	Complete cycle by December	
Check and record pH of random sample (glass, plastic, small sample, large sample)		
Loan reminders. Annually.	By August	
Fire system check	Property Services	
Fire extinguisher check. Annually.	Property Services	
Alcohol stock check. Annually.	January	
Collection and Storage area check. At intervals	Annually	
Update procedure manual. Annually.	August	

Annexure 1. Loan policy/agreement

The policy is sent in the form of an agreement before the loan is made and includes the loan number, date, borrower's name and signature. Print as a single page document.

The loaning policy/agreement of the Terrestrial Invertebrate Collection, Iziko Museums of Cape Town.

1. The borrower agrees to:
   - keep dry stored material insulated against pests, fungus and humidity
   - keep wet stored material fully immersed in the liquid specified on the loan requisition form
   - house the material in such a way that ensures its safety and identity as South African Museum property.

2. The borrower agrees to fulfill the requirements of the documentation of the loan; that is, sign and return one copy of the requisition form on receipt of the material, and respond to loan reminders.

3. The borrower agrees to advise the curator of the collection of any changes of address.

4. The borrower agrees to return the specimens within the loan period specified on the loan requisition form. Should an extension be required, this must be requested in writing.

5. No material may be loaned to consignees not affiliated to a recognized research institution or at a private address. The borrower must arrange for a recognized institution to take responsibility for the material.

6. Material may not be loaned to students unless a supervisor at a recognized institution agrees to accept responsibility for the material.

7. The borrower agrees that no material in loan may be transferred to another borrower without the written permission of the curator of the collection concerned.

8. The borrower agrees not to retain specimens without the permission of the curator of the collection concerned.

9. The borrower agrees not to remove specimens (or parts thereof) or labels from their mountings without permission from the curator of the collection concerned. Where parts are removed for anatomical or histological studies, those parts must be returned appropriately mounted with the specimens. Where destructive analysis needs to be undertaken, this can only be done with the written permission of the curator of the collection concerned.

10. The borrower agrees to label EACH bottle/slide/pin clearly and legibly with a determination label where determinations have been undertaken.

11. With regard to the return post of borrowed material, the borrower agrees to:

- adhere to the posting requirements specified on the loan requisition form.
- ensure that material is clearly packed for its return in the same, or similar type and size, of packaging in which it was received.
- return the loan by courier if it cannot be returned by registered or insured airmail.
- avoid posting material during the month of December.
- bear all postage costs.
- Advise the Museum by fax or E-mail that material has been despatched for return.

12. The borrower agrees to acknowledge the South African Museum for loan material and agrees to deposit a copy of the publication in which the material was mentioned, in the South African Museum library. The acronym, SAMC, should be used when referring to South African Museum material.

(The acronym SAM had been used in the past and this led to confusion as the South Australian Museum also used it).

I have read the above and agree to adhere to all requirements.

LOAN NUMBER ……DATE…….

BORROWER……. SIGNATURE……. T

Fax to: Margie Cochrane or Dawn Larsen 27 021 4813993

Annexure 2. Code of conduct for visitors

In 1999 reciprocity and co-operation agreements were entered into with the University of Cape Town and keys and free access to the collections was granted to certain senior staff members. This naturally opened up new areas of risk to the collections especially where students might also require access. The following code of conduct was drawn up in an attempt to reduce this risk.

GUIDELINES FOR VISITORS TO THE SOUTH AFRICAN MUSEUM ENTOMOLOGY COLLECTIONS

The Museum's primary concern with regard to non-museum collection users, is the security of its collections with regard to:
- damage from handling
- introduction of pest infestation by bringing untreated material into collection area
- the removal of material without authorisation
- the security of data.

All key-holding visitors should acquaint themselves with the Collections Procedures Manual, as non-museum users are often unaware of required procedures and practices.

Below are listed some guidelines to the use of the collections to which visitors are asked to adhere, failing which, access will be reviewed.

- Non-staff key holders who are not regular/frequent visitors should notify Museum staff in advance of an intended visit (during and after work hours).

- No persons will be allowed access to the collections without being accompanied by a staff member or an official key-holder unless by special arrangement.

- No unauthorised visitors may accompany non-staff key holders after-hours.

- No untreated material (e.g. specimens for ID, etc) may be taken into the dry collection area due to the risk of pest infestation.

- No smoking in all areas.

- No food or beverages may be taken into any collection area as food traces can encourage pests, aside from the hazard of ingesting toxic pesticides.

- No material may be removed from the Entomology department except on an official loan. A loan request must be made to the curator or collections manager and the material for loan will be listed and the borrower will be required to sign the invoice before removal.

- To locate material in the collection the computerised genus inventory can be used. Only the computer in the collection area, room EN206, may be used. No personal computer discs may be used in museum computers unless previously authorised.

- Drawers must be handled gently and supported underneath and not held by the side grooves. All material must be carefully handled to avoid damage but should there be any damage, regardless of how insignificant, the collections manager must be notified.

- When work is complete, replace the lids on the drawers and leave the drawers on top of the cabinets. Ensure that the lids and drawers match. These will be checked before they are returned to the cabinets.

- Ensure that specimens are returned to the correct position in the drawer. Some specimens in the re-organised material (the non-Hymenoptera) are not individually numbered and special care must be taken with these so they are not mixed up.

- Drawers and boxes have been treated with various toxic insecticides (gamma BHC, dichlorvos, arsenic, DDT). Wash hands after handling.

- Unless by special arrangement, all offices are out of bounds to visitors.

- The last person leaving should switch off the lights, air ventilation system and all equipment and lock all doors when leaving.

- Fire safety regulations require that security staff is aware at all times of occupants in the building. For after-hour visits the registers at the main entrance or in the control room must be completed on both arrival AND departure.

Annexure 3. Suppliers

Item	Supplier	Contact details
ABS (Acronytril buterate styrene) Plastic strips.	Cape Plastics	021-5118128
ABS unit trays	Cape Plastics	021-5118128
BHC (gamma Benzene hexachloride) solution	Rentokil	021-613040
Bottles with taps, plastic	USABCO	021-9172000
Boxes, Plastic insect	USABCO	021-9172000
Cabinets. See cabinet varnish.	Service Products	021-5316545
Cabinet varnish, Elvolac Polyacrythane 5630815 BN904	Technipaint (Cape)(Pty) Ltd	021 5935653
Card/paper, Acid free card, Camelot cartridge, 135 gram/square m	First Paper House	021-5313424
Chemthane dual pack polyurethane	Chemical Specialities (Pty) Ltd in Cape Town	021-3862171
Doom Foggers	Epping Industrial Suppliers	021-5316666
Entomological supplies	Bio Quip Products	17803 La Salle Avenue, Gardena, CA 90248-3602 USA. Fax: 310-324-7931.
Ethylene glycol	Cape Town Chemicals	021-5119009
Fish Glue (for attaching insects to card)		
Foam, polyethylene for pinning bases	Sondor industries C.C	021-5316310
Glue for unit trays, Alcolin Clear. The supplier will, on request, prepare a 1 litre tin pack size. This can be arranged through Feds	Feds	021-4617202
Jars, plastic specimen, 175 ml with lids with seals	Xactics	021-545311
Labels (wet collection). Synthetic vegetable parchment	Legg and Wessels Packaging	021-5112001
Labels (wet collection), Resistall	University Products Inc.,	P O Box 101, 517 Main Street, Holyoak, Massachusetts 01041, USA
Microscope lamps	Singer Photographic Services (Pty)Ltd	021 4247164/6
Photographic slide holders, Polyprolpylene plastic	Frieda Fitz-Gerald	Fax: 031-448339
Polystyrene and holders, drilled	Erika Polystyrene Products	021-4612180
Unit trays, ABS plastic	Contract Tools	Tel: 0331-429454

*****Vials, glass, code NV7524	Regina Industries Ltd	Fax: 0782-565610
Vials, glass. Vacutainer Blood Collection Tubes	Becton Dickinson Pty Ltd.	372 Rivonia Rd, Sandton 011 8071531

*Glass vials..1 Glass vials.
An excellent vial used for the storage of arachnids is the 30ml glass vial NV7524 supplied by:
Regina Industries Ltd (Director Mr M. Beardmore)
Parkhouse West Industrial Estate
Newcastle
STAFFORDSHIRE ST5 7RU
UNITED KINGDOM

Alcohol was stored in these vials for 18 months at 35EC and then at the ambient temperature in the collection area for two years. To date the evaporation has been less than 5%.

Locally supplied vials should be avoided at all costs as their quality is too poor to even consider for storage purposes. Even with the exchange rate and all additional costs involved in importing goods, the landed cost of the NV7524 is fractionally more than locally supplied vials.

Annexure 4. Insect cabinet specifications

- 50 drawer cabinets: 25 drawers high.
- Cabinet to have two front doors with a brass lock.
- Internal drawer dimensions: 410 X 410 X 48(minimum) mm.
- External drawer dimensions: 442W (side to side) X 460 L (front to back) X 63 height mm.
- A horizontal reinforcement shelf must be positioned across the centre of the cabinet to strengthen the structure.
- Lift-off glass lid set into wooden frame. Lid must have recessed finger grips to facilitate easy opening.
- All drawers must be interchangable: they must fit all spaces and label holders must be placed on the left.
- Plywood for drawer bases and the back of the cabinet (NOT hardboard). Ensure no warping.
- Outside cabinet walls solid wood.
- Rebate in drawer sides to run on plastic strips in cabinet.
- A small brass card label holder with handle to pull open drawer to be centralised.
- A large card label holder to be consistently placed on the left hand side of all the drawers, equally spaced from the top, bottom and left side of the drawer.
- The two screws inside the front of the drawer to be countersunk as they interfere with the placement of the unit trays.
- Any gaps at the corner joins of the lids and less often the bases to be filled with glue to ensure a good seal against insect pests.
- Two coats of catalytic varnish to be applied: Elvolac Polyacrythane (See suppliers).

Annexure 5. Chemicals and reagents

Ethyl alcohol.1 Ethyl alcohol

Ethyl alcohol is donated by Sasol Solvents and a new rebate application must be made with SARS each time alcohol is needed.

To request a donation, contact:
Natalie Warren
Regional Sales Manager
Sasol Solvents
Cape
Tel: (021) 914 - 1055
Fax: (021) 914 - 1063
Cell: (082) 326 9503
E-mail: natalie.warren@sasol.com
This must be done in the form of a polite letter as it is not to be assumed that a donation will be made.

To apply for a SARS rebate application registration:
Contact:
The local SARS office or Mr Jason Meekoly
SARS
PO Box 41
Stellenbosch
7595
Rebate code for Ethyl alochol (undenatured) is 621.08/01.00. SARS registration documents DA 185 and Annexure DA 185.4A3 required.

Alcohol storage and dilution.
96% Ethyl alcohol is stored in the flammable store on the ground floor store. A pump (stored in the glass store) is used to remove alcohol from the 200 l drums. When alcohol is removed from the outside store, the stock book must be completed and the amount used indicated.
The alcohol is then taken to the department and ixed with water (preferably de-ionised if available from Marine Biology) to the required concentration. The diluted alcohol is stored in the entomology safe, as it appears that there had at some stage been a theft of alcohol.

For each litre of 96% alcohol, add about 200ml of de-ionised water (See table below) and then, using an alcohol meter (in drawer in EN207), adjust accurately to 80% if the concentration is not correct.

Alcohol dilution table

See Waller and Strang, 1996 for properties of different dilutions of ethanol.

strength of original alcohol

	100	96	95	90	85	80	75	70	60	50
95	5	1								
90	10	6	5							
85	15	11	10	5						
80	20	16	15	10	5					
75	25	21	20	15	10	5				
70	30	26	25	20	15	10	5			
60	40	36	35	30	25	20	15	10		
50	50	46	45	40	35	30	25	20	10	
40	60	56	55	50	45	40	35	30	20	10

ml of water to be added

Example:

Original stock of alcohol = 96%
Concentration needed = 80%

Therefore mix 80 volumes of 96% alcohol with 16 volumes of water
or
mix 8 litres of 96% alcohol with 1.6 litres of water
or
mix 1 litre of 96% alcohol with 0.2 litre (200ml) of water

Lindane insecticide.2 Lindane insecticide (gamma BHC, Benzene hexachloide).

Use of Lindane was stopped in July 2006 but is retained in the manual as a reference.

Lindane is a toxic insecticide and rubber gloves must be worn when handling it.

Lindane is obtained from Rentokil and usually supplied at the concentration of about 20% in paraffin. This is not a long acting insecticide as was always thought. Each new batch should be tested to establish the most effective minimum concentration.

Usually, a concentration of 20% would be regarded as unhealthily high to use but when dilutions were tested, is was found that 2%, 5% and even 7% was not that effective. 10% was then decided on after testing that concentration on a test group of beetles.

An example of how Lindane can be tested.
Dermestes maculatus is used as the test animal as it is usually available in reasonable numbers as it is used to clean the bird carcasses at the museum.

Various concentrations of Lindane are prepared, 2%, 5% 7% and 10% in paraffin and painted onto the inside bases of boxes not used before (boxes are kindly loaned by Marine Biology).

A piece of dried sausage and a water vial with cotton wool is placed in each box with not less than 10 specimens of live beetles in each. The box is than covered with glass and sealed with tape and kept dark. A control is run in parallel using only paraffin instead of the insecticide solution. Observations are then made on a daily basis. The concentration that kills the entire population within about 3 days is regarded as reasonably effective. The box painted with the effective concentration is retained and re-tested at monthly intervals and evaluated. The bulk store of the selected dilution should also be tested at intervals.

While this sort of testing procedure would not withstand too much scientific scrutiny, it does give us an qualitative indication of the efficiency of the Lindane.

Brenda May beetle relaxing fluid
.3 Brenda may beetle relaxing fluid

96% Ethyl alcohol	265 ml
Water	245 ml
Ethyl Acetate	95 ml
Benzene	35 ml

As well as relaxing beetles, this liquid has been used to remove corroded pins from beetles.

Bonin or carnoy histology fixing solution
.4. Bonin or carnoy histology fixing solution

Ethanol, absolute	60ml
Chloroform	30ml
Acetic Acid, absolute	10ml

The sample/specimen is left in the above solution for 3-5 days and then transferred to 75% ethanol.

Fish-moth bait
.5 Fish-moth bait

5 parts gum Arabic
5 parts sodium fluosilicate
4 parts flour
6 parts sugar
40 parts water (enough to make a thick paste)

Let the gum Arabic stand overnight in water to soften so it will mix easily with other ingredients the next day. Once mixed, dip strips of card into the paste, hang up to dry. Label Apoison@. Replace yearly.

Toxicity of chemicals..2 Toxicity of chemicals.

Toxicity of insecticides is expressed as an LD50 value. The LD50 is the Lethal Dosage expressed as mg per kg body mass which will kill 50 per cent of a random sample of a population of test animals, usually white laboratory rats. Oral and dermal values are given as some insecticides can be absorbed through the skin, eyes and lungs. Chlorinated hydrocarbons accumulate in the body with repeated exposure and in some cases can accumulate to a point where a later exposure to a small dose precipitates acute symptoms or death.

Below are listed some substances used in museums and two household substances for comparison:

Substance	Oral LD50 mg/kg	Dermal LD50 mg/kg
aluminium phosphide (Phosphine)	1 mg/l air	-
arsenic pentoxide (illegal)	8	-
Carbaryl	500	400
DDVP (dichlorvos) (Vapona)	80	75-107
ethylene oxide	7 mg/l air	-
gamma BHC	88-184	900-1000
Mercaptothion (Malathion)	1375-2500	>4100
methyl bromide	1 mg/l air	-
Naphthalene	2200-2400	>2500
paradichlorbenzene	>1000	-
sodium fluosilicate	125	-
Strychnine	1-25	-
table salt (NaCl)	3320	-
Asiprin	1240	-

Annexure 6. Specialist entomological techniques

It is not within the scope of this manual to cover the standard Entomological collecting and preparation techniques as these are covered in other specialist publications (for example, Uys and Urban, 1996).

However, there are certain specific techniques that have been used by researchers at the Museum that will not be found in most of the general publications. These are techniques that have been developed and applied routinely to the Hymenoptera.

Drying alcohol preserved specimens for pinning10.1 Drying alcohol preserved specimens

Material collected in Malaise traps, pan traps etc. are collected and stored in alcohol and need to be dried and pinned for examination. However, some small and weakly sclerotized groups collapse or partly collapse when dried out after removal from alcohol.

This collapsing can largely be prevented by first placing the specimens in an acetone saturated environment for 3 to 8 hours, removed , dried under a lamp and then mounted. Specimens can also be glue mounted prior to acetone treatment. (See van Noort, 1995).

Method.

1. Prepare the saturated acetone environment by soaking a piece of cotton wool in acetone and placing it at the bottom of an acetone resistant jar with a good seal. For a platform, place a piece of polyethylene foam over the cotton wool.

2. Remove the specimens to be dried from the alcohol and set into the required position by floating onto a piece of card. The card must be able to fit into the jar onto the platform of polyethylene. A dropper with alcohol can be used to re-float the specimen until it is in position.

3. Dry the card with specimens to damp and then place into the acetone jar for 3-8 hours.

4. Remove the card with specimens from the jar and dry under a desk lamp or a low intensity microscope lamp for at least half an hour.

5. Specimens are then mounted as required.

Rehydrating dried out liquid preserved specimens

Sometimes alcohol/liquid preserved specimens dry out and become hard and shrivelled. These specimens can be soaked in Decon 90 (or equivalent surface active agent) for 16 hours (Upton & Norris, 1980). They are then thoroughly rinsed and immersed in water until restoration is complete. They are then replaced into the preservative.

A solution of 0.5 % trisodium phosphate can also be used for 24 hours.

Hot water treatment can also be used.

Extracting and clearing of insect parts.2 Extracting and clearing of insect parts

Sometimes certain internal parts of an insect need to be examined, for example, genitalia and mouthparts. These first need to be removed, cleared of soft tissue by macerating in potassium hydroxide (KOH), rinsed and mounted with the specimen.

Method.

1. If the insect is not freshly caught it needs to be softened in a relaxing jar (See Uys and Urban, 1996) for 2-3 days.

2. Remove the parts required. This can be done with a pin, bent at the end to form a hook.

3. Macerate (soak) in 10% (10gms per 100ml water) KOH and leave overnight.

4. Rinse, neutralise in slightly acidic water (2-3 drops of acetic acid in about 3 ml water) and rinse again.

5. Stand in 96% alcohol for about 5 minutes and then air dry.

6. Soak in glycerine and then place in a micro-vial and attach to the original specimen.

Removing corroded pins

The Brenda May relaxing liquid in Annexure 5 can be used to soak the specimens..

An electrical method (Upton & Norris, 1980) (not yet tried by us) can also be used. The specimen is pinned onto a pinning base covered with a brass gauze base that acts as an electrode and another brass rod electrode is placed on the corroded pin. A 3.3 volt/ 30 amp current is passed through the pin, heating it sufficiently to allow the specimen to be pushed off the pin. The specimen is then remounted on a new stainless steel pin and will probably need to be glued on the pin as the hole in the specimen will be enlarged.

Annexure 7. Chronology of staff in the Department of Entomology

Name of staff member	Position	Dates
Trimen, R	Acting Curator Curator	1866, 1872 – 1895
Péringuey, L	Scientific Assistant Curator of Invertebrates Assistant Director & invert. Curator Director	1884 – 1924
Lightfoot, RM	Clerical/ Scientific assistant	1882 – 1921
Purcell, WFW	1st Assistant Dept. of Inverts. Keeper of land inverts. (Excl. Insects)	1896 – 1905
Tucker, RWE	Assistant in charge of Arthropoda	1914 – 1921
Lawrence, RF	Assistant in charge of Arthropoda	1922 – 1936
Barnard, KH	Marine Biologist - Director. Also worked on insects	1911 – 1964
Thorne, CW	Technician but not in Entomology. Went on field trips with Hesse	1922 - 1940/ 1945 - 1962
Hesse, AJ	Assistant entomologist Head of Entomology Head of Entomology, retired	1924 – 1974
Wood, HG (Honorary)	Honorary entomological worker	c. 1930 – 1950
Smithers, RHN	Arachnologist	1936 – 1939
Zinn, H	Technician but not in Entomology. Went on field trips with Hesse.	1940 – 1978
Skaife, SH	Trustee with strong entomological connections	1943 – 1968
Andreae, H (Honorary)	Honorary worker Honorary coleopterist	1949 – 1967
Gess, FW	Assistant entomologist	1959 – 1968
Pearse, ITL	Assistant entomologist	1969 – 1970
Taute, CJ	Assistant entomologist	1970
Prins, AJ	Assistant entomologist	1971 – 1989
Coates, TJD	Assistant entomologis	1971 – 1972
Whitehead, VB	Entomologist Entomologist and Head of Dept. Entomologist (retired)	1973 - 1988/ 1988 – 2002
Branco, V	Technical illustrator	1971 – 1989
Eastwood, EB	Entomologist	1974 – 1977
Rae, HE	Technician	1977 – 1982
Car, C	Technician	1980 – 1983
Cochrane,MA (neé Macpherson)	Technician Collections Manager	1982 -
McConnel, B	Technician	1983 – 1984

Roux/Prins, A	Technician	1984 – 1989
Robertson, HG	Entomologist and Head of Division	1989 -
McShane, G	Technician	1989 – 1992
van Noort, S	Entomologist	1992 -
Larsen, D	Technician Assistant Collections manager	1992 -
Larsen , N (Honorary)	Honorary Arachnologist	1995 -
Nokuthula Mbanyana	Trainee Scientist	2005. Permanent from 2006

Annexure 8. Earliest specimens in the entomology collection.

The earliest specimens in the entomology collection are butterflies:

Family	Name	Locality	Collector	Date	Accession number	Drawer
Hesperiidae	Spialia sataspes	Cape Town	R. Trimen	January 1862	SAM-LEP-A001279	LEP01-L07
Lycaeindae	Deloneura immaculata	Bashee River, Kaffraria	J.H.B. (Bowker?). A006032	1863	SAM-LEP-A006031-A006032	LEP11-L05
Lycaeindae	Athene amarah amarah	Butterworth, Kaffraria	J.H.B. (Bowker?)	1861	SAM-LEP-A008007	LEP11-R16
Lycaenidae	Axiocerses tjoane tjoane	Kingwilliamstown	W.D.	3/09? 1860	SAM-LEP-A006847	LEP11-L23
Lycaenidae	Capys alphaeus alphaeus	Wynberg	R. Trimen	October 1862	SAM-LEP-A006497	LEP11-L16
Lycaenidae	Chrysoritis zeuxo	Cape Town	Collector unknown	November 1860	SAM-LEP-A007371	LEP11-R07
Nymphalidae	Amauris (Amaura) echeria echeria	Knysna, S.A	R. Trimen	1858	SAM-LEP-A014355	LEP04-L09
Pieridae	Eurema (Eurema) desjardinsii marshalli	Butterworth, Kaffraria	J.H.B. (Bowker?)	1861	SAM-LEP-A003029	LEP03-L09

Annexure 9. General notes on conservation of biological collections (Notes prepared for SECTION B: CONSERVATION TECHNIQUES FOR BIOLOGICAL MATERIALTechnikon RSA Museum Diploma Course 1994)

To understand the type of material that makes up biological collections.
To understand the types of deterioration that affect biological collections.
To understand how to prevent deterioration in biological collections.
To develop an awareness of the potential long-term hazards resulting from inappropriate procedures and materials.

Introduction

Biological collections may comprise either animal or plant material. Once dead, animals and plants decompose through the effects of bacterial action, temperature and humidity. As the process continues, insects move in to complete the process, and, in the case of most animals, reduce them to bones and dust.

Fortunately, these processes can be arrested at the time of collection. However, there are many instances where this is not done and museums have dust, the end product of the process, gracing their shelves instead of fine specimens. Recent surveys of natural science collections indicate that there are about 500 million specimens actively deteriorating in museums worldwide. This can been attributed to poor preparation, incorrect storage, improper conservation techniques, and also a lack of documentation of procedures used.

This is an alarming situation considering the loss of data and the investment of time, knowledge and money. If monetary value alone is considered, the estimated cost of accumulating a collection of 1 million specimens has been calculated at R130 million.

Most collections have taken hundreds of years to accumulate, involving hundreds and thousands of man-hours of field work in areas which no longer bear any resemblance to what they were at the time of sampling.

But more importantly, the value of collections lies in their future use. In the past, collections formed the basis of taxonomic studies, a branch of systematics, in which animals are described and classified. The study of systematics has expanded to studies of speciation, phylogeny, biogeography, biodiversity, ecology and population genetics.

Furthermore, collections may be used by archaeologists and palaeontologists for comparative purposes.

Developments in conservation techniques of artworks, books and other non-biological collections have far outstripped those of biological collections. This can be attributed to the fact that those who have managed them in the past tended to think in terms of species rather than material. Modern conservators, on the other hand, think in terms of material. Although one must not lose sight of the fact that animal specimens were once living organisms and should be given the empathy they justly deserve, it is important to think of and manage these collections in terms of materials and compatibility of materials. This will then afford them the protection needed to secure them for their future use.

A9.1. Type of collections

There are basically two types of biological or organic collections:
Wet preserved collections, comprising specimens stored in alcohols or a solution of formaldehyde.
Dry preserved collections (which includes botanical specimens) where specimens are stored without fluid preservatives, either with or without prior treatment, in drawers, cupboards or simply in rooms if they are large specimens.

A9.1. Wet collections

Examples of material in fluid-stored collections are the soft-bodied specimens such as invertebrates (except insect adults and some crustacean specimens that are stored dry), amphibians, reptiles, fish, birds, marine animals and some land mammals and embryos, stored in solutions of formalin or alcohol.
Some fluid-stored specimens require fixing and washing prior to storage.

- **Fixing**
  Fixing is the process whereby the protein constituents of tissue are stabilized to prevent deterioration. The specimens are placed in a fixative, for example, 10 per cent formaldehyde for a time, dependant on the size of the animal, varying from 2 days to 3 weeks. With large specimens, fixing can also include injecting muscles, the abdominal area and brain of a specimen with the fixative to ensure penetration of the fluid.

  There is no hard-and-fast rule to evaluate a specimen's readiness for transfer to storage. It is merely felt for hardness and this knowledge is gained from experience. Too soft is underfixed, too hard overfixed.

  After fixing, the material is flushed of residual fixative by washing in successive strengths of preservative and then stored in that preservative. Sometimes small specimens, such as arachnids, may be fixed and stored in the same medium, such as ethyl alcohol.

  Generally, it is large specimens that are fixed to ensure that all tissue is penetrated and stabilized. In particular, irrespective of size, fish are also fixed as fish tissue deteriorates rapidly.

  Specimens must be fixed in a position best suited to making the diagnostic characters visible for study. Once fixed, the specimen is rigid and the positions of its components cannot be altered.

  Formalin is the most common fixing medium. It is a colourless liquid which is used as both a fixing agent and a preservative. It is usually supplied as a 40 per cent solution and is diluted to between 3 and 10 per cent.

  Formalin has the disadvantage that it can present a major health hazard, being carcinogenic, and the fumes cause irritation of the eyes, mucous membranes and respiratory tract and may result in irritation causing skin rashes.

- **Washing**

Once fixed, specimens are washed to remove the formalin as residues left in the specimen can lower the pH to levels that place the specimen at risk. The specimen is therefore washed in successive strengths of preservative until the pH is stable. (See section B 4d).

Preservatives.

- **Formalin.** As discussed above a 3-10% solution of formaldehyde can also be used as a preservative.

  Although a good fixative and preservative, formalin can oxidize to formic acid and the resultant acidic solutions will decalcify bones and teeth, and cause deposits to form on the specimen. (See section B 4d).

- **Ethyl alcohol**
  Ethyl alcohol diluted to about 70-80 per cent by volume is widely used as a preservative; it has stood the test of time and is regarded as the best storage medium, provided collections are checked regularly for evaporation. Ethyl alcohol has the additional advantage that material stored in it can still be used for histological and DNA studies.

  The disadvantages are that it is flammable, expensive, and volatile so the evaporation rate is high. It is toxic if ingested. Undiluted ethyl alcohol is hygroscopic and specimens stored in it will become brittle from dehydration. Colours can also be leached in this medium especially if exposed to high light levels.

  Material generally stored in ethyl alcohol are arthropods (except adult insects (unless DNA samples), which are stored dry), crustaceans, molluscs, annelids, echinoderms, snakes, lizards, frogs, fish, small mammals, and various types of embryos and material for DNA analysis is stored in 80 per cent dilution.

  In the past, glycerine has been used in ethyl alcohol to maintain specimen suppleness. However, if alcohol evaporates from the jar, the glycerine content may increase to a point where clearing of the specimen occurs; also mould is likely to grow on the specimen in the remaining glycerine and water mixture. (Jones and Owen, 1987).

- **Isopropyl alcohol** (isopropanol) is more pleasant to use than formalin and less flammable than ethyl alcohol. However, it renders specimens unsuitable for most histological work and is more expensive than ethyl alcohol. The suitability of isopropyl alcohol for long-term storage is questionable.

- **Propylene phenoxetol** is widely recommended as a post-fixation preservative. Its main advantages are that specimens retain their colour and remain pliable; it is non-flammable and is comparatively inexpensive. It has been recommended that material be transferred from alcohol to propylene phenoxetol (Stansfield, 1986) but the cost is relatively high compared with other preservatives.

Note.
There have been some reports on the effect on specimens by changing from one storage fluid to another where, more specifically, changing from one alcohol to another results in extreme shrinkage but until more is known it is best to maintain specimens in their original preservative. For example, it was found that material previously stored in ethyl alcohol and then placed in isopropanol showed severe damage (Jones and Owen, 1987).

A9.1.2 Dry collections.2 Dry collections

Variously processed dry material
Examples of dry storage are the storage of the insects and other arthropods, birds (skins and feathers), some reptiles, mammal skins, bones, shells, bird eggs, hard corals and plants. Dry material is kept in conditions open to the atmosphere within a small environment such as cupboards or drawers, where control is relatively easy, or in a large environment where control is more difficult. Most of the material is prepared in some way beforehand. For example, skins are treated, insects are pinned and dried and skeletons are prepared.

Freeze-dried material.
Some material is treated prior to dry storage by freeze-drying. Freeze-drying is the process whereby water is removed from frozen material by sublimation under vacuum. That is, water passes directly from the solid phase (ice) to the gaseous phase, omitting the liquid phase. The advantage is that the specimen retains a life-like appearance (if well positioned prior to processing) and there is no shrinkage. This technique is more suited for display purposes. This technique has a more limited application for botanical purposes, although it has been used successfully for mosses, lichens and algae (Stansfield, 1986)

Doubt has been expressed about the long-term preservation of freeze-dried specimens, as they are prone to insect attack. the entire carcass remains intact with the protein not `fixed', and is therefore a more substantial and desirable source of food for pests. (See McInnes 1986).

Other collections.3 Other collections
Biological material also includes microscopic slide preparations of whole small specimens or parts of specimens, such as wings, genitalia and other appendages.

The application of molecular studies and biotechnology to systematics has resulted in new types of non-traditional material that require a different approach to curation and preservation. These non-traditional preparations are referred to as ancillary preparations, one of which is

frozen material such as blood, sperm, tissue, whole animals or venom. These are stored at about -70EC to -90EC.

A9.2. Agents of deterioration

IINTRODUCTIONt is the responsibility of those looking after collections to ensure that the agents (causes) of deterioration are carefully controlled. These destructive agents include:

- Physical neglect (handling, poor storage etc)
- Pollution (poor ventilation, poor quality preservatives)
- Poor lighting (high UV levels)
- Water/ flood
- Fire
- Theft and vandalism
- Incorrect humidity
- Temperature
- Pests
- Oxidation
- Custodial neglect (management policy)

The agents of deterioration common to all collections will be dealt with first. Thereafter, the specific agents of deterioration relevant to each type of collection, and the corresponding conservation procedures, will be examined.

- **Physical neglect**
  Physical neglect is one of the primary causes of deterioration and takes many forms.

  Poor techniques
  A poor attempt at remedial conservation by an inexperienced worker amounts to no more than neglect. All remedial conservation must be left to the specialist as poor attempts at remedying a problem usually results in more damage than before.

  Insufficient space .1 Insufficient space (Physical neglect)
  It stands to reason that the more crammed and cluttered the storage areas, the greater the risk of deterioration through breakage, abrasion, poor maintenance, and loss and neglect in general. Furthermore, a disorganized, confused and unsystematic collection cannot be used effectively and this negates the reason for having the collections.

  Whereas it is difficult to `create' space when it is limited, additional storage can be created through more efficient use of space. Space usage should be carefully planned and effective space saving measures should be sought constantly.

  Vibration .5 Vibration (Physical neglect, poor storage)
  Strong vibration can cause separation of components of specimens and movement of items to a point where they fall from shelves and

stoppers on bottles and vials loosened, which would result in evaporation of fluids.

Ensure that storage areas are free of strong vibration. In areas where earthquakes are a risk, barriers should be used.

Handling and usage
All specimens must be handled with care. This applies especially to heavy items containing specimens. These must be adequately supported to prevent slipping, bending or creating any stress that might alter the value of the specimen.

Loans
Collections form the basis of scientific research and it is one of a collection manager's tasks to ensure that the material is accessible to any legitimate researcher who might need it, whether local or abroad. Material is therefore lent out at the request of an approved borrower.

Lending material is a costly and time-consuming procedure and the risks to the material are enormous. There is the risk of physical damage and loss in the post, neglect by the borrower, failure to return the material and, of course, damage due to destructive analysis.

All museums should have a loan policy and this must be strictly adhered to. There must be strict control over to whom the material is lent. Material should only be loaned to legitimate borrowers who are attached to a recognized institution. Material should not, under normal circumstances, be lent to private borrowers. It should be borne in mind that there are indiscriminate collectors who pay, or are paid, large sums of money for valuable specimens and artefacts.

For transport, material should be packed in such a way that it is well insulated against shock and breakage. Specimens or boxes of specimens, should be packed in larger boxes surrounded by insulation material, such as foam or soft polystyrene chips, the depth of which is at least one third the length of the longest axis of the enclosed container.

Accurate records of loan details should be kept and procedures should ensure that material is acknowledged on receipt by the borrower and the lending institution notified when it is returned.

Destructive analysis
In special circumstances a researcher may request the use of a specimen for analysis that necessitates the destruction or partial destruction of that specimen. Such sampling can decrease the future scientific value of the specimen; in order to balance the legitimate needs of the scientific community with the long-term preservation of the collections, museums should have a strict policy regarding this. Each request for sampling should be considered according to certain parameters and policy of the institution. Permission would depend on

the number of intact specimens that are available and a condition would be that dissected portions be returned in micro vials or on slides.

Poor documentation .8 Poor documentation (Physical neglect)
All changes in methods and procedures of collection care must be documented since changes can only be made on the basis of what has preceded. Without the appropriate documentation, changes in collection care procedures can be regarded as no more than interference and tampering. Poor documentation threatens the scientific integrity and long-term preservation of material. Before making any changes, thoroughly investigate all preceding procedures. Once the changes are made, record and document those changes.

Documentation procedures should be described in a manual where all relevant information pertaining to the collection is recorded and available, especially to new staff members. An example of contents would be:
1. Specimen preparation and treatment.
2. Specimen condition (checklists)
3. Storage/ display environments.
4. Use of collections for research
5. Instructions on collection use.
7. Archival documentation.

- **Pollution .2 Poor ventilation (Pollution)**

  Storage areas should be well ventilated for the benefit of both the collection and the user of the collection. The atmosphere in most collections is loaded with hazardous and damaging fumes, and good ventilation will reduce the hazards associated with these fumes. Good ventilation will also reduce the possibility of corrosion, mould and dust.

  GOOD VENTILATION DOES NOT MEAN EXTERNAL WINDOWS OPEN TO THE COLLECTIONS. These conditions would allow too much fluctuation in temperature and humidity, too much light, and introduce pests from outside.

  Ideal storage conditions are free of windows, but instead have good artificial ventilation system and appropriate lighting.

- **Light.3 Light**

  Materials are affected by both visible light, measured in Lux, and invisible ultra violet (UV) light, measured in micro watts per lumen, w/lm (of visible light). To measure visible light, a lux meter is used and to measure the proportion of UV in visible light, a UV monitor is used.

  Both types of light can cause fading or discolouration of material although UV does more damage due to its higher energy. In general, the shorter the wavelength of light (UV), the more aggressively it causes fading. So fluorescent lights are worse than incandescent lights, but sunlight (especially outside where the light is not filtered by window glass) is worse than either of the former sources of radiation.

Direct sunlight and even strong indirect natural light should be avoided at all costs and where light levels are too high, filters can be used on windows and lights, or exposure time reduced. Fluorescent lighting should also be avoided or filtered as they emit UV radiation. Thomson, 1978: 2-62.

In general, dry-stored material, such as fur and feathers, should not be subjected to light levels higher than 50 lux with a maximum ultraviolet light content of 75 w/1 m. This would also apply to fluid collections. In collection areas where material is exposed to light, it is best to keep the area in darkness when not being used.

- **Water/flood.4 Water/flood**

To reduce the risk of damage from flooding, all material should be stored more than 10 cm off the floor and away from any potentially hazardous areas. Although flooding is the exception, damp is a more common problem. This causes fungal growth on dry-stored material, delamination of woods and discolouration and rotting.

To reduce the risk of moisture-related problems:
- control the humidity (See dry stored material)
- do not store material against damp walls or near leaking pipes.

Although thymol, which is a fungicide, can be used to inhibit mould growth, this does not address the source of the problem.

Some museums have water sprinkler systems as a fire-prevention measure. Material should be sufficiently covered to protect it in the event of the system being triggered accidentally.

- **Fire.6 Fire**

Most collection areas contain large quantities of potentially hazardous materials, such as chemicals, papers, boxes, plastics, etc.

Stocks of these materials should be stored in an organized way, off the floors and away from power points. Bulk storage of flammable goods and chemicals should be in an outside store, and only sufficient stock for immediate needs should be kept in the work area.

- **Theft and vandalism.9 Theft and vandalism**

Although this risk generally falls outside the responsibility of a collection manager, it is nevertheless essential to be aware of the risks. Most museums take precautions regarding this hazard, with special attention focused on valuable and portable specimens. However, theft within a research collection situation is possible especially if an unreliable user is left unattended in the collection store.

The precautions taken in this respect would be determined on an individual basis, subject to departmental policy.

- **Oxidation**

  Most materials in storage are subject to damage from free radicals resulting from oxidation. And while there is not much that can be done about it, it is worth being aware of it so one can make attempts to slow the process by atmospheric controls, namely temperature, moisture, pollutants. (Leckie and Williams, 1994)

- **Custodial neglect**.

  This results when collections are not protected by its custodian in both its actions and policies.

- **Temperature.**
  Temperature control is more important for wet collections while humidity control is more important for dry collections. See below.

- **Pests.** Affect only dry material. See below.

- **Humidity.** Affects only dry material. See below.

A9.3. CAUSES OF DETERIORATION AND PREVENTIVE CONSERVATION OF FLUID COLLECTIONS. CAUSES OF DETERIORATION AND PREVENTIVE CONSERVATION OF FLUID COLLECTIONS

A9.3.1. Poor specimen preparation.1 Poor specimen preparation (Physical neglect)

If fixing and preservation are not carried out correctly using the correct fluids, or if fixing is done too late after collection, decomposition could take place, resulting in a poor specimen that would disintegrate easily.

A9.3.2. Evaporation of liquid preservatives.2 Evaporation of liquid preservatives

Even with, what is regarded as well-sealed containers, evaporation takes place. If routine checks and topping-up are neglected, the specimen will eventually dry out and become brittle and useless. See Annexure 6 Rehydrating dried out liquid preserved specimens.

To prevent this, the evaporation rate of the collections must be known. Once this is established, a system of routine (preferably annually) topping-up must be introduced so that each container is checked before the fluid level drops to a level where the specimen is placed at risk.

Sometimes, for various reasons, there is often doubt as to the preservative in a container. In the past, curators have resorted to the age-old and rather unscientific method of olfactory evaluation. Formalin and isopropanol are

irritating and toxic and this method can prove to be a most uncomfortable exercise, especially in the case of formalin where one's mucous membranes can be rendered useless in one test. Fortunately, there is a safer and more scientific method.

Waller & McAllister (1986) have developed a spot test whereby strips of filter paper are impregnated with an indicator and these are merely dipped into the test fluid with immediate results.
(Waller and McAllister, 1986).

A9.3.3. Incorrect concentrations of fluid preservatives.3 Incorrect concentrations of fluid preservatives (Physical neglect)

If preserving fluids are not of the required concentration and the percentage of water is too high, the specimen will simply rot and will disintegrate when handled. This can result from incorrect preparation of the fluid, and should evaporation take place from ethanol containers, the concentration of water increases as it is the ethanol that evaporates first.

Conversely, if the concentration of preservative is too high, this can damage the specimen, making it too rigid or brittle.

Concentrations of fluids should be checked, especially in the case of a large specimen to jar ratio. The ideal specimen to jar ratio is about 1:6.

If there is any doubt regarding concentration, fluids can either be topped-up or replaced. Replacement is better but too costly for large containers. Topping-up can be done either with the undiluted fluid, and checking the concentration with the appropriate alcohol hydrometer, or with the fluid of the correct percentage. However, the latter could be inaccurate as the assumption is that the existing fluid in the jar is of the correct strength.

It is therefore advisable to build up a profile on the preserving fluids in the collection, taking a random sample based on type of storage fluid, size of container and type of material and even colour of fluid, and measure fluid concentration and pH. This data can then be documented and when enough data has been accumulated, accurate predictions can be made.

A9.3.4. Incorrect pH

pH is a measure of how acidic or how alkaline a substance is. The pH of fluid-stored material is of vital importance. The ideal pH is 7.00. The fluid should be replaced if below 6.50 or above 8.00. If the fluid is too acidic, decalcification can take place and if too basic, clearing can result.

To prevent a change in pH caused by the formation of formic acid in formalin, the addition of a buffer to the preservative is necessary. A buffer is a chemical that can absorb any alkalinity or acidity thereby preventing a change in the pH value of the solution. Hexamine (Hexamethylene tetramine) is one such substance and can be used at a proportion of 200g to one litre of 40 per cent formaldehyde.
(Jones and Owen, 1987).

A9.3.5. Inappropriate containers .5 Inappropriate containers (Physical neglect, poor storage)

Most museums boast a selection of containers as varied as the species they hold, ranging from peanut-butter jars to pill vials.

At the turn of the century, the containers that were used were glass jars with ground-glass lids. Each lid was ground specifically to match its jar. With petroleum jelly to complete the seal, these jars were more than satisfactory.

However, over the years, lids were often switched between jars, rendering the seals inefficient. Furthermore, the glass used was a borosilicate that becomes extremely fragile over the years. Flowing of the glass also takes place over the years, creating uneven thicknesses in the walls, especially of the larger containers. This makes containers fragile and dangerous to handle.

At present, there is an array of containers from which to choose and extreme care must be exercised when making a choice.

Glass is generally considered to be the best material for a storage container. Not only can one see the specimen easily but its durability far exceeds that of plastic. Some plastic containers are satisfactory but become brittle when exposed for long periods to ultra-violet light and various chemicals. If plastic containers are used they must be strictly monitored.

Polypropylene plastic lids seem to be the most suitable material for providing a good seal. Metal is unsuitable as it eventually corrodes, causing the lid to leak. Lids with rubber seals are also unsuitable for long-term storage, as the rubber eventually deteriorates after prolonged contact with the fluids.

When considering containers:

- Test a new type of container prior to use. A great deal of time, money and frustration can be saved by first subjecting a new type of container to an accelerated shelf test. To do this, take a representative sample of the test containers, fill with the fluid, and store at about 35EC. As a control, duplicate the exercise with containers already in use that are known to perform satisfactorily. Examine the containers at monthly intervals. One will get a fair idea of performance in the first few months, but continue the test to render the result conclusive. Compare the two types of containers for evaporation, quality of lid and record the results.

- Standardize on type and size of containers. Not only is a room full of uniformly sized and shaped containers more pleasing to the eye, but it is also more efficient and practical in terms of planning space and storage.

In the case of the smaller containers and vials, a further suggestion would be to place them in holders of some description. Moving individual small jars and vials is time consuming, inconvenient and the risk of breakage is high. However, if holders are used where many jars are grouped together in a line, this facilitates rapid inspection and relocation. Furthermore, this

would also save space as shelf height could be reduced to slightly more than the container height. Handling space above the container would no longer be needed as the unit tray of jars could be slid out when needed. Types of jar holders are wooden trays or rectangular blocks of flame retardant polystyrene with holes drilled for the containers.

A9.3.6. Poor labelling.6 Poor labelling (Physical neglect)

A specimen with no collection details is of little scientific value.

Labels for fluid-stored material should be placed inside the jars but must be legible from the outside. Placing labels on the outside of a container must be avoided as they get stained, chewed by insects or simply fall off. Various papers are available but the paper selected must have a high wet tensile strength, for example a synthetic vegetable parchment or one called Resistol. (See section B 9b).

Data are written on labels in Rotring and Indian ink or 2H lead pencil.

Computer-aided labelling is certainly the ideal but there are various unresolved problems. Certain toners or inks contain resin that is used as a binder and this resin may be soluble in alcohol and sensitive to sunlight, causing print to detach from the paper. Although laser-printed labels seem stable at the outset, the longevity of these labels seems dubious.

In old collections there is the problem of disintegrating labels and it has been suggested that such labels should be replaced by new labels and the old ones filed (Kishinami, 1989).

A9.3.7. Poor temperature control.7 Poor temperature control

As with dry-stored material, temperature and humidity also need to be controlled. The warmer and drier the atmosphere, the greater the evaporation rate.

Ideally, a wet collection store should be at a refrigerator temperature but this is costly and very few museums have budgets that would afford this. Practical conditions would be 18 to 21ºC with as little fluctuation as possible although this is also difficult to maintain in Summer conditions.

A9.3.8. Poor documentation.8 Poor documentation (Physical neglect)

It is important to document fixing and storage procedures of specimens or batches of specimens. This will help researchers to evaluate the usefulness of material, ensure continuity of care, and ensure adequate care while specimens are on loan.

A9.4 Causes of deterioration and preventive conservation of dry collections5. CAUSES OF DETERIORATION AND PREVENTIVE CONSERVATION OF DRY COLLECTIONS.

A9.4.1. Insect pests.1 Insect pests

Skins, hides, bones, horns, feathers (and any material of animal origin) and plants are damaged mainly by the beetles *Anthrenus* and *Dermestes* (Dermestidae, order Coleoptera) and *Stegobium* and *Lasioderma* (Anobiidae, order Coleoptera), clothes moths (Tineidae, order Lepidoptera), cockroaches (Blattidae, order Blattodea), fish moths (Lepismatidae, order Thysanura) and Booklice, (Psocidae, order Psocoptera).

Insect infestation becomes apparent as the droppings (frass) and/or exuviae (cast skin of larvae) settle around the affected specimen. Frass varies from fine brown powder to small pellets, depending on the insect involved. When this happens instant action must be taken against infestation. One must consider that, by the time the frass is visible, damage will already have taken place. Furthermore, after treatment this frass must be cleaned away so that future infestations can be detected.

Just as fluid collection levels are checked regularly, dry material needs to be checked and evaluated for insect damage at regular intervals with regular fumigation or preventive measures to remove the pests. A programme for this should be instituted so that the entire collection is inspected at least annually.

NOTE
For osteological collections, the bones of small specimens are cleaned by making use of a colony of dermestid beetles. This process should never be undertaken in the vicinity of stored collections but instead, in an isolated area well away from collection areas.

Infestation can be prevented by:

- Removal of the source of infestation.
  Potential sources of infestation outside the museum must be removed, for example compost, damp and rotting vegetation, nests and dead animals in and on the building, especially near ventilator inlets and outlets. Certain blue- and white-flowering Asteraceae are known to attract the varied carpet beetle (*Anthrenus*).

- Physical barriers
  Barriers such as well-sealed drawers, cupboards, gauze over air intakes, polyethylene plastic bags etc. are ways of preventing insect pests from getting into the collections. Cabinets doors and lids of drawers in which material is stored should have good seals to prevent the entry of insects.

- Chemical methods.
  The current trend is away from the routine use of insecticides due to the health risk to staff and to the collection material. Consideration

must be given to the fact that fumigants not only destroy the pests but in some cases, the collection material as well. (Peltz & Rossol, 1983)

The approach now preferred is a routine and systematic inspection of the collections, treating only when and where necessary. THIS SYSTEM CAN ONLY BE INSTITUTED ONCE THE ENTIRE COLLECTION HAS BEEN TREATED FOR PESTS AND ALL EVIDENCE OF THEIR PRESENCE REMOVED. In addition, all incoming material (returned loans, new material) must be treated for pests before incorporating into the collection.

In the past, material was treated with DDT, arsenic and other extremely toxic non-biodegradable substances. For this reason, it is best to wear protective clothing when handling the material, namely disposable gloves, dust smock and mask.

ALL PESTICIDES MUST BE CONSIDERED TOXIC, the relative toxicity to the individual being dependent on age and general state of health.

Chemical can be used in various ways:

Barriers
Benzene hexachloride (gamma-BHC, Lindane)

Gamma-BHC in a paraffin base can be painted around the rims of drawers and cupboards, thereby acting as a deterrent.

Baits
Bait or attractants are prepared by mixing the chemical deterrent with a foodstuff attractive to the pest. An example of this is bait made for the control of fish moths.

Anti-feedants
In this method chemicals are applied to the specimen needing protection. For example, by impregnating the fur of an animal with the chemical deterrent. This system applies to the vertebrate material. For example, sodium fluosilicate can be used during the preparation before mounting of specimens.

EULAN, an aromatic sulphonamide derivative, has also been used to mothproof specimens during mounting. EULAN is non-toxic to humans but it makes the protein indigestible to moths and beetles, thereby rendering the material permanently protected
(Rau, 1968).

Fumigation
This is the method by which toxic gas is distributed throughout the storage area. Application is either gaseous or a by using a solid or liquid that releases a gas.

The use of fumigation should not be limited to when infestation becomes apparent but also as a preventive measure. Before new material is introduced into a collection or any storage area, it must be checked for the presence of insects and the standard procedure must be to treat it in some way to kill off any possible insects. This is done not only to prevent damage to the incoming material but also to prevent existing collections from becoming contaminated. Furthermore, when material is returned from a loan, it too must receive similar treatment.

Should there be an infestation of a large volume of material where a whole room needs treatment, outside contractors can be used. They can either treat the material on site or material can be taken to them.

Fumigants:

DDVP (dimethyl-dichlorovinyl phosphate), Dichlorvos or Vapona.
DDVP is used extensively in households as well as agriculture. This an effective fumigant but is toxic and must be used carefully. This material is banned in some countries but is readily available in this country. It is highly volatile and breaks down within two to seven days. Over exposure to it will cause nausea, headaches, dizziness, pains in the kidneys and can lead to liver damage. It must be handled with rubber gloves in a well-ventilated area. Where containers have been treated with DDVP, they should be opened and ventilated for several hours before the specimens are worked on. It is also a carcinogenic substance.

DDVP is ideally suited to confined spaces such as drawers, cupboards or display cabinets where small pieces can be placed in each unit for about one week and then removed (Endrödy-Younga & Baunok, 1984).

DDVP is slightly heavier than air, so it would need to be placed in a raised position if used in a large area. Its effectiveness is also reduced with an increase in relative humidity.

It is acidic and therefore corrosive. It is not suited to collections where metal is used, such as insect pins, and it has been known to cause bleaching when certain material, such as butterflies and moths, is exposed to it for long periods.

Fumigation using domestic `foggers' can also be used.
(Dawson, 1992: 11).
(Hall, 1988: 895).
(Williams & Walsh, 1989: 34-69).

Paradichlorbenzene (PDB)
Is one of the least toxic but an effective insecticide although carcinogenic over long periods of exposure. It is also effective against mildew.

The vapour is heavier than air so it must be placed above the material being treated.

However, it can affect some plastics and can bleach some materials. It can also dissolve fats, so that skins exposed to it could become greasy.
(Dawson, 1992: 13).

Naphthalene
Was a very popular fumigant in earlier times but there is some doubt as to it effectiveness. (Dawson, 1992:12). It acts as a deterrent but fails to kill effectively. Also carcinogenic.

Methyl bromide
This chemical is not suited for metals or materials containing proteins but is more suited for the fumigation of books and paper. It is highly toxic and its use is now being phased out because of its ozone depletion qualities.
(Dawson, 1992: 12).

Other methods

Carbon dioxide.

Although not strictly a fumigant, the use of carbon dioxide has been proposed as a safe alternative for de-infestation. To date is not a practical option as the material requiring treatment needs a long exposure time.

Freezing.

Remove the lid of the drawer, place in a polyethylene bag, remove some of the air and seal. Place in the deep-freeze for about 72 hours. Remove and allow to stand at room temperature until there is no evidence of moisture in the bag. (Florian 1986, 1990, Graham-Bell, 1986).

Heating.

This technique is best suited to insect collections, where freshly collected material is set and then dried at 60ºC for about 12 hours. Insects are unable to withstand extended periods at a high temperature. This procedure is not suited to vertebrates and collections where skins, wood, paper and fabrics can be damaged by heat and desiccation.

AFTER TREATING MATERIAL FOR PESTS, REMOVE ALL EVIDENCE OF THEIR PRESENCE. Only by doing this will it be possible to detect re-infestation.

A9.4.2. Incorrect temperature and humidity.2 ncorrect temperature and humidity

Ideal conditions for storage are a temperature between 19º and 21ºC and a relative humidity (RH) between 55% and 60% (See McInnes 1986). At a relative humidity over 65% there is a danger of mould growth on specimens and pelts. Extreme dryness should be avoided where skins and pelts are concerned as desiccation can cause cracking and embrittlement. Although certain collections such as dry stored arthropods and bone are not unduly affected by a low relative humidity, it is always best to maintain a stable relative humidity as fluctuations will expand and contract the material and this can eventually cause damage.

Although elevated temperatures might not affect some material directly, it is important to remember that all reactions between materials and substances are accelerated at higher temperatures.
(Thomson, 1978: 64-121).

A9.4.3. Poor cleaning and handling.3 Poor cleaning and handling (Physical neglect)

Surface dust, if left untreated will penetrate bone, fur and feathers and can become impossible to remedy. Specimens should either be kept in dust-free cabinets or drawers or covered with polyethylene plastic (not Polyvinylchloride PVC. See section B 5e).

Light surface dust may be blown off using compressed air (not near delicate specimens!), or gently brushed using a feather or soft brush. Heavily soiled specimens will require special treatment.

Grease marks on birds and mammals are a result of improper preparation and degreasing before mounting. This needs to be attended to by a taxidermist. Grease stains act as an attractant to insects so prompt action must be taken.

A9.4.4. Poor labels.4 Poor labels (Physical neglect)

Various types of labels are used for dry-stored material. Before selecting a material for labels, it must be fully investigated. It must be inert and acid free, whether it is paper, card, metal or plastic.
(Hawks & Williams, 1986: 105-108).

A9.4.5. Pollution.5 Pollution

There are two types of pollution, particulate and gaseous. Particulate is where actual particles are suspended in the air and gaseous is where vapour of a substance is mixed with the air.

Micro-environments inside storage areas must be free of materials that can interact and degrade the specimens. Pollutants in enclosed environments can result from fumes emitted by wood used to manufacture the cupboards, paper, cardboard, paints, synthetic polymers and adhesives and even other specimens; the most damaging of these being wood and wood by-products.

Wood, especially teak and oak, exudes volatile acetic and formic acids that corrode metals such as support wires, insect pins and labels. They have been known to react with egg shells and molluscs, resulting in Byne's disease, where a destructive efflorescence forms when calcium from the specimen reacts with the acids.

To seal the wood of cabinets, a two-component polyurethane varnish must be used (See section A 10b Chemthane). The single component household type emits volatile substances for long periods after coating (Conversation with C. Hawkes 1993 and notes, Material for Mounts, from 1992 International Symposium in Madrid).

Specimens such as birds, mammals, shells, eggs and bones should therefore not be placed directly on to wood or cardboard. They should be stored on padding covered with acid free tissue paper.

Polystyrene foam is also unstable and it exudes harmful volatile substances. An alternative is polyethylene foam. An example of its use is for the pinning bases in an insect collection.

Where plastic bags or covers are used, polyethylene plastic, and not polyvinylchloride, must be used. The latter gives off chlorine which can bleach, corrode and denature certain materials.
(Thomson, 1978: 124-154).

Testing for pollutants

PH Testing.4 pH Testing.

The pH of a cupboard or drawer can be tested by using pH papers. The best to use are those made by Merck. These are first dipped into a mixture of de-ionised water and glycerine. Using purified de-ionised water will ensure that there are no substances in the water that will interfere with the results. The glycerine keeps the paper moist enabling substances in the atmosphere to go into solution on the pH paper. Leave the paper in position for 24 hours and then evaluate.

Beilstein test..5 Beilstein test.

To test for chorine. The test is based on the reaction of chlorine with copper compounds at high temperatures, using a Bunsen burner, to produce substances that burn with a bright green flame.

Method.
Heat a piece of copper wire (used for wiring houses, stripped of its insulation) to glowing red in a Bunsen burner. Heat until no colour, except the flame colour, is visible. There should be no green colour in the flame. The wire can be cleaned by first dipping it into 10% nitric acid. After heating the wire, touch a piece of the material being tested and return the wire to the flame immediately. A plume of green is a positive test for chlorine.

Read CCI Notes 17/1 for details and hazards.

A9.5. Causes of deterioration and preventive conservation of microscope slide material

Microscope slides should be stored flat to prevent movement of the specimen and coverslip should the mounting agent not be completely set. They must not be placed directly one on top of the other and must be protected from dust, damp and light.

Microscope slides are stored in commercially available slide cabinets or any custom made cabinet.

For transport purposes, microscope slides must be placed flat in cardboard slide-holders and then packed in an insulated box.

A9.6. Causes of deterioration and preventive conservation of frozen ancillary material . CAUSES OF DETERIORATION AND PREVENTIVE CONSERVATION OF FROZEN ANCILLARY MATERIAL.

The application of molecular studies and biotechnology to systematics has resulted in new types of non-traditional material also requiring curation and preservation. These non-traditional preparations are referred to as ancillary preparations, one of which is frozen material that is kept at temperatures of minus 70º to minus 90ºC. This type of material includes tissue, blood, whole animals, semen, venom, etc. and usually complements material in other types of collections, for example whole animals, skins, skeletons, etc.

Storage of this type of material is problematic as the specimen cannot withstand any variations in its environment. Any thawing will allow the proteins to deteriorate and therefore the value of the specimen will be lost.

Disadvantages:

Cost of the equipment - the development and maintenance of such a collection is expensive, (Ultra-cold freezer and liquid nitrogen tanks). Furthermore, an alarm and back-up generator for the freezer is also required in the case of a power failure.

This type of collection exists for the sole purpose of analysis and is destroyed in the process. This not only brings us back to the ethical concerns of destructive analysis discussed above but also to the issue of numbering and accessioning. The accessioning system used will have to allow for the loss of material. Furthermore, there is a need for an efficient system of cross-referencing accession numbers, analysis results with voucher specimens in traditional collections.

Storage and rapid location of samples. Storage space is limited yet more than one specimen is needed for future use. Specimens need to be stored so they are rapidly and easily accessible without the risk of raising the temperature in the freezer.
(Cato & Schmidly 1991: 91-99).

A9.7. Causes of deterioration and preventive conservation of herbarium material . CAUSES OF DETERIORATION AND PREVENTIVE CONSERVATION OF HERBARIUM MATERIAL

A9.7.1 Insect pests.1 Insect pests

The primary offenders are the cigarette beetle, *Lasioderma serricorne* and the drugstore beetle, *Stenobium paniceum* (Anobiidae); and the varied carpet beetle, *Anthrenus verbasci* (Dermestidae), the German and American cockroach, *Blatella germanica* and *Perplaneta americana*; fishmoths, *Lepisma saccharina;* and booklice, *Lipscelis* and *Trogium* (Order Psocoptera)

Infestation can be prevented by:

- Removal of the source
- Physical barriers.
- Chemical methods. The most widely used means of herbarium pest control is an annual fumigation with Methyl bromide. This is done by outside contractors when the conditions are optimal for insect activity, that is, in summer when temperatures are around 25ºC and RH about 75%
- Microwave. Microwave treatment is used in herbaria but only on fully dried material.
- Low RH (Relative Humidity). A low RH and clean incoming air are major factors in reducing pest infestations. A RH of below 50 per cent will prevent fungal growth thereby eliminating the food source for psocids. A low RH will also inhibit the growth of certain pests.
- Freezing. Rapid freezing of specimens at minus 18ºC will destroy insects. For resistant dermestids it is suggested that the material is frozen rapidly, thawed and then refrozen. Hall, 1988: 885-905. Florian, 1990: 1-7.

A9.8 Health and safety

A museum working environment carries potential health hazards and employees need to be aware of them. Workers are very often exposed

to hazardous chemicals and insecticides over long periods and while the effects are not always felt over a short period, the accumulatory affect can result in illness later in life.

In the entomology department the primary threat is from insecticides used for fumigation and insecticide residues on old specimens, drawers and field boxes.

Inhalation of fumigants must be avoided and areas that have been fumigated must be vented well before entering the area.

When handling hazardous chemicals such as Lindane, protective gloves must be worn as the chemical can be absorbed by the skin. Inhalation of alcohol fumes must also be avoided.

Hands must be washed after handling drawers and old field boxes as the latter especially are contaminated with DDT and Arsenic, chemicals that were freely used in the early days of collection preservation.

Formalin is severely irritates the mucosa causing severe burning and sensitivity and is also carcinogenic. The very fact that it is used to fix tissue of dead animals, suggests that prolonged inhalation could also fix one's lungs. Protective equipment must be worn or extractors must be used when working with this chemical.

Acquisitions of birds and mammals carry potential disease risks such as Avian Flu, Plague (Cosgrove et al, 1992), Anthrax, Rabies, Bovine Tuberculosis, Brucellosis, Psittacosis (Parrot fever),Tularaemia and Tetanus. Workers are usually routinely inoculated for Rabies and Tetanus. When dead birds and animals are received, the cause of death must be known and museum workers must wear masks and gloves when preparing them.

Annexure 10. References.

ANDREI, M. A. and GENOWAYS, H. H. 1999. Changes in pH in Museum Storage Fluids, 1-Effects of Resistall Paper Labels. Collection Forum 13(2): 63-75.

BEIRNE, B. P. 1955. Collecting, preparing and preserving insects. Publication. Canada Department of Agriculture. 932: 1-133.

CATO, P. S. & SCHMIDLY, D. J. 1991. Policies concerning the use and management of ancillary preparations in vertebrate systematics collections. In: Cato, P. S. & Schmidly, D. J. eds. Natural History Museums: Directions for Growth: 91-104. Lubbock: Texas Tech University Press.

BOT, J., SWEET, S. & HOLLINGS, N. 1986. A Guide to the Use of Pesticides and Fungicides in the Republic of South Africa. Pretoria: Department of Agriculture.

CANADIAN CONSERVATION INSTITUTE. 1984. Care of Mounted Specimens and Pelts. CCI Notes 8/3.

CANADIAN CONSERVATION INSTITUTE. 1989. The Beilstein Test, a simple test to screen organic and polymeric materials for the presence of chlorine. CCI Notes 17/1.

COCHRANE, M. A. 1992. Report on the International Symposium and First World Congress on the Preservation and Conservation of Natural History Collections in Madrid. Unpublished report. Cape Town: South African Museum.

COSGROVE. J., DONALDSON, D., HUGHS and MALOFF. W. 1992. Plague at the museum: Disease transmission potential and biosafety precautions. Collection Forum 8(1):1-8.

DAWSON, J. E. 1992. Solving museum insect problems: chemical control. CCI Technical Bulletin 15: 1-26.

ENDRöDY-YOUNGA, S. & DAUNOK, I. 1984. Efficiency and health hazards tests on Vapona used in insect collections. Entomologia Generalis 10(1): 47-51.

FLORIAN, M-L. E. 1986. The freezing process - effects on insects and artifact materials. Leather Conservation News 3(1): 1-13.

FLORIAN, M-L. E 1990. Freezing for museum pest eradication. Collection Forum 6(1): 1-7.

GRAHAM-BELL, M. 1986. Preventive conservation: a manual. Handbook 2. British Columbia Museums Association.

HALL, A. V. 1988. Pest control in herbaria. Taxon 37(4): 885-907.

HARGRAVE, C. W., SUTHERLAND, K G., MARSH-MATTHEWS, E. and MATTHEWS, W. J. 2005. Multiple Interacting Factors Affect pH in Museum Storage Solutions. Collection Forum 19(1-2): 23-31.

HAWKS, C. A. & WILLIAMS, S. L. 1986. Care of Specimen Labels in vertebrate research collections. Proceedings of the Workshop on Care and Maintenance of Natural History Collections. Royal Ontario Museum Life Sciences Miscellaneous Publications: 105-108.

HERHOLDT, E. M. 1990. Vertebrate collections management: a personal perspective with special reference to southern Africa. In: Herholdt, E. M. ed. Natural History Collections. Their management and value: 1-11. Pretoria: Transvaal Museum.

JONES, E. M. & OWEN, R. D. 1987. Fluid preservation of specimens. In: Genoways H. H., Jones, C. & Rossolimo, O. L. eds. Mammal Collection Management: 51-63. Lubbock: Texas Tech University Press.

KISHINAMI, C. H. 1989. Archival Storage of Disintegrating Labels from Fluid-Preserved Specimens. Collection Forum 5(1): 1-4.

LECKIE, C. G. K. and WILLIAMS, S. L. 1994. Studies of the Russell Effect: Part 1 and Part 2. Collection Forum 10(2): 50-64

LONDT, J. G. 1986. A Beginners Guide to the Insects. A Wildlife Handbook. Wildlife Society of Souther Africa.

McINNES, G. Y. 1986. Conservation and storage: vertebrate material. In: Thompson, J. M. A. ed. Manual of Curatorship. A Guide to Museum Practice.

MORTON, J. E. 1950. Collecting and preserving zoological specimens. Tuatara 3(3): 104-114.

PELTZ, P & ROSSOL, M. 1983. Safe pest control procedures for museum collections. New York: Centre for Occupational Hazards.

PUYLAERT, F. & JOCQUÉ, R. 1992. `CAL': New Era in Labelling for Alcohol Collections. Newsletter of the British Arachnological Society. 64: 5.

RAU, R. 1968. insecticides and the Eulan treatment. Southern African Museums Association Bulletin 9(2): 60-63.

ROBERTSON, H. G. 1992. Report on International Symposium and First World Congress on the Preservation and Conservation of Natural History Collections in Madrid. Unpublished report. Cape Town: South African Museum.

SMITHERS, C. 1982. Handbook of Insect Collecting. Delta Books. Johannesburg.

STANSFIELD, G. 1986. Conservation and storage: biological collections. In: Thompson, J. M. A. ed. Manual of Curatorship. A Guide to Museum Practice: 289-295.

STEEDMAN, H. F. (ed.) 1976. Zooplankton fixation and preservation. Paris: UNESCO.

THOMSON, G. 1978. The Museum Environment. 1st edition. London, Boston: Butterworths, in association with the International Institute for Conservation of Historic and Artistic Works.

UPTON, M. S. & NORRIS, K. R. 1980. The Collection and Preservation of Insects and other terrestrial arthropods. *The Australian Entomological Society 3*. Brisbane.

UYS, V. and Urban, R. (Eds). 1996. How to Collect and Preserve Insects. Plant Protection Research Institute Handbook 7. Pretoria.

VAN DER MERWE, M. 1992. Report on the International Symposium and First World Congress on the Preservation and Conservation of Natural History

Collections in Madrid. Unpublished report. Cape Town: South African Museum.

WALLER, R. & MCALLISTER, D. E. 1986. A spot test for distinguishing formalin from alcohol solutions. Proceedings of the 1985 Workshop on Care and Maintenance of Natural History Collections. Life Sciences Miscellaneous Publications. Royal Ontario Museum.

WALLER, R. and STRANG, T. J. 1996. Physical Chemical Properties of Preservative Solutions -1. Ethanol-Water Solutions. Collection Forum 12(2): 70-85.

WILLIAMS. S. L. & HAWKS, C. A. 1986. Inks for documentation in vertebrate research collections. *Curator* 29(2): 93-108.

WHITEHEAD, V. B. 1983. Methods of insect Control in Museums. Unpublished paper read at the South African Museum Association Western Cape Regional Conference, Stellenbosch.

WILLIAMS, S. L., HAWKS, C. A. & WEBER, S. G. 1986. Considerations in the use of DDVP resin strips for insect pest control in biological research collections. Biodeterioration 6: 344-350.

WILLIAMS, S. L. & WALSH, E. A. 1989. Developing chemical pest control strategies for museums. Curator 13: 34-69.