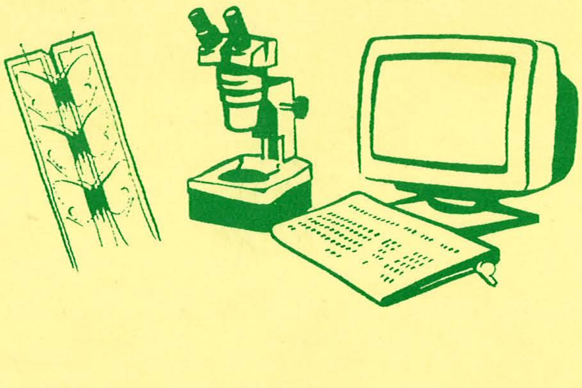
Journal of Biological Curation



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Journal of Biological Curation

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The Biology Curators Group was founded in 1975 with the following terms of reference:

1. To facilitate the exchange of information between individuals concerned with the collection of biological specimens and records, their conservation and interpretation.
2. To present the views of biological curators to the Museum Association and other bodies.

BCG holds regular meetings, usually based on topical themes, and occasionally in association with other groups. There are usually two meetings a year, one in the Spring which incorporates the AGM, and one in the Autumn.

Part Five completes Volume One of the *Journal of Biological Curation*, and is the issue for the subscription year 1993. The Committee of the Biology Curators' Group plan to amalgamate the *Journal* and the *BCG Newsletter* into a new publication, *The Biology Curator*, which will commence publication in subscription year 1994. Write to the Editor or the Newsletter Editor for information on back issues of the *Journal* or the *Newsletter*.

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The Design of an Education Aquarium

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Abstract

The original concepts of the Natural History Centre and Aquarium at Towneley Hall was to provide an education facility for schools, colleges and the local community. In June 1986 it was decided to upgrade the aquarium within the confines of the Zoo Licensing Act 1981 and improve the educational potential. This paper details the technical design of the new aquarium, and summarises its educational advantages.

Introduction

Interest in studying living material in aquaria originally developed in the mid-nineteenth century and the modern sciences of marine and freshwater biology arose from these early discoveries. The word aquarium - derived from the latin (a place for watering cattle) - was used to describe various glass receptacles designed by Phillip Henry Gosse and used for housing various species of aquatic life. In 1855 Gosse was successful in formulating a recipe for artificial seawater which enhanced the situation for land locked biologists.

Around this period public institutions, notably museums, began to display living material. Liverpool Museum was so successful in this venture that visitor figures increased by twenty per cent in the year 1857. Evidence for this popularity can be seen from the 5th Annual Report (Liverpool Museum, 1858) which states that:

"During the year several aquaria both salt and freshwater have been established in the museum and have proved objects of very great interest to visitors; indeed, there is good reason to suppose that it is mainly owing to these new additions that the number of visitors has been so much in advance of previous years".

When present, live animal exhibitions have consistently proven to be the most popular attraction in museums.

The Natural History Centre at Towneley Hall

The Natural History Centre was erected in Towneley Park in 1983 on the site of two old greenhouses in the old walled garden. The original greenhouses were used by the Parks Department to exhibit various plants and animals on a very informal basis to the general public on request. The Natural History

Centre was financed from the proceeds of a Municipal Lottery and was officially opened in 1984. The new aquarium was fully operational by 1989.

The Brief for the New Aquarium

In drawing up the brief for the aquarium the original concept of the Natural History Centre was followed, *i.e.* to provide an educational facility for schools and colleges. It was decided to make the exhibits relevant to the local area by displaying fauna and flora found in and around Lancashire. Various education bodies were consulted, notably the Curriculum Development Centre in Burnley (part of the Local Education Authority), and STEEL (Science and Technology Education in East Lancashire). Both these organisations are concerned with the development of science teaching up to 'A' level and provided useful information on the objectives, content and assessment patterns standardized in the Biology Syllabus for 1989.

In biology the educational purposes of following a course for the GCSE examination are described as:

1. To develop an interest in and enjoyment of the study of living organisms.
2. To encourage an attitude of curiosity and scientific enquiry.
3. To promote an appreciation of the importance of experimental and investigative work in the study of biology.
4. To promote respect for all forms of life.
5. To develop knowledge and understanding of fundamental biological concepts and principles.
6. To develop awareness of the relationships between living organisms, between living organisms and their environment, and the effect of human activities on these relationships.

The aquarium is the ideal vehicle to demonstrate an understanding of living things. The content of the nationally agreed syllabus is divided into four themes:

1. Diversity of Organisms
2. Relationships between organisms and the environment
3. Organization and maintenance of the individual
4. Development of organisms and the continuity of life

The Natural History Centre fulfils most of these criteria using living displays, graphics and audio visual presentations. It was apparent from these aims and objectives that a large proportion of the curriculum required a practical input. One of the purposes of the examination is to assess the candidates' ability to make accurate observations and measurements; conduct simple experiments; record observations, data and other information in a concise, logical form; analyse, interpret and draw conclusions from experimental data and other biological information.

In order to display as many diverse organisms as possible and demonstrate relationships between these organisms it was decided that the display should contain seven ecosystems:

1. Stream
2. Canal
3. Predator Tank
4. Lake
5. Estuary and River
6. Tidal Rock Pool
7. Sub-Littoral Area of a Rocky Sea Shore

It was felt that within these ecological niches it would be possible to show how physical and biotic factors influence the relationships between various organisms, and the effect of the organisms on their environment. The aim was to demonstrate aspects of ecology such as competition, dependence and interdependence, food chains and food webs.

The formulation of this brief was discussed at all stages and comments were received from various organisations. A fairly large aquarium was set up in the Natural History Centre prior to the building of the main displays, in order to monitor the reaction from schools and the general public by means of a questionnaire based survey. The test display showed animals and plants found in a tidal rock pool and allowed the staff to experiment with various types of lighting and filtration. It proved to be a resounding educational success and we were able to demonstrate various behavioral phenomena such as symbiosis. We also used the display to gain support from councillors during our annual committee inspection.

During the construction of the aquarium, work packages were designed to include practical studies related to local ponds and streams and to the River Calder. The 'Pond Life Package' includes lectures, worksheets and equipment for experimental work, including measuring physical factors, e.g. temperature, light and pH. Equipment provided includes nets, trays, specimen containers for collecting organisms and a range of microscopes, magnifiers, keys, etc. for studying the material.

Experiments include estimating population densities using nets and counters; sampling the plant community and the mud; studying adaptations for breathing, e.g. looking at secondary adaptations of aquatic insects and classifying these structural modifications under the functions they fulfil, e.g. movement, reproduction and life in running water.

The work packages are closely related to the displays in the aquarium and many of the species caught during the sessions can be viewed in great detail in the aquaria. Therefore in order to exhibit these species to their best advantage the design of the infrastructure required careful consideration.

Design of the Aquarium

The project needed to be phased, so that the finances could be spread over a longer period of time and alternative sources of revenue could be investigated, e.g. grant aid and sponsorship, to give a reasonable financial base. The initial stages consisted of a new roof, the installation of the main display tanks and associated plant; and the construction of a quarantine section to house reserve tanks and food preparation area.

There was a fairly flexible timescale; construction began in 1987 and finished in 1988. Once the aquarium was functioning there was a two month period before fish and invertebrates could be introduced, to allow the filter beds to establish their bacterial faunas for biological filtration.

It is much easier to maintain large aquaria with efficient filtration systems rather than maintain a larger number of smaller tanks with less efficient back-up facilities. There was little chance of increasing the current establishment of two natural history staff so the staff time available for maintenance was an important factor to be considered. Therefore the scope of the project was limited to seven large tanks with associated filters to display seven basic habitats. This also maximised the educational impact and provided the optimum conditions for the welfare of the inmates. Plans and specification were drawn up and passed to the Borough Surveyors Department in January 1987.

Maintaining a Closed System

In order to maintain each habitat and imitate the conditions found in the animal's natural state in an aquarium, environmental factors such as temperature, light levels and water chemistry needed to be carefully controlled. It might be possible to maintain the conditions in a closed system within tolerable limits and the animals may stay healthy and survive for long periods. However, there is little scope for the animal to show any other activity, or withstand further environmental change.

The very act of confining an animal and restricting its sensory experiences, mobility and choice of diet limits its ability to regulate its internal state. If confined for long periods in unsuitable conditions an animal may be able to show morphological and physiological adaptations, e.g. a fish may increase the number of red blood cells in oxygen poor water or may exhibit some reorganisation of its metabolism and enzymes when exposed to a different temperature. However, these long term changes are not reactive to environmental conditions seen in exposure to seasonal fluctuations. Therefore, if conditions could not be maintained to keep the animals acclimatised and living well within a range over which they can regularise their physiology and behaviour (preferably close to some optimum where the costs of regulation are minimal) then the educational potential cannot be exploited fully.

For the project to be a success, the infrastructure, i.e. lighting, filtration, temperature control, etc., and the quarantine back-up facilities needed to be designed to very high standards within a facility for additional technology as and when it became available.

Artificial Light

The special composition of artificial light is very important for the well-being of fish, invertebrates and plants. The main point is to supply the wavelengths which stimulate photosynthesis and simulate natural lighting conditions in fresh and salt water. With these requirements in mind, high pressure mercury lamps supplemented with actinic blue lamps were chosen. 'Flora Set P and F' offered an range of benefits:

1. Compact design; as we were limited for space above the tanks.
2. Simple installation by means of a mounting bracket; most of the lamps were fitted in-house.
3. Built-in terminal for easy connection; again this simplified in-house installation.
4. Very long lamp life; this was an excellent economy measure and reduced running costs.
5. Low heat generation; a very important benefit, although some of the tanks would be individually cooled, it was hoped that the ambient temperature would be kept at about 13°-15°C.
6. Uniform light distribution; high illumination is very important especially for invertebrates. However certain areas of some of the tanks were to be shaded to create low light levels to provide quiet secure places.
7. Spectrum effective for plant growth; it was hoped that living plants would eventually be grown.

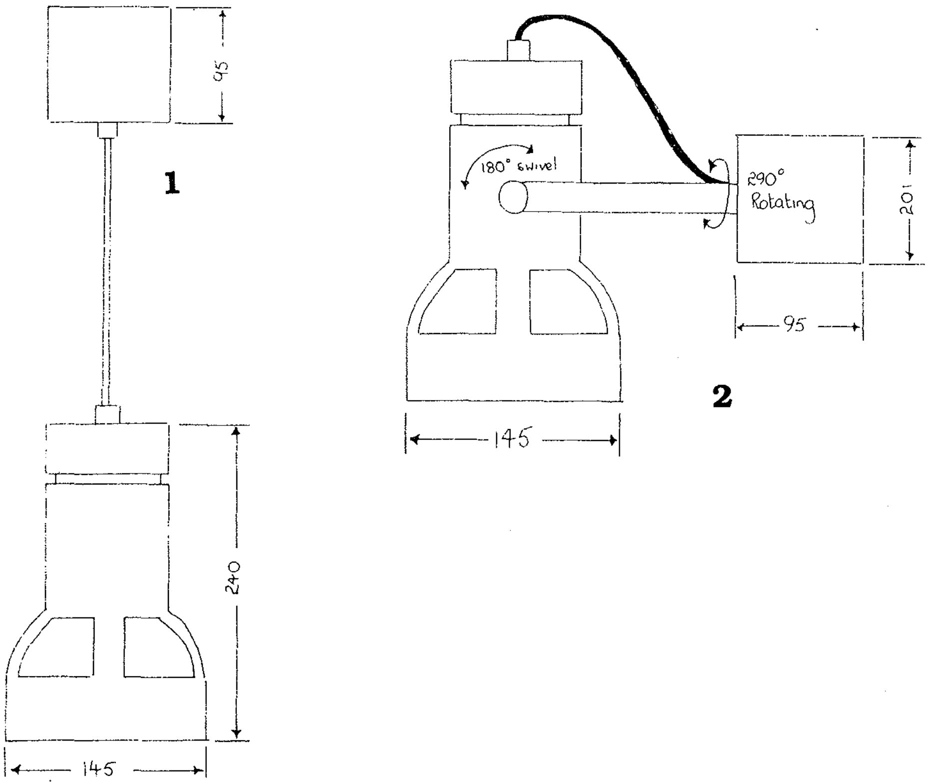

Fig. 1 Flora-Set lights, measurements in mm. 1. pendant; 2. wall-mounted.

8. Economical with high luminous efficacy; the HQL-R 80W De Luxe lamp was used in the FLORA-SET and used only 80 watt (plus 9 watt for ballast) and it generated approximately the same luminous flux as 2 incandescent reflector lamps of 150 watts each.

Each tank will have 3 pendant fittings, with an additional three wall-mounted fittings above the rock pool tank, giving a total of 24, 80 watt lamps (see figs 1 and 2). The lighting would be controlled on a timeswitch which allowed a variation of day length on a seasonal basis. Each set of lights above the tanks would be individually controlled by a cord switch. A particular advantage of this type of lighting is the slow increase in luminous flux after switching on the lamp. The full luminous flux is reached approximately 3 minutes after switch on. This prevented any undue stress to the fish and they are acclimatised slowly to an increase in light levels.

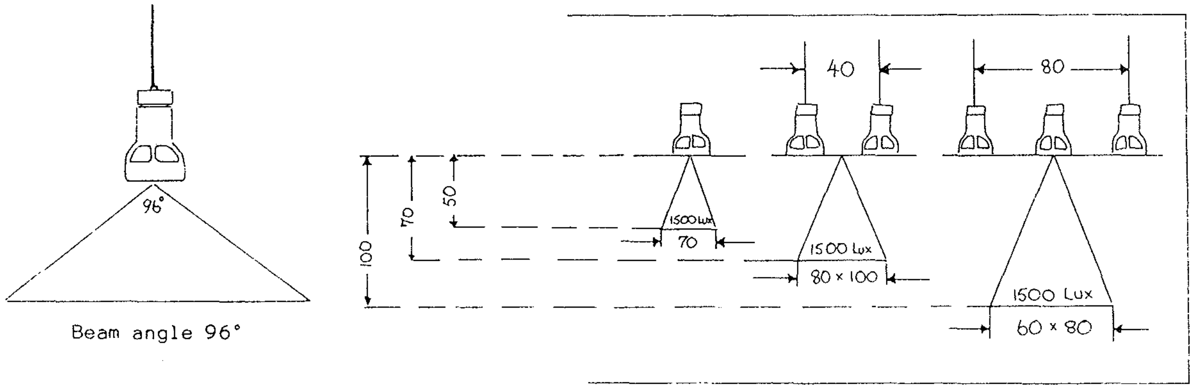

Fig. 2 Flora-Set lights, diagrammatic representation of beam angles and light intensity (measurements in cm.).

Spectral Analysis - The biochemistry of the plants and animals is very complex, e.g. in plants photosynthesis takes place in light of 435/450 and 650/700 nanometres (see figure 3). Photomorphogenesis (plant patterns - leafshape) are determined in the range 600-750 nm and phototropism (the direction a plant will face) requires light at the blue end of the spectrum (350-500 nm). The Flora-Set HQL-R80W de luxe light is manufactured to a CIE specification under the abbreviated title of Full Spectrum Lighting. This provides the correct balance of ultra violet, which research is now showing to be necessary for the health of plants and fish.

Actinic Tubes - Although the Flora-Set provided a good spectral power distribution with peaks at the appropriate wavelengths, it was decided to increase the light at the lower end of the spectrum by having actinic blue lamps over certain of the tanks (specifically the rock pool display). The actinic florescent lamps were used as long-wave UV sources. They peak at about 420-430 nm (see figure 4). Because salt water rapidly absorbs red light many marine fish and invertebrates have evolved adaptations to blue light. These animals will benefit from the use of actinic blue lamps.

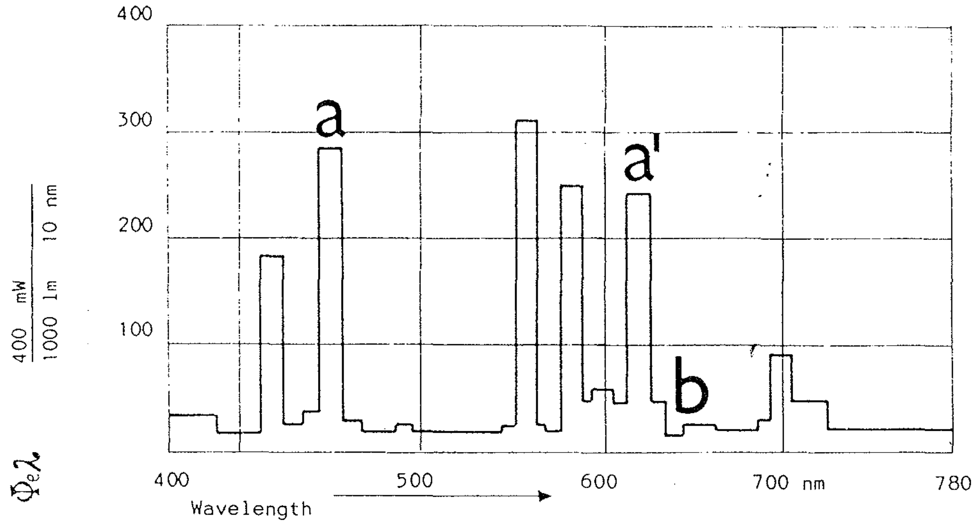

Fig. 3 Spectral analysis of Flora-Set lights. a. and a1. photosynthesis; b. photomorphogenesis.

Light Penetration into Water - The water surface reflects back part of the light rays and this reflection increases with the angle of incident. Obviously, the illumination decreases with distance from the source of light. For geometrical reasons the illumination of a given object or surface is inversely proportional to the square of the distance from the light source. This meant that the lamps would have to be positioned as close to the surface of the water as possible; the manufacturers recommend a minimum distance of 40 cms for safety.

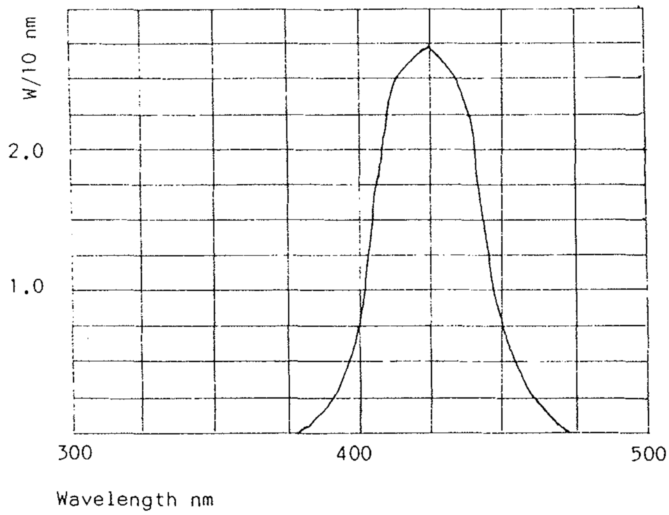

Fig. 4 Spectral analysis of actinic blue lamps.

In addition to distance the penetrating qualities of light depend upon the optical properties of the water, and in particular its transparency. The main effect of turbidity on light is extinction or attenuation. Consequently a very efficient filtration system was designed to provide crystal clear water and optimum conditions for the well being of the fish.

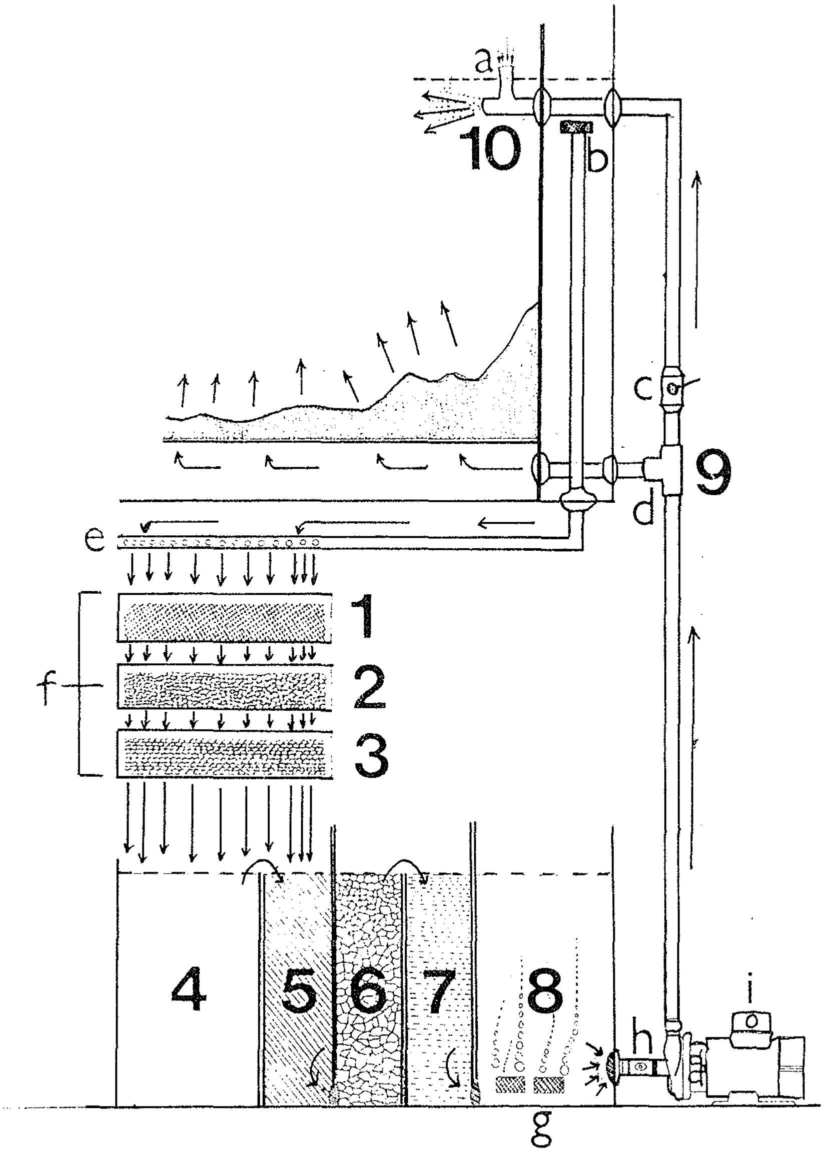

Fig. 5 The ten stages in filtration (see text) a. 'Venturi' device; b. one inch diameter over flow pipe with coarse filter' c/d/ adjustable valve and T-piece on 3/4 inch pipe balancing reverse flow between 'venturi' and under-gravel return; e. spray bar to spread water flow; f. filter trays stacked two inches apart; g. airstones to aid re-oxygenation; h. non-return valve to prevent siphoning if pump fails; i. Stuart Turner pump.

The Filtration System

Amino acids, proteins, phenols, polyphenols and many other organic compounds are excreted by fish and invertebrates into the surrounding water. In the wild these compounds form part of the nitrogen cycle and are converted by bacteria to atmospheric nitrogen, but in a closed system such as an aquarium the build-up of these compounds and their derivatives are highly toxic to fish and invertebrates.

To prevent the accumulation of wastes, a filtration system was required. To provide the most effective filtration system it was decided that a wet and dry mechanical and biological filter, with an optional capacity for chemical filtration, should be designed with the following prerequisites:

1. Effective but cheap to build
2. Easily maintained with minimum man-hours
3. Sufficient capacity for the proposed stocking levels

To keep costs down, the 10 stage filter was designed to be constructed 'in-house' using commercially available materials adapted for the purpose.

Physical Filtration

Trickle Filter (Stage 1) - This part of the system comprises a trickle filter through a 2" thick fitted foam pad which has 45 ppi (pores per inch) and filters out large pieces of detritus and waste. The pad requires periodic cleaning and maintenance. One of the main advantages of this stage in the filtration is the prevention of waste reaching the filter beds beneath, where it would decay and acidify the bacteria faunal beds and eventually destroy them.

Aerobic Filter (Stages 2/3) - The water trickles slowly through the foam prefilter into the first gravel bed which consists of 'Litag Granules'. Aerobic bacterial faunas build up on the granules which are damp rather than submerged. Consequently the bacteria are able to work more efficiently removing harmful toxins like ammonia. This process of removal is known as biological nitrification. It requires high levels of oxygen and nitrifying bacteria like nitrosomonas. Biological nitrification can be summarised by the equation:

$$55NH_4+ + 5CO_2 + 76O_2 \text{ nitrosomonas } C_5H_7O_2N - 5NO_2 - 52H_2O + 109H+$$

One of the products of this oxidation are nitrites which in large quantities are extremely harmful to fish and must be removed. The second filter bed in the dry filter system contains fine gravel which again provides a large surface area for denitrifying bacteria.

These filter beds are prone to the development of anaerobic conditions when circulation fails or when dead spaces occur due to blockage with sloughed bacterial film or detritus. The risk is reduced if the filter bed is raked and disturbed periodically and the prefoam mechanical filter is kept clean and functioning.

Settlement Chamber (Stage 4) - The water passes from the biological dry filter into the settlement chamber. If any detritus or small particulate matter remains it falls to the bottom of the reservoir. This sediment is easily removed using a syphon.

First Anaerobic Filter (Stage 5) - The water passes over a weir into a chamber filled with coarse gravel. This provides a large surface area for an anaerobic bacterial fauna. Here the nitrites are further oxidised to nitrates and can be summarised by the equation:

$$400NO_{2^-} + 5CO_2\ NH_{4+} + 1950_2 + 2H_20$$
$$\text{nitrobacter}$$
$$C_5H_70_2N + 400NO_3 + H^+$$

This process is known as nitrification, some of the nitrates produced are used up by the anaerobic bacteria living in the oxygen depleted wet filter. This is known as dissimilation, several species of anaerobic bacteria are capable of converting the nitrates into nitrogen or nitrous oxide (see nitrogen cycle). Complete removal of the nitrate constitutes denitrification. Because denitrification is primarily an anaerobic process conditions in the wet filter are ideal.

Chemical Filter (Stage 6) - The water now passes through the mesh filter at the bottom of the coarse gravel chamber into another chamber containing 'Zeolite' or Activated Carbon Granules. This forms the basis of the chemical filtration by removing ammonia by absorption. Several species of anaerobic bacteria have the capacity to convert some of the nitrates back into ammonia and nitrites. This section of the filter is a safeguard against introducing nitrites and ammonia into the tank.

Second Anaerobic Filter (Stage 7) - The water now flows over a weir into the final filter stage which is a chamber filled with fine gravel which again provides a large surface area for anaerobic bacteria.

Re-Oxygenation (Stage 8) - The water now flows into a final reservoir; because of the biological filtration, the water here has a low oxygen content, and therefore is saturated with oxygen via airstones.

Second Physical Filter (Stage 9) - The water is drawn out via a mesh filter which prevents debris from entering the impeller chamber of the pump. It is then pumped through a reverse flow under-gravel filter. Because the water flows up through the filter bed rather than being drawn through it, no debris can accumulate on the bottom of the tank. Instead debris is sucked out of the tank and strained out at Stage 1 of the filtration system.

Water Surface Cleaner (Stage 10) - A large quantity of the water is passed via a ball valve to a 'Venturi' which provides surface turbulence and the cleaning of the surface film, allowing oxygen to penetrate and the release of carbon dioxide and other harmful agents.

Although the filtration design hopefully allows for a complete nitrogen cycle, there are several factors which affect an enclosed system. Because denitrification is primarily an anaerobic process conditions in some of the tanks, e.g. the marine and salmonoid displays, are usually hostile. These displays by necessity will be rich in oxygen with high levels of turbulence and aeration, bringing oxygen to most parts of the system. Denitrifying bacteria usually only work where oxygen is greatly depleted, so few of them survive in the tank. Nitrification therefore exceeds denitrification and nitrate always accumulates. This means regular water changes are needed to remove and keep the nitrate level low.

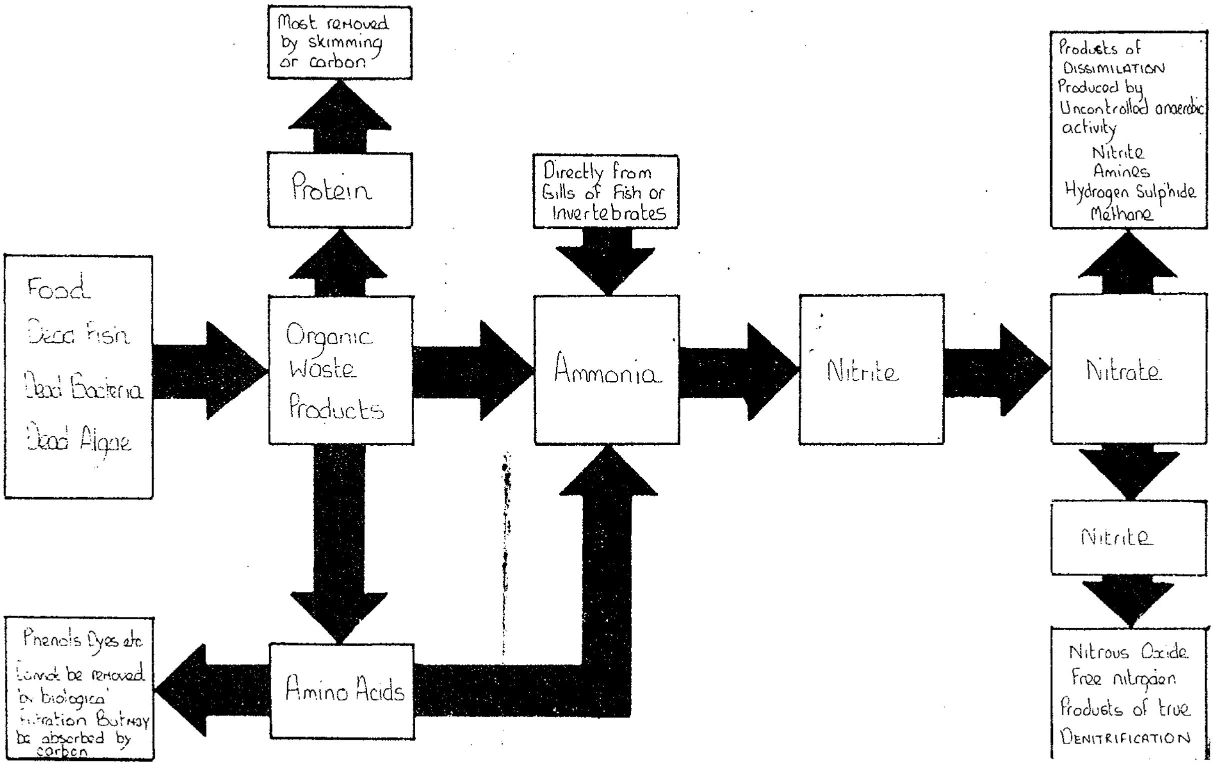

Fig. 6 Summary of the Nitrogen cycle in relation to filtration in a closed system.

Because of the nature of tap water and its constituent contaminants, e.g. copper, chlorine, ammonia and nitrates, some treatment of tap water is necessary before water changes. The water for the aquarium is stored in two four hundred gallon header tanks situated above the main display tanks. The header tanks are filled with tap water via a float switch and vigorously aerated to remove the chlorine. Each tank is insulated and in the future might be connected to a cooling system. Provision has been made for a deioniser to be installed which will remove any dissolved metals.

Special Filtration Items

Special items are needed for filtering the two marine tanks, such as protein skimmers, ultra violet sterilisers, ozonizers, and ion exchange filters.

Protein skimmers - . A very large proportion of the organic waste excreted into the water by fish and invertebrates consists of polarised molecules. This means that one end of the molecule is attached to water and the other end to air. Hence protein accumulates at the surface of the water. The protein skimmers designed for the marine tanks work by producing thousands of air bubbles. Because the molecules of organic waste are polarised they accumulate around the air/water interface of the bubble. One end of the fish waste molecule is hydrophobic and the other end is hydrophillic; the bubble's air-water interface allows both requirements to be satisfied (see figure 7).

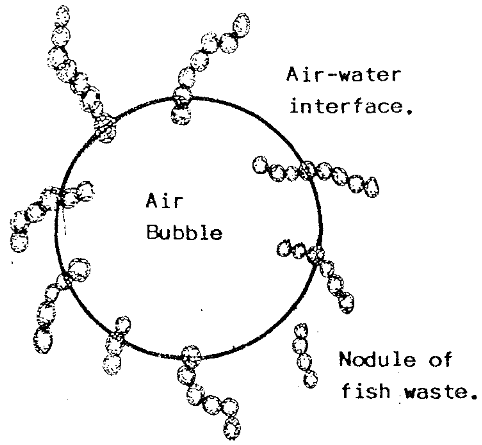

Fig. 7 Diagram showing how fish waste attaches to an airbubble (see text for explanation.

In the simple air-driven skimmer used in the aquarium, bubbles are driven up the perspex cylinder and burst at the surface of the water. The protein is released and forms an oily film on the top of the column. As air cannot pass easily through this film, protein is pushed to the top of the skimmer where the dirty froth is collected in the removable top cup.

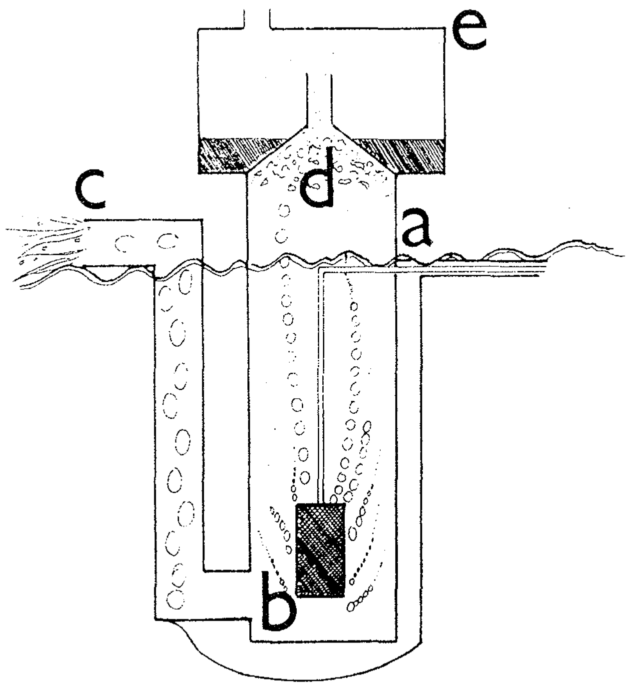

Fig. 8 Protein Skimmer. a. water from the aquarium enters the cylinder; b. diffuser; c. outlet back into the aquarium; d. protein froth; e. removable top.

The protein skimmers are only capable of removing polarised molecules and other products bound up to them. There is still a proportion of non-polarised products which cannot be removed by this process; these include a certain number of complex chemicals which cause the water to yellow. These may be removed only by water changes or chemical filtration, i.e. filtering through activated carbon in the biological wet filter.

There is one other major disadvantage of protein skimmers, they can remove a proportion of trace elements if they become chemically bound to the polarised molecules. Therefore, it is necessary to introduce a trace element solution to the rock pool tank for the filter feeders and algae.

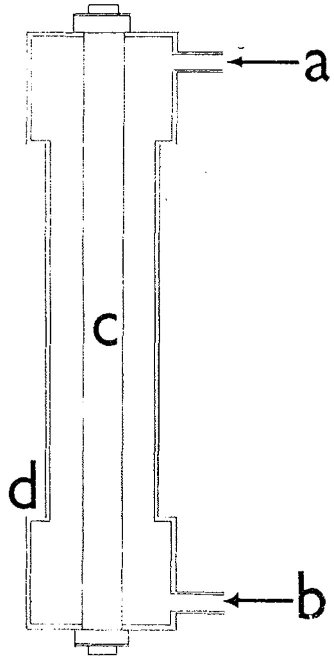

Fig. 9 Protein Skimmer. a. water from the aquarium enters the cylinder; b. diffuser; c. outlet back into the aquarium; d. protein froth; e. removable top.

Ultra-Violet Sterilizers - These destroy free swimming disease organisms in the display tanks. This works by producing high intensity short wave ultra violet radiation, powerful enough to kill the organism by passing through the cell wall and destroy the DNA in the nucleus. Unlike other methods of sterilization, ultra violet has little or no effect on water chemistry.

Normally short wave ultra violet cannot pass through glass and can only penetrate water to a depth of 5 cm. The glass tube has to be made of a special quartz glass to allow the ultra violet through. The ultra violet sterilizer is used only to kill free-swimming organisms, it cannot kill diseased organisms attached to the fish.

Cooling Systems

Temperature profoundly affects all biological systems. It alters the properties of most biological materials and determines the rate and type of biochemical reactions. Water has a high thermal capacity compared to air, i.e. it can absorb a large amount of heat energy for a small rise in temperature. However, enclosed systems show dramatic fluctuations in temperature which can affect the metabolism of certain fish and that of the surrounding water. However, the thermal tolerances of fish and invertebrates vary greatly: the inmates of a tidal rock pool show adaptations to varying environmental conditions related to the time of day or the tidal cycle; but thermal shocks and sudden large scale variations in temperature have a dramatic affect on the cardiovascular activity and respiration of fish which live in stable environments like ponds and lakes with only seasonal variations in environmental conditions. Therefore, some form of temperature control is needed to maintain the condition at or about the optimum for the species concerned.

There are plans for three of the ecosystems to be temperature controlled, i.e. the two marine tanks and the salmonoid tank, and additional cooling systems will be installed in all the other tanks in the future. The ambient temperature of the building is subject to seasonal variations; there is some control by the use of extractor fans. The main method of temperature regulation will be by thermostatically controlled cooling units, consisting of a compressor and a temperature exchanging canister, connected to an Eheim Power Filter 2017. The unit should be capable of cooling the water to between 11-14°C. Seasonal variations can be accounted for by thermostatically controlling the temperature.

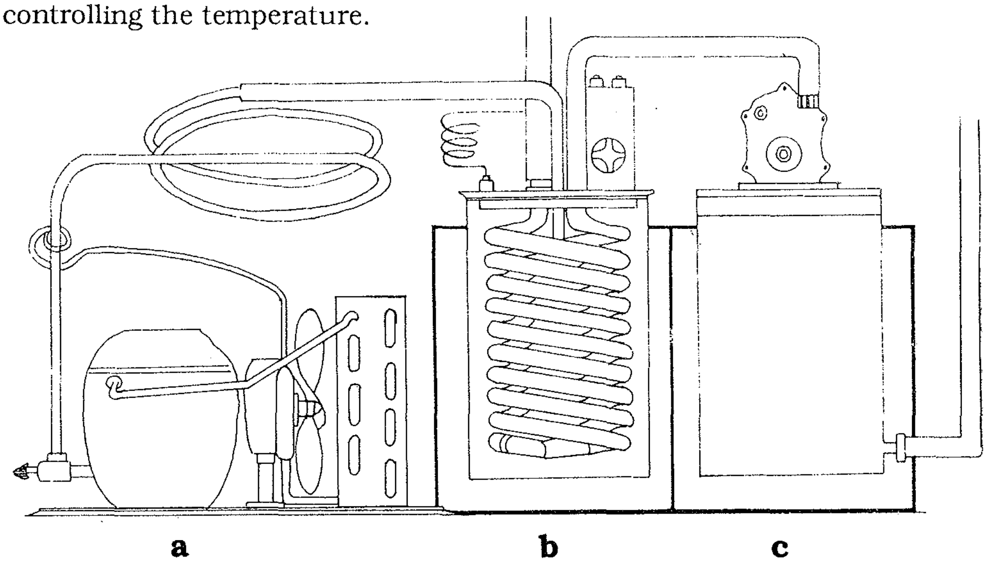

Fig. 10 Cooling system. a. compressor; b. heat exchanger; c. Eheim Power Filter.

Glass-reinforced Plastic Tanks - Specification

It was decided that the tanks should be 48" x 36" x 36" in size to provide sufficient capacity for the proposed stocking levels. Also this depth of tank ensured reasonable light penetration; any deeper and the light rays are attenuated to an unacceptable degree. Several types of tanks were reviewed, e.g. all-glass/siliconed sealed, concrete, and metal framed, each with inherent disadvantages:

All-glass aquaria
- i) In order to fit the filtration system holes would have to be drilled at various points - a difficult procedure with glass.
- ii) The thickness of the glass, needed to withstand the water pressures, and the strengthening needed at weak areas meant that each tank would weigh in excess of 800 lbs when filled.
- iii) The costs involved were prohibitive and the durability of the silicone sealer was suspect.

Concrete aquaria
- i) The tanks once constructed would need to be sealed to prevent chemicals leaking from the concrete.
- ii) The construction would be a permanent fixture and a fairly lengthy and messy process.
- iii) There would be problems fitting and seating the pipes for the filtration system, also sealing the glass front.

Metal-framed aquaria
- i) The frame has to be reconstructed in high quality stainless steel to prevent corrosion, especially in the marine tanks.
- ii) Very costly especially for the glass.

Eventually, after careful consideration, glass-reinforced plastic (fibreglass) tanks were chosen. Initially several firms were approached for quotations and technical advice, but only two, both from outside the district were 'tooled up' to meet the requirements. Both firms were contacted enclosing a drawing of the construction of the tank with a suggested method of glazing and the various additional specifications required, e.g. an anti-splash screen.

Pumping Equipment

Stuart Turner pumps were chosen for a variety of reasons:

a) They are widely used by public aquaria throughout the country in the same sort of applications;
b) They are robust in construction with a good ability for continual running;
c) Relatively maintenance free and very reliable;
d) Spare parts are easily obtainable;
e) Wide performance range with good safety features incorporating a built in thermal overload protection;
f) A generous discount on the price.

Eight pumps were purchased, which means that we have a spare for emergencies. The five freshwater tanks will be served by a 903 pump with a stainless steel construction. This prevents the saltwater corroding the brass and contaminating the tank with copper poisoning which is extremely lethal to marine invertebrates. The 903 provides an excellent flow rate which means the water should pass through the filter at least twice an hour, i.e. 100 litres of water per minute.

Plumbing (UPVC System)

The pipes and fittings were made from unplasticised polyvinyl chloride. They have a low installation component cost with a good chemical resistance and high pressure rating. All the materials conform to the British Industrial Research Association Code of Practice for Food Usage, so they are ideal for use with livestock. The pipes and other plumbing were fitted in-house by the Natural History staff. It is a fairly easy material to work with and is designed for solvent welding.

Blower or Exhauster Unit

The blower will be used to supply air to all the main exhibition tanks and the quarantine facilities in the preparation room via a main two inch airline. At various intervals where necessary it will be drilled to take a $^1/_4$" valve and airlines attached.

Problems and Developments

The aquarium was opened to the public on Friday, 25th August 1990. Visitor figures increased and educational work began almost immediately. In fact the Pond Life Package, run in conjunction with indoor work in the aquarium, was over subscribed.

Almost straight away unforseen problems became apparent, because the associated plant, e.g. pumps, cooling equipment, lights, exhaust and blower units, were working twenty-fours hours a day seven days a week, the ambient temperature within the building increased. The building by necessity is well insulated with a double skinned roof and thermal padding distributed throughout the timber structure as well as double glazing on the exhibition tanks. This meant that in trying to cool the tanks we increased the temperature in the surrounding air. It was decided to instal air conditioning for summer and an air extraction system to supplement it during cooler months. The main air-conditioning unit was installed centrally and industrial extractor fans installed in the roof space at either end of the building. We now maintain the ambient air temperature at between 55-60°C with a relative humidity of between 60-70%.

In the original plan we decided to individually cool only three tanks. Subsequently, because of various measured fluctuations, all the tanks now have a cooling plant functioning to allow greater temperature control.

Another problem which immediately manifested itself was the heating effect of the Stuart Turner pumps. These pumps have a metal casing with a plastic impeller. They run constantly and consequently there is a measurable temperature different between water entering the pump and that leaving to flow into the tank. The copper casing of the impeller chamber acts as an excellent heat exchanger. A change to a cool running version with a nylon impeller has proven very effective and this type will be eventually installed in all the systems.

We have also increased the size of the quarantine area to accommodate the larger specimens in the main exhibition tanks. Inevitably certain species rapidly outgrow their environment, e.g. some marine fish increase their size threefold within a very short space of time. Consequently some specimens are released or donated to other institutions with bigger tanks.

A recent acquisition is a large invertebrate tank to house a variety of cephalopods. The tank measures 10' x 3' designed along the same lines as the other tanks with similar filtration systems, lighting and cooling plant. This has been particularly popular with many children gathering around the display trying to spot a very introverted Common Octopus *Eleone cirrhosa.*

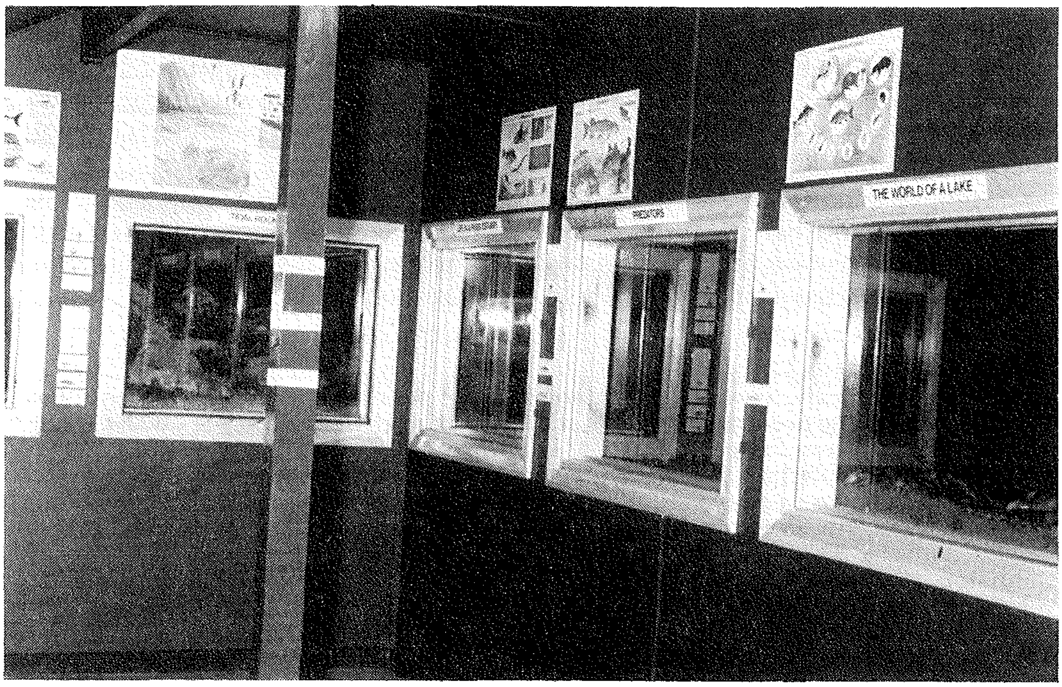

Plate 1 View of the Aquarium showing individual displays

The Educational Role of the Aquarium

The original concept of the aquarium was to provide a series of displays showing the variety of freshwater fish and invertebrates found in and around the Burnley area, and marine animals found around the coastline of Lancashire. To date we have exhibited a wide diversity of water life with associated behavioral mechanisms, e.g. schooling in salmonoids and symbiosis with shrimps and sea anemones. Feeding patterns have been used to illustrate food chains and food webs to many children during practical sessions. The 'Catch' from a day's pond dipping is usually transferred to a suitable aquarium for closer detailed examination. This has enabled the staff at the Natural History Centre to interpret many aspects and objectives of the National Curriculum and encourage and develop an interest and appreciation of all forms of life. Live displays are dynamic and provide an excellent vehicle for promoting an attitude of curiosity and scientific enquiry and are extremely useful in experimental and investigative work in the study of biology. In the Pond Life Package simple experiments have been set up to help children make and record accurate observations, and to analyse, interpret and draw conclusions from the data and other biological information.

In order to realise the full educational potential of living displays the design and maintenance has to be of a very high standard with careful consideration given to inherent problems in running a closed system.

The primary desire of the staff at the Natural History Centre is to provide a stable ecosystem in an environment that is close to that of the wild community being simulated. Improved technology and maintenance can help reduce the enormous losses of organisms through mishandling, unsuitable conditions, etc.. There is a distinct possibility that prolonged and intensive collecting at particular sites will upset and deplete the environment and the balance of natural communities. Therefore for educational purposes we cannot ethically or morally subject live animals to stressful conditions beyond their normal environmental range.

The live exhibits at the Natural History Centre have a very important role in education and can stimulate children to realise the importance of wide range of conservation problems as well as providing an insight into aspects of biology which are not normally seen in the classroom.

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Reminiscences of a Museum Assistant (1926-45)

Doris Parkin,

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Preface

In 1982, Steve Garland, Derek Whiteley and myself collectively wrote a series of papers featuring Sheffield City Museums (*Biology Curators Group Newsletter* **3** (2)). Amongst them was an account of the museum's present and former staff and their work, which was inevitably less complete for our predecessors. Fortunately a former museums assistant, Doris Parkin (nee Downend), has now written a sequel to help remedy the situation.

Doris worked at Sheffield City Museum from 1926 to 1945. Thereafter she continued to live in Sheffield until the retirement of her late husband, and their move to Bakewell. Today, Doris is still involved with museums, as a warden at Bakewell Museum, and with the Derbyshire Wildlife Trust as Secretary of the Wye and Upper Derwent Group.

Whilst many of the persons referred to by Doris are largely unknown to present-day curators, the circumstances and pattern of her employment are still of general interest, and a more than parochial reflection of those times.

Tim Riley, Sheffield City Museum

Reminiscences

The date was 20th March, 1926, a Saturday morning, when I entered the portals of Weston Park Museum, Sheffield for an interview for the post of student assistant. I found five other hopeful applicants but, to my delight, I was chosen for the position and asked to commence duties on the following Monday morning. This rather shook me as I was officially still at school. Before returning home, I called in at the school (there was Saturday morning school at Notre Dame High School in those days) - to inform the headmistress of my appointment, and to collect my books and other belongings. After all, the headmistress had suggested I try for the post - although she really hoped I would stay on for Higher School Certificate and go on to University to read Botany. This I would love to have done, but my father was unemployed, and at 16 I thought it was time I was earning to help the family finances. Grants were not so readily forthcoming in those days, and since my father was self-employed he had no unemployment pay at all, and was paying the cost of home and family, including my school fees out of his savings. So, although I left school with a heavy heart, I was walking on air by the time I reached home to announce my good fortune - and the handsome reward of £40 a year.

So began my 20 years connection with the Sheffield Museums. It was all very strange at first. The official staff comprised the Curator - Mr. Elijah Howarth, Assistant Curator - Mr. J.W. Baggaley, and Assistant - Mr. Alfred Walker. I was the shy little schoolgirl launched into this man's world. Mr. Howarth was a benevolent looking gentleman, almost a Father Christmas figure with his white hair and beard. Mr. Baggaley, who was to be my tutor, was kindness itself and most considerate of my shyness. Mr. Walker tried not to be too 'soft' with this girl intruder, but at heart was as kind as Mr. B.

I was soon to discover that Mr. Howarth was to be antagonistic towards me on principle. His opinion of females was that their place was solely in the home. A typical Victorian patriarch - women were, to his way of thinking, incapable of anything but domestic chores. I learned from Mr. Baggaley that he had had several young men to train, but all had failed to satisfy him, as they were more interested in the new-fangled hobby of making 'wireless sets' than in studying zoology. It was his suggestion that a young lady might prove a better appointment, and with some reluctance, Mr. Howarth agreed on the experiment.

I was selected from the six candidates because I had already matriculated and had studied shorthand and typing. This meant that, in between my training in zoology and museum work, I was to be Mr. Howarth's secretary. He was a man of very mixed personality. However, I quickly came to appreciate the quality of his literary talent, but as he had (I learned later), only recently acquired dentures, his speech was not always very articulate, and as he used exceptionally long words which were entirely unknown to me, I was often in great difficulty transcribing my shorthand. This was when Mr. Walker came to my aid. He had been acting as secretary before my advent, and was familiar with the Chief's vocabulary, so that between us we could usually make a reasonably satisfactory transcript of the shorthand. As the typewriter I was using was a rather ancient Monarch and very heavy, this part of the job I did not really enjoy, but was quite prepared to take the rough with the smooth.

The part that I found quite fascinating was the zoology which I was learning, and the mounting and cataloguing of specimens. It was just the right time of year for collecting pond life, and Mr. Baggaley had installed an aquarium in the office where I placed the results of my pond-scratching expeditions. Although I had studied botany at school, and revelled in the subject, zoology was new to me - I did not even know of the development of frogs from spawn to tadpoles and adult frogs, it was all a wonderland to me. Our office windows were at tree height, overlooking a well wooded lane at the back of the Museum, and we could watch the birds among the branches without their being aware of our presence. There I saw my first Greater Spotted Woodpecker - a real thrill.

At one stage, Mr. Baggaley introduced me to the marine collection - many of the specimens had been collected by Dr. Henry Sorby. Mr. Howarth, coming into our office, saw me sketching these specimens. He seemed quite pleased to find me showing so much interest, and proceeded to relate how he had gone with Dr. Sorby in his yacht, to collect these very same specimens. This made me all the more interested in the collection, and in the remarkable manner in which Dr. Sorby had mounted the specimens into lantern slides, (colour transparencies were unheard of in those days - or even 35mm slides). The slides were mostly of jellyfish, starfish, shrimps, zoophytes and the like, preserved and mounted between two pieces of glass, thin enough to put into a 'magic lantern' as the projector was called. Subsequently, Mr. Baggaley designed a display frame, illuminated from inside, which we used, on special occasions, to show Dr. Sorby's slides.

Later Mr. Baggaley dropped a hint to me that I might take an interest in the geological collection. The fossils on display badly needed re-labelling, the originals, hand-written, having faded badly. I was given this task to do and thus began my love of palaeontology. I found it all so fascinating and would go into the limestone area of Derbyshire finding more fossils, mainly molluscs and corals. By this time I had joined the Sorby Scientific Society of which Mr. Baggaley was Secretary. The Geological Section was particularly strong, and I would go, come rain, hail or shine on their expeditions. I was not only the youngest member of the Society, but often the only female to attend the geological section meetings. Thus began my life-long interest in the Sorby (later to be re-named Sorby Natural History Society).

It was not until some months later I appreciated why Mr. B. had introduced me to the study of palaeontology. Mr. Howarth sent for me and informed me that what was really required on the Museum staff was a geologist, there not having been one since the demise of Mr. Bradshaw in 1917. "But", said Mr. Howarth, "no woman could be a geologist". I meekly answered "But, I have been studying geology", and showed him my folder of notes and drawings on the subject. He was, obviously, not prepared for this response, and dismissed the subject.

At this time, there was no superannuation scheme in the Sheffield Corporation, and Mr. Howarth had reached the ripe old age of 76 and still employed. Part of his unreasonable behaviour was due to his advancing years. Thus, at the September 1927 Committee meeting he was asked to retire, while my position was made secure when I was appointed to the permanent staff.

The following years teemed with interest and I was supremely happy in my post. I soon became accustomed to being handed a closed matchbox by an enquirer, with the information - "it contains something that buzzes, I think it's a hornet!". Almost instinctively, I knew it would be a wood wasp, alias giant sawfly (*Sirex gigas*), or the smaller steel blue sawfly, but these were much less common. On one occasion the Sheffield Housing Manager brought a *Sirex gigas* for identification, with the information that the tenant in a new Council house had reported a gas leak. The plumber, investigating, found this insect, with its head fitting to a small hole in the lead gas-pipe. What had happened was that *Sirex* had hatched from its pupal stage in the pine floor-board, or skirting board, and chewing its way out, came up against the gas-pipe. An insect capable of chewing wood, could easily cope with soft lead, and poor *Sirex* had thus gassed himself. On another occasion a man arrived with one of his fingers bandaged, handed me the inevitable matchbox and said this insect had stung him. I carefully slid open the lid of the box and revealed - *Sirex gigas.* I asked the enquirer whether his finger hurt badly - "Well", he replied, "not so much now", so I enlightened him with the news that *Sirex*, although a member of the Hymenoptera (wasps, bees and hornets), did not possess stinging properties. We unwrapped the suffering digit - there was no trace of the attack, but the owner assured me that it had stuck "that sting thing" in his finger. "Oh yes", I replied "it took your finger for a piece of wood in which to lay its eggs!". He was not amused!

Another enquirer, a very respectable looking young man, handed me a glass tube which contained about 20 fleas, all hopping madly about. I looked at the young man and hesitated to enlighten him, then I thought perhaps he owns a flea circus! So, I put the usual question "Where did you get them from?" when he explained that he was the manager of a grocery shop, and these insects, in scores or more, were in the cupboard where they stored the wrapping paper. How, or why, they were there, I never discovered.

So many other enquiries came to mind. One dear old gentleman arrived, again with a closed matchbox - this contained a Puss Moth. On opening the box, I told him - "This is a Puss Moth". He looked so incredulously at me, and replied, rather indignantly, "That's no moth - look at its feathers - it's some kind of bird" - and who could say him nay!

One of the most gruesome items, though, was what appeared to be a fossil bivalve. My first reaction was to say just that, but somehow it did not look quite right, so I popped the usual question - "Where did you get it from?", and was rather taken aback by the reply - "From my kidney" - Ugh! How glad I was I had not identified the object as a fossil shell!

Early in 1930 a new Secretary was engaged to relieve me of my clerical duties. Miss Ivy Bower proved very competent and we became great friends, remaining so to this day. (She became Mrs. George Jackson).

At this time we were finding the limitation of exhibition space a grave problem. I was now attending the Sheffield University, (part-time), by the kindness of the then new Professor of Zoology (Professor L.E.S. Eastham), who came over to the Museum, soon after his appointment, to make our acquaintance. Mr. Baggaley explained that, although I was able to undertake plenty of book-learning, and had access to extensive collections of preserved specimens, I did need some practical work and, hopefully, some qualification to impress the Committee with my worth as a Zoological Assistant. The Professor immediately offered to make a place for me with his first year medical students, and I was allowed time off on Wednesday mornings to do the practical work at the University. This eventually led to the institution of a certificated course in Biology, intended mainly for teachings requiring an extra subject, and included botany and zoology. We attended on Tuesday evenings for botany and Saturday mornings for zoology. The class consisted of about 12 students and continued for two years. This fascinated me and I worked hard for my certificate. Professor Eastham was a really wonderful tutor, with a very ready wit, and his lessons were delightful. Also, I enjoyed learning about the biology of flowers and other plants, having become fairly adept at identifying them through the Sorby meetings. Following on these lectures, and mainly through the insistence of members of the Sorby Natural

History Society's Geological Section, Mr. W.H. Wilcockson became tutor of a W.E.A. tutorial class in geology, held at the University. This took care of another evening a week, for the next three years. Also my weekends became fully booked. The geological meetings were not limited to the spring, summer and autumn months but continued through the winter, and I had great difficulty in persuading my parents that, even though it was raining, and threatened to snow, the field meeting would be held.

Until 1934 Mr. Baggaley was Curator of the Museum and Mappin Art Gallery. The Museum collections were fairly static, but there were many travelling exhibitions held in the Art Gallery, and we were often employed, preparing a catalogue for the printers, until quite late in the evening before the opening day. However, after the building of the Graves Art Gallery a Director of Art Galleries was appointed and Mr. Baggaley became Director of Museums.

Because of the importance of Sheffield in the development of the cutlery trade, the cutlery collection was very special and attracted visitors from many parts of the world. This was Mr. Walker's department. He, too, dealt with the Ethnographical collection, also Silver and Ceramics. After I was given charge of the natural history collections, Mr. Baggaley concentrated his interests in Archaeology as well as guiding and advising Mr. Walker and myself in our departments, and, of course, attending to the administration.

In his early days at the Museum, Mr. Howarth had instituted a system of appointments of attendant staff which included various tradesmen. This had continued down the years, so that we had two joiners to attend to any repairs to the woodwork and exhibition cases, also making new cases when room was available for them. There was a printer with a small printing press on which he printed stationery, notices and labels. There was a painter and decorator, a plumber and a picture framer. These men filled in their time on attendant duty, but in addition, there were three 'police' attendants, as they were called. They were not craftsmen and worked 8-hour shifts, undertaking night duty as one of their shifts. Two lady attendants completed the attendant staff, they supervised the two cleaners; altogether a happy group. I thought this arrangement very good, it meant we were almost self-sufficient, and it was rare indeed to call in outside workmen.

However, when the Direct Labour Group was formed by the Socialist Council, our independent arrangement came to an end, and all the maintenance jobs had to handed over to the various departments of the Corporation. The printer was still allowed to print labels and the joiners to do some odd jobs.

With the continuing over-crowding problems of exhibits at the Museum, we appealed to the Committee for funds for extension, but these were the austerity years of the 1930's, the economic conditions throughout the Country were appalling. Only a fairy godmother could help us, and this arrived in the person of Alderman J.G. Graves, a Sheffield businessman, already a great benefactor to the City. Alderman Graves offered, I think it was £16,000, for a Museum extension. Plans were prepared and the building commenced. The Museum was extended by two long galleries, an imposing marble-floored entrance hall and two further shorter galleries at the front, with a wide corridor between the front and rear galleries, and lecture room at the end of the corridor. It had been increasingly difficult to conduct parties around the crowded Museum. This was especially so with the classes of school children, quite impossible to maintain the interest of 40 children when only a handful could see the specimens under discussion.

Our lecture room was to have roof-lighting, a large screen and projector which, at that time, took the large $3^1/_4$″ square slides. Colour photography was unknown, and I spent a lot of time preparing slides which I hand-coloured, in readiness for the great day when the extension would be completed. This was in 1936 and we had the official opening ceremony on 16th April, 1937. This was a grand affair, opened by a V.I.P. - Sir Philip Sassoon. A wonderful buffet had been prepared, and waitresses from the Town Hall, wearing smart uniform and long white gloves, came along to serve. However, Sir Philip had very little time to spare, and we were not a little disappointed when, after unveiling the plaque, (in what we thought was unseemly haste), he rushed off in the official car to catch a plane back to London from Doncaster. He never had a bite of the feast prepared, but the rest of the invited company, committee and staff did justice to the goodies!

We had worked very hard re-labelling, renovating and displaying the exhibits in their new cases. All the silver and Sheffield Plate had been cleaned and polished. The existing cases repolished, and where necessary repaired. The cutlery collection which, heretofore, had been housed in cabinets of drawers, was beautifully displayed in showcases in one of the front galleries. The other front gallery contained the ethnological collection, and the two new galleries at the back housed the ceramics, glass, silver and archaeological exhibits. I had the two old galleries, newly floored and renovated, for the zoology and geology, with part of the corridor between the front and rear galleries, for the mineral collection. Here, too, we exhibited recent acquisitions. Upstairs we had two offices, a very imposing library/Committee room, a workroom and a photographic darkroom. We had, previously, used a converted outside toilet for a darkroom. Mr. Baggaley had his Director's office, Miss Bower and I shared the second office, and Mr. Walker installed himself in the so-called laboratory or workroom. This we were supposed to share, it was provided with workbenches for mounting specimens, etc. However, the benches were usually quite crowded with specimens from Mr. Walker's department being cleaned, restored or catalogued, so I moved a small table into my office and used that for my specimens undergoing treatment.

With the increased exhibition space, I suggested having a live display in the Museum entrance hall and prepared a plan for an aquarium/vivarium which the joiners built for me. This consisted of a wooden frame-work with light oak facings, in which 8 rectangular aquaria tanks were fixed, so that the aquaria appeared like 3-D pictures in the cut-outs of the oak. In these we put frogs, newts, fish, stick-insects, caterpillars and any other live specimens that came along. We had electric aerating pumps in the aquaria and could creep through a small door at one end to attend to the tanks from inside.

One of the attendants (Horace Broad, the painter and decorator) was particularly interested in this and became my assistant keeper of aquaria. He had helped considerably with re-mounting the collection of birds, prior to the opening of the exhibition. Previously, the birds were all mounted on turned wooden stands, very Victorian. Broad and I selected the best specimens and mounted them as far as possible in habitat groups, a vast improvement in appearance and teaching value, although some of the specimens left much to be desired, but funds were too limited for the purchase of replacements. We cleaned the dirty ones, and used hair dye on the faded ones!

Occasionally, specimens of birds would be brought to the Museum by people who had found them in dying condition, or already dead. These we despatched to an old taxidermist living at Deepcar, an amazingly clever taxidermist but unable to read or write, so communication was rather difficult; we had to hope his son would be home to decipher our instructions. (No telephone there, of course).

Having found the aquaria such an attraction, I planned to have a wild flower display. Mr. Baggaley opposed this at first, thinking it would occupy too much time collecting, identifying and keeping the flowers fresh. However, I assured him I was prepared to undertake the work, and started with a small table on which I placed about 2 dozen jars, each containing a different wild flower collected from the neighbourhood. Having seen some displays in other Museums of flowers in all sorts of odd containers, from jam jars to ink or sauce bottles, I was determined to have my specimens in uniform jars, and used rectangular specimen jars of varying sizes, the small flowers in front in small jars, larger ones behind - in rising sizes. The jars tended to get knocked over by over-enthusiastic visitors, and I then designed a special display table with rising shelves. Our collection grew to such proportions that, eventually, the joiners made a double-sided display table, and on one occasion I had 112 different varieties of flowers on display, mostly collected in Dove Dale and the Manifold Valley. Each weekend I was out in the country collecting my specimens, going one evening midweek to find fresh specimens to replace any fading ones. The flower table proved a very popular feature, many visitors arriving regularly, on a Monday afternoon, when they knew fresh flowers would be in place. Always I was careful not to collect any rare flowers, nor did I encourage visitors to bring flowers to the Museum. My modest contributions were sufficient.

Sometimes unusual specimens would come to hand. The wholesale fruiterers in the Sheffield market occasionally informed us of strange stowaways amongst the bananas. We would receive outsize cockroaches, *Gecko* lizards, an occasional snake, several, (at intervals), opossums, some only mouse size, some nearer the size of squirrels, also, a few large *Mygale* spiders, their soft, hairy bodies and long, furry legs giving them a most cuddly appearance. At other times an unusual bird - for an inland region - would arrive, storm-tossed, off its normal course. One such was an immature Puffin which arrived on the afternoon of a Conversazione, and became No. 1 live exhibit that evening. Another immature sea-bird to arrive was a Gannet, having a wingspan of more than 5 feet. This was very weak, and I went to the local fishmonger for suitable food with which to revive it, leaving it with a bowl of water, (and many newspapers), locked up in the Committee room, overnight. By the following morning it was completely revived, and very lively. The Committee room was in a sad state. Mr. Baggaley and I donned gloves, and between us released our captive gannet over the nearby reservoir, hoping it would reach the east coast in good health.

In 1937 the Museums Association instituted a Diploma Course for Museum Assistants, the course to occupy three years, only those assistants having three years experience thus able to obtain the Diploma. I registered for the course with the first batch of students. This entailed attending museums in different parts of the Country to take the various courses. The first one - a general studies - was held in Liverpool Museum. There were about 16 students attending that first course. I found it an interesting experience seeing how other Museums organized their work, and comparing notes with the other students. The second year course, for general natural history, was held in Bristol. By the date of the third year, specializing in zoology, the second World War had broken out. It was October 1939 and the Museum selected was Manchester. What a dismal place Manchester was in the black-out. My accommodation was appalling, and the weather likewise. The course was helpful and interesting but, otherwise, I was glad to return to Sheffield and prepare for the examination the following year.

With the coming of war all our fragile specimens had to be packed away in a safe place. We considered how best to do this and decided to acquire dustbins. We spent several weeks wrapping and packing the glass, china and silver specimens in these dustbins which were then housed in the ducts underneath the galleries.

There was one collection, however, the Blue John vases, which had to be unpacked and put on exhibition. This collection was bequeathed to the Museum by Mr. J.W. Puttrell who had spent his lifetime making a unique collection of this rare mineral, from Castleton in Derbyshire, fashioned into most exquisite chalices and vases. A friend of Mr. Puttrell's came looking for them, and objected, in no uncertain terms, because they were not "on display in one case as the Puttrell Collection, according to his Will". This we did, exhibiting them in a wall-case in the corridor.

A few weeks later, on the night of December 12/13, 1940, the German Luftwaffe made Sheffield their target, and the blitz of incendiaries and high explosive bombs rained over Sheffield for several hours. A landmine fell behind the Museum, the blast destroying most of the glass roof and damaging many of the cases. Of the Mappin Art Gallery, practically only the stone frontage remained intact. The Puttrell collection of Blue John suffered badly, the blast having travelled down the long gallery opposite the wall-case containing the collection. Many of the specimens were shattered, including all the most delicate ones. It was heart-breaking! Although I attempted to re-assemble the pieces, the task was hopeless, Blue John is a soft spa and crumbles to dust with such drastic treatment.

The Museum had to be closed, and the staff - attendant and official -

spent much of the time sweeping up the broken glass, then making temporary repairs to the cases, and restoring any specimens capable of being restored. Once the Museum was tidied up, school classes were able to attend again the blacked-out lecture room, and much of my time was engaged in this work.

Towards the end of 1940 I met the man who was to become my husband. We were engaged in 1941, (he having been mobilised into H.M. Forces in the meantime), and married in July 1942. This meant a complete change of my status in the eyes of the City Fathers. As no married woman was employed by the Council, except on a temporary basis during wartime, I had to resign my position as a permanent employee, and join again in a temporary posting. I must admit to being somewhat angered at this ruling, having devoted sixteen years of energetic service in the department, but rules are rules and I accepted my fate. It seemed a choice between a lonely, though interesting, existence as a spinster museum assistant, or married life with, as it later proved, the joy of constant companionship, a beautiful home and two lovely children, (now grown up with children of their own). So, in August 1945, the war now over, I resigned my post and joined my husband in Scotland until his demobilisation at the end of that year.

However, my interest in the Museum has never waned. I visit the place now, not without some envy at the increased number of staff members, and all the opportunities they have for field work, also chances of improving the display of specimens, and production of scientific publications. The City Treasurer must be much more generous with funds than during my 20 years on the staff.

As the meetings of the Sorby Natural History Society are held in what I regard as 'my lecture room', my link with the Museum has continued for more than 60 years.

The Hawkmoths of the Western Palaearctic.

By A. R. Pittaway FRES.

Published 1993 by Harley Books in association with the Natural History Museum, London. ISBN 0 946589 21 6. 250pp. 20 col.pls, 60 figs, 58 maps.

£55.00

There are nearly sixty species of Sphingidae known from the Western Palaearctic and this book encompasses them all. Each is illustrated by colour photographic plates of set specimens, as now used in most recent publications. There are also a number of distinct subspecies included. The larvae of a number of the more western and widespread species are illustrated by colour paintings, although many from south-eastern areas have yet to be described.

Each species has a distribution map and a description of its range, with references. There is a full list of synonyms and a detailed description of the adult and immature stages, when known, together with notes on subspecies and distinguishing features. There is also a summary of biological and ecological information, including a full table of known parasitoids. The knowledge of their biology is extended into a large amount of information concerning the rearing and breeding of many species. These details are obviously based on the vast experience of Tony Pittaway with this family. His enthusiasm for the group lies with their biology and ecology and he devotes a chapter to their ecology, including photographs of many of their habitats in eastern Europe that are less familiar to western Europeans.

The book is a thorough and detailed treatment of the western Palaearctic hawkmoths in the true Harley Books tradition and will remain a standard reference for a long time.

Steve Garland.

Uses of Egg Collections: Display, Research, Identification, The Historical Aspect.

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This paper is based on a talk I delivered to the one-day seminar on egg collections at Tring Museum on 15 February 1990, which has been discussed in the previous issue of this journal (Sutcliffe, 1993). I have been in charge of the egg collection at Tring, which is one of the two largest in the world, for over 20 years, and therefore may have more experience of eggs on a world basis than anyone else in Britain.

Display

Display is, in my view, the least important use for egg collections, and the public display of real eggs is to be discouraged. Eggs exposed permanently to light will inevitably fade, and after a period of time, will become worthless. In Britain at least, egg displays in Museums appear to have an unfailing attraction for kleptomaniacs; for some reason the Americans do not have this problem. Lloyd Kiff, curator of the egg collection at the Western Foundation of Vertebrate Zoology in California (the other of the two largest collections), told me that he was often faced with blank incredulity when he discussed the collection with visitors. "Why on earth should anyone want to collect bird's eggs?" was apparently a frequent comment.

Tring Museum has a cabinet of British birds' eggs in glass topped pull-out drawers. For many years it stood immediately opposite the post card counter. Some years ago, when the new book shop was opened, the post card counter (which of course would have been permanently manned at all times when the Museum was open to the public) was dismantled. Within a week, the egg cabinet was broken into by children, and eggs stolen. It has now been moved to the entrance hall, where it is once again under constant supervision. However, I presume that many Museums do feel it is important to maintain egg displays, and this raises the problem that if all such displays are self-destructing, from whence shall come supplies of new material? For this reason, I am of the opinion that collections of eggs which are in any sort of suitable condition should not be destroyed, but should be placed in some suitable storage for the future.

Research

Research is in my opinion one of the most important uses of egg collections. Generally speaking, the researchers who have tended to use the egg collections at Tring during the period when it has been in my care have been those who were conducting monographic studies of a particular species, and wished to examine every available specimen in every museum. The information they are looking for includes measurements and shell weight, but most importantly, dates, localities, identities of collectors and so on. It should be pointed out that, unlike collectors of British birds' eggs, who are egg collectors and very rarely ornithologists, those who build up collections of foreign eggs are nearly always ornithologists, and very rarely egg collectors.

I am frequently asked, why do you need so many specimens? Isn't one blackbird's egg the same as any other? The answers are, yes, we do need a lot of specimens, and no, they are not all the same. It is only when one examines a very large collection that one realises the problems of identity that can arise, and can appreciate the range of colour and shape which can occur. All patterned eggs vary to a tremendous degree.

Nor is there justification for Peter Robinson's opinion (Sutcliffe, 1993: 20) that most research work can be done by photography. This shows some lack of understanding of taxonomic principles. Bird's eggs actually display an extremely small range of colours in a very great number of subtle variations in shade, and identification of eggs often depends on distinguishing such subtle differences. Present day colour photography is quite inadequate to cope with these variations. Almost any book which contains colour photographs of eggs demonstrates how utterly inadequate photography is in conveying any real idea of the appearance, colour and texture of an egg.

It is this variability that makes them useful for studying taxonomic and genetic theories. for example: the eggs of the Robin (*Erithacus rubecula*) are typically white or pale pink in ground colour, with reddish-brown dots and markings. The full range of variation, however, goes from pure white (unmarked) to a dark reddish brown. The eggs of the race *E. r. superbus* from the Canary Islands (sometimes called the Superb Robin) have been described in the literature as being particularly "richly marked", and in a small series of eggs this would indeed appear to be true. But, if a long series is examined, one which contains a sufficient number of eggs to allow one to see the full range of variation (and one must remember that specimens showing the extreme ends of the range are very rare), it can be seen that eggs agreeing in every respect with those of the Superb Robin do in fact occur in the mainland races.

The only thing that is remarkable about those from the Canary Islands is that they are nearly all like that. One must assume that egg colour is genetically controlled; the studies of many researchers on variation in the colour of cuckoo eggs has suggested strongly that this is the case. One explanation, therefore, is that the population of the Canary Islands was descended from a very small number of colonists, or even from a single female, who quite by chance happened to be carrying the gene for these strongly marked eggs. There is of course, no way of proving this, but it does fit in with the view that the Canary Islands were of oceanic origin, never connected to the African mainland and received their avifauna by limited aerial colonisation.

The question as to whether eggs are a useful guide to taxonomic relationships in birds is a vexed one, and one which has been argued about over the years. Unfortunately, in my view, too much weight has been attached to David Lack's paper on the eggs of the Turdidae which appeared in *The Ibis* in 1958. He expressed the opinion that egg colour is valueless as a taxonomic character, because he found that in the Turdidae egg colour cut across generic boundaries and appeared to be entirely adaptive; eggs of closely related species were often very different in colour, and those of unrelated species often similar. While not refuting his conclusions insofar as they apply to this family, it is unfortunate that his conclusions have been assumed by some people to apply to the eggs of all passerines. This is not so. The eggs of the Sylvidae present a totally different situation. In this family it is often difficult to distinguish the eggs of closely related species; but the eggs are absolutely distinguishable at a generic level. Not only are they distinguishable, but many of the genera are uniquely coloured, which one would not expect if the colour were purely adaptive. Thus the pink spotted eggs of the *Hippolais* warblers resemble no others, and the brownish-pink specked eggs of *Locustella* and the green-spotted eggs of *Acrocephalus* are also quite distinguishable. The Thick-billed Warbler *Phragmaticola aedon* has in recent years been placed in the genus *Acrocephalus*, but its egg in no way resembles eggs of that genus. It is, in fact, almost indistinguishable from eggs of *Locustella*. Contra Lack, therefore, eggs can be useful in some cases, and should not be totally ignored as a source of taxonomic help.

Identification

Identification of bird eggs is a very complex subject, in fact it is sometimes more an art than a science. I am always surprised at the number of people who seem to assume that identifying an egg is the same as identifying a bird - you look at it and you say "Oh yes, it's a so-and-so". It is of course true that the eggs of some birds are absolutely distinctive. An ostrich egg, for instance, could never be mistaken for anything else, nor could the egg of a diver. The 4 species of diver all lay very distinctive brown eggs with black spots which are unlike those of any other family. The eggs of 3 species, however, are distinguishable from each other only by size. But here we have a problem. The average egg size of the 3 commoner species, the Red-throated, the Black-throated and the Great Northern, relates to the size of the birds, thus the Red-throated is the smallest and the Great Northern the largest, but it does not follow that every egg is assignable to species on size. The eggs of most bird species vary in size by up to 25% on either side of the average. This means that there is a very considerable overlap in the size ranges of the three species. Eggs of the White-billed Diver are probably indistinguishable from those of the Great Northern, but they are very rare in collections. Tring Museum has none, and I have never seen one, so am unable to comment.

Several factors complicate the identification of many birds eggs. These are the extreme variation in colour and pattern occurring within the species, coupled with the fact that similar egg-colours and patterns can occur in totally unrelated birds. This is complicated even more by the possibility of abnormal or freak eggs which can occur from time to time. These may be totally unlike the normal eggs of the species but may well resemble those of some other bird. The olive eggs of the Nightingale look pretty distinctive and very different from the blue eggs of the Indian Chats formerly placed in *Larvivora* but now merged in *Luscinia*. Occasionally, however, the Nightingale will throw up a blue clutch which is virtually indistinguishable, and indicates that the eggs are basically similar, a blue ground with, in the case of the Nightingale, an overlying brown pigment which may occasionally be absent. Very occasionally, it would appear that such freaks become stabilised. The eggs of the *Hippolais* warblers, as I mentioned earlier, are very distinctive spotty pink eggs, but the eastern race of the Booted Warbler (*H. caligata*) produces an egg which is pale mottled grey. If one did not know, one would never guess that it was a *Hippolais* egg.

This situation is very rare indeed, I know of only two other instances of striking difference of this kind between different races of the same species; these are the Dark Grey Bush Chat *Saxicola ferrea* of India, and the Blackbird. The Chinese Black-bird (*Turdus merula mandarinus*) has consistently pink-ground eggs rather resembling those of a Mistle Thrush, and the races of southern India have much darker and glossier eggs than those of European populations. In the last instance, it is however possible that the various populations are almost, if not actually, specifically distinct.

For these reasons, we do not guarantee the identity of any egg brought in, but nearly always qualify it by phrases like "most probably the eggs of..." or "not distinguishable from..." or "likely to be..." and so on. Nevertheless, it is also true that when one has worked with eggs for a long time, one develops a sort of "sixth sense" in regard to identification. Many times I have had to check an egg supposed to be the egg of such-and-such, and although it may agree fairly well in colour, shape and pattern, I am conscious that there is something "wrong" with it. One often cannot say exactly what, but instinct born of years of experience tells you that it isn't what it is supposed to be.

We sometimes have to identify eggs for Customs and Excise. These are usually eggs which are being imported, and the identity has to be checked. Identifying eggs in this context is notoriously difficult, as one often has little idea of the origin of the eggs (the Customs tend to be reticent on this point). Most raptor eggs, for example, cannot be identified with certainty on a world basis; but knowing the country of origin narrows down the possibilities considerably. Only a couple of weeks ago, Customs brought in some eggs originating from an aviary in Florida, which they believed to be pigeon eggs, in the hope that I could identify the species. Well, of course pigeon eggs are oval, glossy and white, and only differ in size. I had to say that had they been able to tell me that the eggs had been wild taken on (say) Madeira, I could have checked the species known to occur o the island, and see which one laid eggs nearest to these in size, but as it was all I could do was confirm that they were pigeons'.

Another example of the sort of difficulties involved was demonstrated a number of years ago when the RSPB brought us a clutch, believed to be Kite eggs, but which the owner claimed were Buzzard. In a laid-out series, Kite and Buzzard eggs look very different, but on comparing individual eggs, it can be found that every single Kite's egg can be matched by one of a Buzzard. In other words, Buzzard has a much greater range of variation, and the range of Kite is contained within that of Buzzard. Yet again, Dr. Hilary Fry sent me the remains of a hatched tern's egg from an island in the Persian Gulf, and asked me to identify it. He was sure it must be one of three species but didn't know which. Here again, in a series, the eggs of the three terns looked fairly distinctive, and some eggs could be assigned with reasonable certainty to one of the three species. But there were many duplications, and I found that eggs matching the one sent were to be found within the ranges of all three.

Very strange cases sometimes occur. Levaillant's Cuckoo (*Clamator levaillantii*) lays blue eggs and parasitises blue-egged babblers in West Africa. In one very small area, some of the babblers produce rose pink eggs instead, the only instance I know of a bird laying an egg quite like this. Not to be outdone, the Cuckoo has in this area produced a pink egg to match.

Eggs of the Great Auk

Nearly every year we receive at least one enquiry from a member of the public who believes that he has an egg of the Great Auk. In some cases these have been cherished family possessions for years, and it is always very sad to have to disillusion the person. Most frequently they turn out to be Guillemot eggs, which are very similar in shape and pattern,but about half the size. Other candidates include ostrich, emu, goose and swan. Once I had to go down to Christ's Hospital school to examine a supposed Great Auk's egg in the collection there. It proved to be very accurate in size, shape and pattern - but it was made of papier mache. What is not always realised is that 75 eggs of the Great Auk are known to exist, all of which are individually distinguishable on the basis of the pattern of their markings. Nearly all of them have been known since the middle of last century and their histories documented in considerable detail. A number have changed hands in the sale rooms on more than one occasion. Monochrome photographs of all 75 have been published (Tompkinson, 1966) It is possible, but most unlikely, that any unknown and undocumented specimens still exist. I referred to a papier mache egg. It was in fact, quite a common practice during the nineteenth century for replicas of Great Auk eggs to be made, and kept in private collections, in view of the great rarity of the originals. Many of these were cast in plaster, and were deliberately made as replicas of specific known specimens. There is also an amusing story to be told. A famous collection of the early nineteenth century was that of J.D. Salmon. When he died, his collection was left to the Linnean Society. Many years later, the Great Auk's egg was found to have been removed, and replaced by a swan's egg which had had spots painted on it.

Age

Another very vexed question is that of the age of bird's eggs. No test has yet been discovered for dating an egg with any accuracy. Of course, very fresh eggs will look new, and very old eggs will become rather dull and dusty, but a lot depends on how carefully they were prepared, and the conditions under which they has been stored. Eggs stored in the damp will become mouldy, those not stored in absolutely air-tight containers will eventually, after many undisturbed years, become covered with dust. A well-prepared egg, stored under ideal conditions can remain looking remarkably young even after 150 years. The only good guides I know to ageing are fugitive pigments, and these are of very limited application. In the eggs of sparrowhawks and goshawks (even if kept in the dark) the bright blue ground colour completely fades of 20-25 ears, and all eggs in older collections have a chalky white ground.

Historical Aspect

The second half of the nineteenth and the first half of the twentieth centuries were the great (or as some would say, the bad) era of egg collecting. People collected eggs, much as today they collect stamps, gold coins, 78 rpm gramophone records, Chinese jades, etc. (I know one man who collects lawn mowers!). Eggs had been collected as far back as the seventeenth century, but as far as I am aware nothing from this period has survived. The oldest dateable egg we have in the collection is a gannet's egg collected in 1807, but a number of undated specimens may well be older. The Montague Collection which we received in 1813 probably contains eggs dating from the latter part of the eighteenth century. In the heyday of collecting, specimens were exchanged, bartered and sold at auction rooms; many very large collections were built up and then auctioned when the owners died. Many famous collections were lamentably broken up in this way, others remained intact and were donated or sold to museums where they formed the basis of the collections there. One very famous collection, the Nehrkorn Collection, built up I believe almost entirely by purchase, is now in a museum in Germany, and contains many rarities. There are indeed still some bird species from generally uncollected corners of the world of which the only known eggs are in the Nehrkorn Collection. During the lifetime of a collector, many eggs would be bought and sold, and thus a great many specimens changed hands many times before reaching their final resting place. Many specimens vanished, for one thing is certain that the extant collections, extensive though they may be, represent only a tiny fragment of the material that was being actively collected.

Collections vary very widely in their scope and documentation. Collectors, like Jourdain for example, carefully noted not only date and locality, but evidence of incubation, detailed descriptions of the nest and nest site, and much other valuable scientific information - often far more valuable than the eggs themselves. (If he were alive today, Jourdain would probably have been an enthusiastic participator in the BTO Nest Records scheme). In other words Jourdain was primarily an ornithologist, and his egg collection, large though it was, was regarded by him as an aid to study rather than as a collection in its own right. This what all egg collections *should* be.

At the other end of the scale was Count von Rödern, a German aristocrat whose collection was bought by Lord Walter Rothschild towards the end of last century, and is now at Tring. This consists mainly of single eggs, not clutches, sometimes with the dates and localities (usually approximate) scrawled on them in pencil. However, Rödern deliberately sought out unusual varieties, and in a number of instances his collection contains wider ranges of variation within a species than the collection of any other single collector.

Then there was Henry Munt, who only collected eggs laid in captivity, and only if they were pure white. He must have built up a considerable network of correspondents who bred parrots, pigeons and so on, and obtained from them all their addled eggs. As such, his collection is a remarkable document of the birds in his chosen families which were being bred in Britain at the time.

Collectors ranged from the monumental to the insignificant. We have some eggs, for instance, collected by Audubon. We have an Arabian ostrich egg collected by the famous explorer Charles Doughty and owned for a time by Lawrence of Arabia. On the other hand, nothing appears to be known about Mr. Foottit other than that he once owned a large collection which was subsequently dispersed. In the early days of this century, S.A. Buturlin travelled to the mosquito-infested swamps of the Kolyma delta in eastern Siberia to bring back the first known eggs of Ross's Gull. We have some of them here, and I for one, find a tremendous thrill in holding one in my hand and thinking of the romantic (and probably very dangerous) journey that lay behind their collection. We also have the first known clutch of eggs of the Curlew Sandpiper, taken and described by Henry Popham, another very careful and meticulous recorder. They are still our only clutch of the species. These men were not the kleptomaniacs that in this day and age egg collectors are usually portrayed as being; they were serious ornithologists who travelled to far flung, and dangerous corners of the earth, to increase the world knowledge of species which at that time were little known, often describing nests and eggs for the first time. This is not encouraged today, which is a great pity in view of the fact that for over a third of the world's species of birds (many of which are rapidly vanishing) the nests and eggs have never been described or even found. I was told a ripping yarn some years ago, about a birdwatcher who went on an Ornitholiday to the Himalayas. Tramping along a mountain trail he saw a bird fly off to the side and settle on a nest some short distance from the path. He identified the bird, but being a loyal RSPB supporter, he knew that it was not "cricket" to disturb a bird on its nest. So, although he was itching to know what the eggs looked like, he passed dutifully on his way. On his return to England he made some enquiries and was stunned to be told that he was the first person ever to have seen the nest of that species, the eggs of which of course remain undescribed. Thus was an excellent scientific opportunity lost.

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REVIEW: The Spiders of Great Britain and Ireland 2-part Compact Edition

by Michael J. Roberts.

Published by Harley Books, Martins, Great Horkesley, Colchester, Essex CO6 4AH (1993).

Price £80.00 (complete); £49.95 (part 1 - text, 7 col. pls, numerous figs); £39.95 (part 2 - 256pp. 236 col. pls); £3.75 (supplement to hardback edition).

It hardly seems five years since the last of the three volumes of the hardback edition of this work was published. In that time, it has become established as an essential tool for those involved in spider identification, and its worth has been widely recognised. This is not the place to recapitulate the many things, mostly praiseworthy, said about it, but to comment on the present publication.

There are two aspects to this new work: one is the re-formatting of the original material, and the other is the supplement. Regarding the former, the original volumes have been re-issued as two; the textual and diagrammatic volumes 1 and 2, together with the supplement as an appendix, are now all together as part 1, and the colour plates of volume 3 are still separate as part 2. Apart from such things as the title pages, the material is identical; this is because the text pages are formed from a run-on set printed at the same time as the original hard-back version. Unfortunately, therefore, it has not been possible for the publishers to correct typographical errors, but most of these are noted in the Supplement. However, it must be said that the publication as a whole is to the high standard that we have come to expect from Harley Books.

For those who already possess the hardback edition, the separately available, modestly priced supplement will have the greatest value. This consists of corrections to the original text, of the description of eight additions to the British spider fauna too late for previous inclusion, and a very useful re-assessment of some members of the genus Philodromus which is causing problems at the present time. This process of addition and re-assessment is ongoing and the idea of a regular update along these lines is very attractive. It is to be hoped that the author and the publisher will see their way to considering this.

At little more than half the price of the original edition, the appeal of the softback edition ("compact" seems to be a misnomer since the only reduction in size is in the thickness of the covers) will be mainly to the amateur. Libraries are usually more interested in hardback versions; professionals, although they might be attracted to two volumes being combined, will probably want something more hard-wearing. Most workers currently active will already have the hardback edition and will only require the supplement, but the work should provide an incentive to those people wanting to enter this field of study.

Stanley Dobson

The Role of Museum Natural History in Interpreting and Protecting the Environment: An Outsiders View

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The primary concern of this article is to discuss methodology rather than interpretive techniques. It will examine the proposition that museum natural history will gain a new role which will make a major contribution to protecting our environment; one of enabling and empowering communities, rather than display and interpretation alone. Despite a new direction, this approach must be based on traditional museum qualities of research and preservation.

It might seem strange than an archaeologist should seek to address the subject of natural history interpretation, especially through a specialist journal. However, as a manager I have worked on a number of natural history projects, and in my career have worked in a museum service run by a natural historian, Norman Atkinson in Angus, where the environment was given a high profile. It was there I began to appreciate the size of the audience for natural history and the level of support for it "out there".

The overall picture, as I see it, is as follows. As in the archaeological world there are a number of publicly funded organisations with specific remits. From an outsiders point of view these seem reasonably well funded, although I am sure that those inside or with greater knowledge than I would not concur. Next, and this is its great strength, there are a large number of committed amateur groups, many at the forefront of research and recording. These include a large body of "semi-professionals" who do much of the biological recording in the UK.

However there is not an opportunity for the casually interested person to interface with the subject. It seems to me, as such a person, the only way to get more than superficial information is to make a commitment by joining one of the "semi-professional" bodies. It may be that this is just a marketing problem, that the opportunities exist but are not clearly signposted. However, I believe that it is deeper than that, and it is this that I wish to address.

Current Approaches

I will discuss current approaches, and suggest that they are not making the most of opportunities, and then go on to suggest that the approach which will succeed in the Highlands is one which will fully involve communities, and indeed empower them, and finally, suggest how this might be achieved.

There is such a plethora of professional organisations involved in interpreting the environment that a fully coordinated approach is impossible. Nor need such an approach be a good thing. I believe that the variety of different standpoints of the various organisations could lead to a healthy mix of approaches, but this will only happen if each allows for the existence of others, and communicates about their intentions. The current level of suspicion and protectionism that characterises many of the workings in the Highlands can only lead to duplication and a reduction in quality. Organisations must be aware of what each of the others does. I think that it is an indictment, and I use that strong word deliberately, that the DONE Report (Development Opportunities in the Natural Environment produced by Highlands and Islands Enterprise (HIE), Scottish Natural Heritage, (SNH) and Highland Regional Council, (HRC)), (Ash Partnership, 1991), could be produced without mentioning or taking into account the role of Inverness Museum and the biological recording and interpretation work that is conducted there. That the potential role of museums was ignored is a gap in the report that has yet to be rectified.

A major development recently has been the setting up of Scottish Natural Heritage, an organisation with whom I have worked on a number of occasions. I am impressed with the dedication of the staff and with the developments that are being undertaken. Certainly the profile of the organisation is far higher than its two predecessors combined. Like all organisations undergoing change, particularly under this government, there is a slight loss of confidence in core values. I would suggest that, although there is a need to act entrepreneurially, and adopt some practices of the business world, we should have confidence in our core values of preservation, research and education. Many organisations, Local Government, Highlands and Islands Enterprise, and museums have gone through this. I believe museums have reached a stage where they have changed, and are now rediscovering the confidence to once again return to their core values. SNH will do the same, and indeed the signs are that it is happening already. I would encourage all, in museums and outside, to "keep the faith". We can deliver our values, but in a way that impresses our political masters. The public want quality, that much is commonly agreed. I believe, however, that the public are not taken in by superficial displays that lack research. The public can tell the visitor centre that has created one-off displays bought in from outside design consultants. They will visit these and pay for entry, but what they will come back to is the centre that offers the opportunity to learn in a comfortable and relaxed atmosphere. The centre that succeeds will be the one that successfully conveys to the visitor the excitement and enthusiasm that the staff have for their subject. The one that can show the public the latest findings, the research that is going on now, in a way that gets over the excitement of those who are doing that work. This view is increasingly being touted by consultants, I would cite the KPMG Seminar at last years Museums and Heritage Show in London, (KPMG Peat Marwick, 1992). The public are looking for more than a "Leisure Experience". However we tart it up in language such as "Leisure Learning Opportunities" it means that our core work is valued, and will be supported, if we can involve the public and give them an understanding of what we do.

This is not to say that there is not a role for the static display. I am referring here to the sorts of display that, for example, Forest Enterprise, and Ranger services do well. The typical wooden hut, with displays and reconstructions of habitats and the like. These work well, and can and are duplicated on sites around the country. But I do not believe that they can be translated to the large scale. There is a danger that many of the new, large scale interpretive ventures around the country will be larger versions of these, staffed by shop attendants and restaurant staff, and distanced from the source of their information — the professional staff working at the cutting edge. I believe the key to success of these projects, apart from good planning, marketing, and all the other business skills, will be how far they give the visitor an opportunity to feel involved in the work of the parent organisation. It is a question of empowerment. If we give the visitor only a surface display of what we think they want, we are assuming that they are not capable of independent thought and development. If we give them the opportunity to understand what we do, why do we do it, how they can influence us, and the opportunity for personal development through learning, then they will respond by sharing our problems and our values with us, and give us their support to help us solve them. But how does this work in practice?

I think that it would be a mistake to think solely in terms of centres interpreting natural history. That is not to say that there is not a place for them; I am working as part of a team looking at a marine environment centre at the moment. But let us start by looking at why we interpret things at all. Part of the reason is for the economic benefit that such centres bring in, in terms of visitor spending and job creation. Let us not kid ourselves, this is a major reason why funds are becoming available for such projects. However, the main gain for society is social and educational. My work on the human history side is concerned with working with communities, giving them a sense of the past, and thereby an understanding of the present. This promotes a sense of the very collective experiences that created the community in the first place. It gives incomers and locals alike equal access to common history and legend. This understanding of the present and sense of community gives a confidence to enable the community to grow for the future. If this is true for human history how much more is it the case for the environment. Communities are where they are because of the landscape in which they sit; have developed as they have because of the environment in which they live; and will have a future only if they have an understanding of how to look after their world, both on the micro and the macro scale. Thus communities need to understand the place the environment has in their lives if they are to appreciate what effects they might have on it.

The Holistic Approach

Much of this will be accepted wisdom by the reader. However, I would add to this that the future of natural history interpretation lies in an holistic approach to interpretation. The old divisions can no longer survive. The point we have to get over is that people impinge on the environment in many detrimental ways. To get this message over we must get them to take personal ownership of the problems, and thus work towards resolving them. I would maintain that this is best done through showing how the environment impinges on them. Thus the human element, how human history and the present have been moulded and influenced by, and indeed are the result of, the micro environment in which each community exists, is vital. One way of achieving this is the eco-museum approach. This approach moves away from single, or even multi disciplined approach, to one which seeks to preserve and interpret all aspects of a culture, both human and natural. People are empowered by understanding; giving them information and knowledge is the way to giving them understanding and ownership of problems. Once this has been done solutions can be sought.

If it is accepted that an understanding of the present through the past, in both human and natural history terms, is a way forward a route becomes clearer. Communities must be empowered through a holistic approach to past and present. Museums, regardless of who runs them, are used to doing this, and, further, it is part of our raison d'etre. But the role of the multiplicity of organisations must be empowerment of the community, a sharing of information, and acceptance of community values. Once done this means that each organisation can support that element of a community's plans that most closely fits its own values and directions. An example of this can be found in Lochcarron, a small community in Wester Ross. At a modest level a community group want to preserve and interpret their heritage. They have decided on a theme of industry in the highlands, as their community partly grew from an attempt to produce linen cloth in a factory in the eighteenth century. Because many of the attempts at industrial development in the area are a result of geological and natural features, from mining in the bronze age to oil rigs in the 1980's, they are including in their displays a major section on how the environment has effected human settlement and development. This element plus landscaping and tree planting to create a micro environment on the site, is being supported by SNH. Ross and Cromarty District Council is assisting with the rest of the displays, and Ross and Cromarty Enterprise (the Local Enterprise Company) and RCDC are supporting the tourist element of the project. An example of organisations with both differing and overlapping aims, working together through a local group, empowering them, not just to run a museum, but to assist in helping that community to grow towards the future and understand the importance of the environment around them. This may be on a small scale, but I would argue strongly that the returns demonstrate it is a very high value for money exercise.

But communities cannot do this without support, nor can they get information without someone gathering and disseminating it. As Miles (1987: 92) suggested, it is vital that museums continue their role particularly as centres for biological recording, and as the report showed, this cannot be done everywhere, as not all museums can employ professional natural historians on the staff. The Miles Report suggested centres of excellence whose role would be to support other institutions. In the Highlands historically this has been Inverness. With Local Government reform around the corner, there is no better time or place to raise the subject of how this role can be maintained and developed into the future. I hope, and intend, that this will be debated as part of the discussions which will surely take place as soon as the announcement of the future is made.

Summary

Organisations must co-operate on the macro-scale by recognising that they may have overlapping aims and respecting the rights of others to work in a given field. The best way of ensuring cooperation is by working through communities and letting them be the catalyst for developments. This has the added benefit of empowering people and having them take ownership of the environmental issues facing us all. I see the future of biological interpretation as one soundly based in an holistic approach, and I see it firmly based in eco-museums around the Highlands, supported by a wide range of organisations. I think that it is an exciting future, and I cannot wait!

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REVIEW: Bibliography of catalogues of type specimens in world's zoological and palaeozoological collections

by Wiktor, J. & Rydzewski, W.

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The stimulus for this catalogue was the XIV International Congress in Copenhagen in 1953 which stressed the importance of type specimens to science. Professor Wladyslaw Rydzewski of the Museums of Natural History, Wroclaw University began work on the catalogue and work was continued by Jadwiga Wiktor on the death of Professor Rydzewski. The bibliography comprises a catalogue of type specimens of living and fossil animals. It is divided into two parts: Zoological and Palaeozoological and there is also a supplement of additional material found during editing the first part.

The bibliography is arranged in 9 sections: a preface; an introduction which describes the kinds of catalogues which have been included; the zoological classification used in the bibliography; a list of abbreviations to zoological taxa; a list of institutions known to have zoological and palaeozoological collections with references to authors; the Zoological catalogue; the Palaeozoological catalogue, and an index to authors names (with the exception of the Preface and Introduction, these are repeated in the supplement).

The main parts of the bibliography (the Zoological and Palaeozoological catalogues) begin with a catalogue of catalogues, followed by details of individual catalogues arranged alphabetically by author under each main taxonomic division. Where the catalogue is part of a general catalogue this is indicated and the cross reference given.

From my limited knowledge of catalogues of types, this appears to be a comprehensive compilation. All the catalogues which I looked up were included and the index and cross references worked well (at least four current BCG members are cited as authors). Compiling such a catalogue is an arduous and time-consuming task and Jadwiga Wiktor and the late Professor Ryzewski have made a valuable contribution to systematic zoology and palaeozoology.

Geoff Stansfield

Pest Control in Natural History Museums; A World Survey

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Museums contain considerable material resources of scientific, historical and educational importance. However, the organic composition of certain museum objects represents a potential food source for a range of pests, notably insects. Damage to zoological and botanical material, textiles, books, paintings, wooden artifacts, furnishings and buildings can result from the feeding, burrowing and defaecating activities of pests, causing damage ranging from minor, localised deterioration of individual objects to extensive and total destruction of entire collections. Traditionally, museums have relied on the application of chemicals as the principal strategy for prevention and control of pest infestations in collections; however, concern has been raised over the effectiveness of such treatments, hazards to human health (Croat,1978; Peltz and Rossol,1983; Irwin,1987; Williams and Walsh,1989), and potential damaging influences on specimens and materials (Jedrzejewska, 1967; Tilbrooke, 1978; Zycherman and Schrock, 1988; Hammick, 1989).

Until recently, little research had been undertaken on problems associated with pests in museums. A survey of pest control practices used in 27 New York city museums indicated that staff had little knowledge of the hazards, precautions and regulations relating to the use of pesticides (Peltz and Rossol,1983). Earlier, the Association of Systematics Collections surveyed pest control practices in American museums and published the results in 'Pest Control in Museums' - a status report (Edwards, Bell & Stanley, 1980). This represented the first comprehensive guide to pest control in museums and included the range of chemicals used, reactivity with materials and pests encountered, although information was not requested on health and safety aspects of pest control policies. Stansfield (1985) reported that no comprehensive survey had been undertaken to determine the status of collections in Britain and that inadequate information and few recommendations existed for pest control management programmes in museums. Linnie (1987) subsequently surveyed pest control policies in 89 museums throughout Great Britain and Ireland; however, little information remained on the status of collections worldwide.

To clarify the situation and establish priorities for further research, a survey of selected natural history museums worldwide was undertaken during 1987 and 1988. The survey was directed primarily at museums with holdings of zoological and/or botanical material. Information was requested on building design and environmental conditions relating to control of pests, types of pests found, damage caused, collections affected, existing control strategies and the effects if any, of control practices on personal health. The six-page questionnaire used is reproduced at the end of this paper (*Figures 8-10*)

Results

The survey focused primarily on national, regional, city and university museums. A circulation list of 121 natural history museums worldwide was compiled from the Directory of Museums and Living Displays (Hudson and

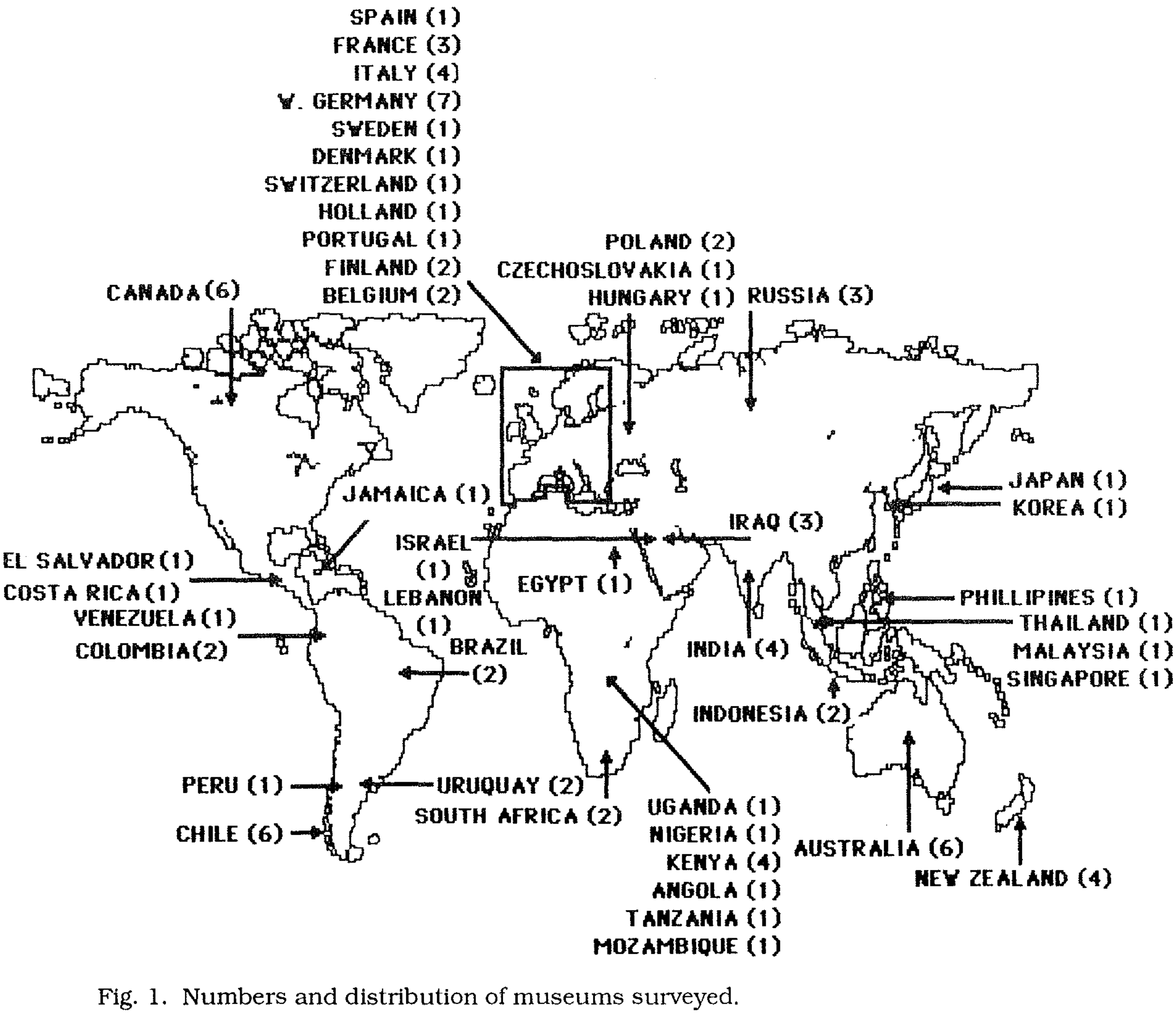

Fig. 1. Numbers and distribution of museums surveyed.

Nicholls, 1985). The United States, Great Britain and Ireland were excluded from the mailing list as they had been surveyed by previous workers (Edwards, Bell and Stanley,1980; Linnie,1987). From the 121 museums contacted, 92 completed questionnaires were received representing 72 museums in 46 countries (*Figure 1*). The results outlined represent percentages of completed returns and refer primarily to dried, perishable collections of animals and plants.

Types of collections managed by respondents.

The survey was directed primarily at museums containing collections of zoological and /or botanical material. However, although zoological collections were managed by 79 per cent of those surveyed, the majority of respondents were responsible for more than one type of collection. Botanical collections were managed by 22 per cent of respondents followed by anthropological/ethnographical collections by approximately 16 per cent. Other collections managed include decorative arts (1 per cent), technological (1 per cent), mineral (6 per cent) and palaeontology collections (3 per cent).

Quantities of specimens held in museums.

Collections varied in size from small museums with fewer than 5,000 specimens to national and regional museums with several million specimens (*Figure 2*). Thirty one per cent of the museums surveyed have over one million specimens in their care.

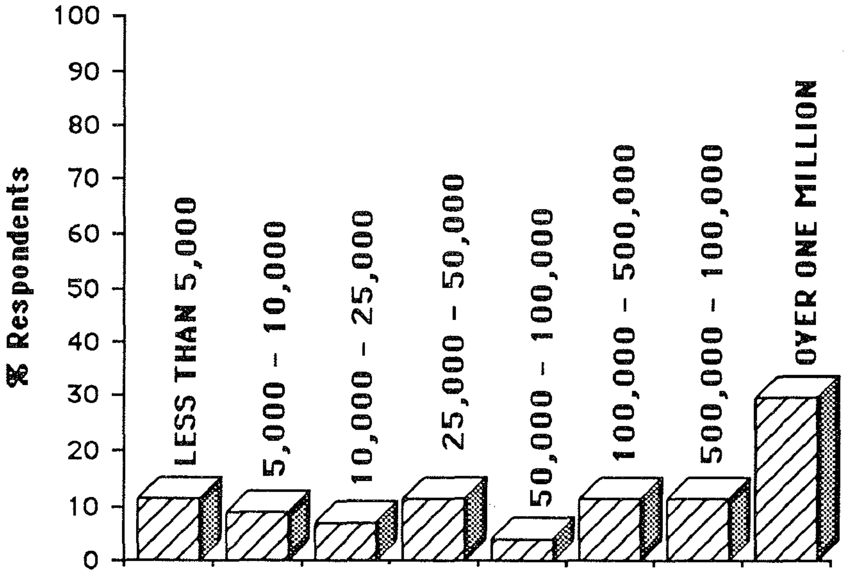

Fig. 2. Approximate quantities of specimens held by museums

Types of storage containers used in museums.

A wide range of storage containers and display cases are used in museums. Wooden storage units (92 per cent), large exhibition type cases (74 per cent) and enclosed drawers within cases as in entomological collections (62 per cent) are the most widely used. Metal storage case are used in 50 per cent of the museums surveyed and a considerable amount of material is stored on open shelving (35 per cent). Cardboard boxes are used to store specimens in 8 per cent of museums.

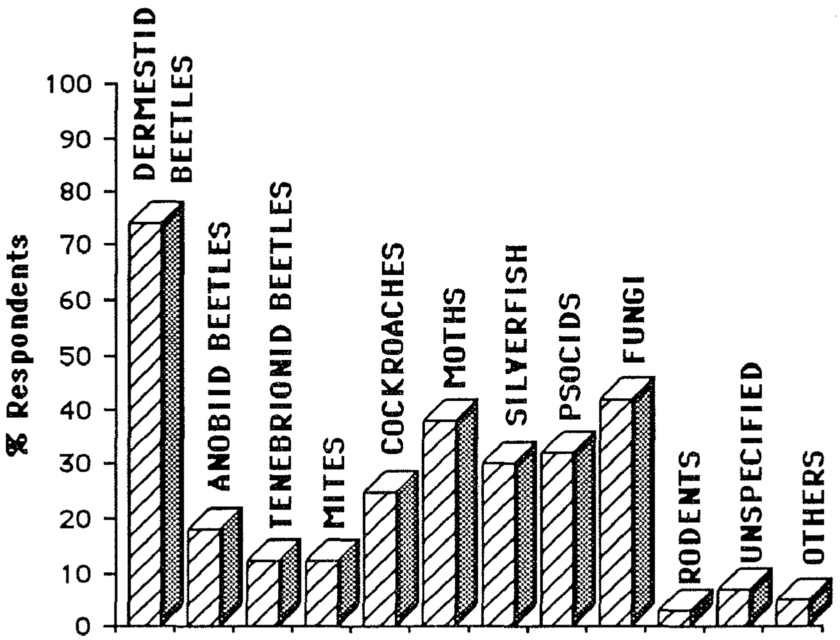

Fig. 3. Range of pests encountered in museums

Pests fully identified and described as 'serious' problems were;

COLEOPTERA	: Dermestidae	Trogoderma angustum (Solier)	1 account
		Reesa vespulae (Milliron)	3 accounts
		Anthrenus verbasci (Linnaeus) 'Varied carpet beetle'	2 accounts
		Anthrenus sp.	7 accounts
		Attagenus sp.	2 accounts
	: Anobiidae	Stegobium paniceum (L.) 'Biscuit' or 'Drugstore beetle'	2 accounts
		Lasioderma serricorne (Fabricius) 'Cigarette beetle'	2 accounts
	: Tenebrionidae	Tribolium sp.	1 account
LEPIDOPTERA	: Tineidae	Tineola bisselliella (Hummel) 'Common clothes moth'	1 account
RODENTIA	: Muridae	Mus sp.	1 account

Table 1

Environmental conditions reported in museums.

Eighteen per cent of respondents reported controlled temperature levels throughout their museums including storage and display areas while 11 per cent reported controlled humidity levels, although little information was provided to indicate if such controls were dictated by specific collection requirements. Twenty one per cent of museums have some method of recirculating air although only 8 per cent use air filtration units. Fifty nine per cent of museums have storage areas with windows opening directly to the building exterior with no evidence of screening to prevent pest entry, while 17 per cent have doors in storage areas which open directly to the outside.

Range of pests encountered in museums.

Ninety seven per cent of respondents reported evidence of past or recent pest infestations, with the hide, bacon and carpet beetles, (Coleoptera/Dermestidae) the most widely encountered and distributed affecting 54 museums in 37 countries. Twelve different 'groups' of pests were reported by respondents (*Figure 3*). Of these, the Dermestidae were considered the most serious threat to collections by 47 per cent of respondents followed by 'moths' at 17 per cent, and anobiid beetles (Coleoptera/Anobiidae) at 10 per cent. Other pests which created serious problems for some museum workers although at very low occurrence rates included, mites, psocids, flour beetles, rodents and miscellaneous unidentified beetles. Fungi, although not strictly pests, presented 'serious' problems for 19 per cent of respondents and are therefore included in the results. The pests fully identified and described as 'serious' problems are shown in Table 1.

Damage to museum specimens and materials caused by pests.

Damage to collections resulting from the activities of pests was reported by 78 per cent of respondents. Most of this damage (35 per cent) which ranged from minor isolated accounts to major and extensive damage to entire collections was caused by Dermestidae (*Table 2*). Thirteen per cent of those surveyed attributed the total loss of insect and other collections to Dermestidae.

Reesa vespulae, (Coleoptera/Dermestidae), a parthenogenetic species responsible for extensive damage to insect and herbaria collections in Finland (Makisalo, 1970; Hamalainen and Mannerkoski,1984), was positively associated with three separate accounts of serious damage to insect and bird collections while freeze dried material was also attacked. Other damage caused by the range of pests listed includes weakening and surface damage to ethnographical material, loss of strength and appearance of holes in wooden artifacts, the complete destruction of a collection of musk-ox horns and the general spoiling of objects due to accumulation of insect frass, while the value of one particular collection was seriously undermined by the destruction of labels and information material caused by mice. Fungi were responsible for general degradation of zoological, botanical and ethnographical material including severe discolouration and staining of specimens.

Pest Group	Main collections affected	Extent of damage	Occurence rate (%)	Comments
Dermestidae (hide , bacon and carpet beetles)	Skins, mounted specimens, dried insect collections, skeletal material.	Minor and localized to total destruction of material	35	Mostly by 'dermestids', also included Anthrenus spp., Attagenus spp., and Reesa vespulae
Anobiidae (furniture beetles)	Pulverization of dried plants, powdering of wooden arefacts, holes in herbarium sheets and wooden artefacts.	Minor to serious	7	Caused by Stegobium paniceum and Lasioderma serricorne
Moths	Fur and feather loss in mammal skins. Insect collections and ethnographical material	Minor to serious	13	Feather and skin damage by Tineola bisselliella
Psocoptera ('booklice')	Insect and botanical collections	Minor to total destruction	4	Cruciferae and Ranunculaceae affected
Fungi	Zoological, botanical and ethnographical collections	Minor to serious	20	Disfigurement, discolouration and staining of material. Weakening and rotting of wooden artefacts.

Table 2

Suspected source of pest infestations in museums.

Forty seven per cent of respondents directly associated pest infestations with the integration of new acquisitions and the return of loan specimens while 37 per cent linked pest entry with ventilation systems. Other suspected modes of entry were associated with visitors clothing (one account), entry through unscreened windows (three accounts) and one account of entry from a birds nest in a museum wall. Two accounts of collection damage were attributed to endemic pest populations within other areas of the museum. Thirty eight per cent reported a seasonal pattern in the occurrence of infestations with noticeable increases in late spring and early summer.

Pest control strategies used in museums.

In the majority of museums surveyed, 83 per cent use some form of pest control strategy and 80 per cent reported the use of pesticides in collections. However, non-chemical methods including humidity and temperature controls are also used (*Figure 4*). Pesticides are used in fumigant treatments and for ongoing residual protection in display and storage cabinets. Forty eight per cent of respondents use three or more different pesticides with naphthalene and p-dichlorobenzene (PDB) being the most widely used substances (*Figure 5*). Dichlorvos, (2, 2-dichlorovinyl dimethyl phosphate) in the form of polyvinyl chloride slow-release resin strips is also in popular use but uncommon in

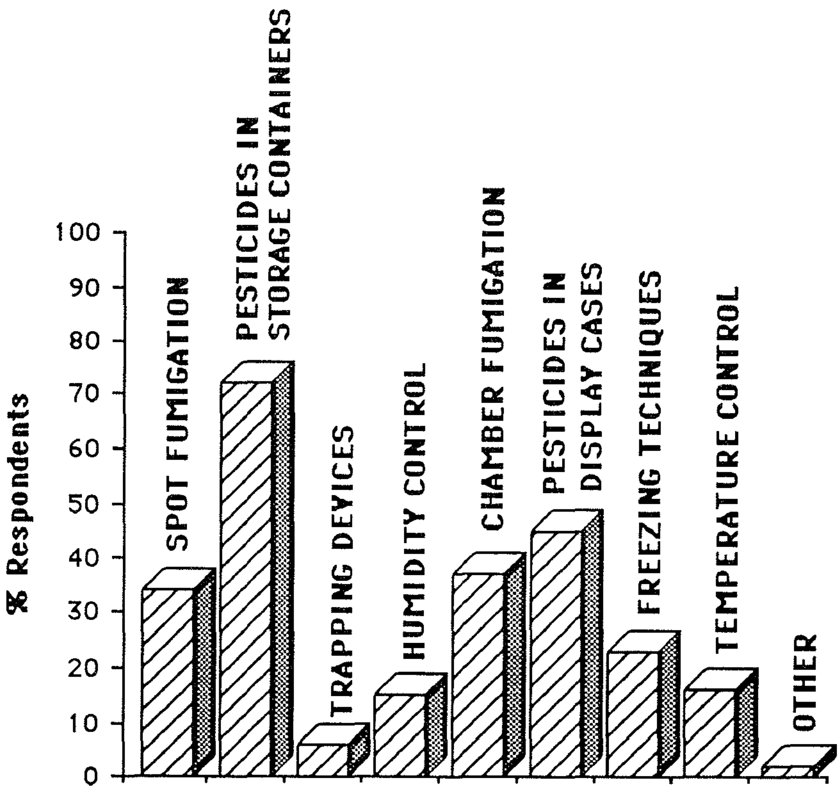

Fig. 4. Pest control strategies used by museums.

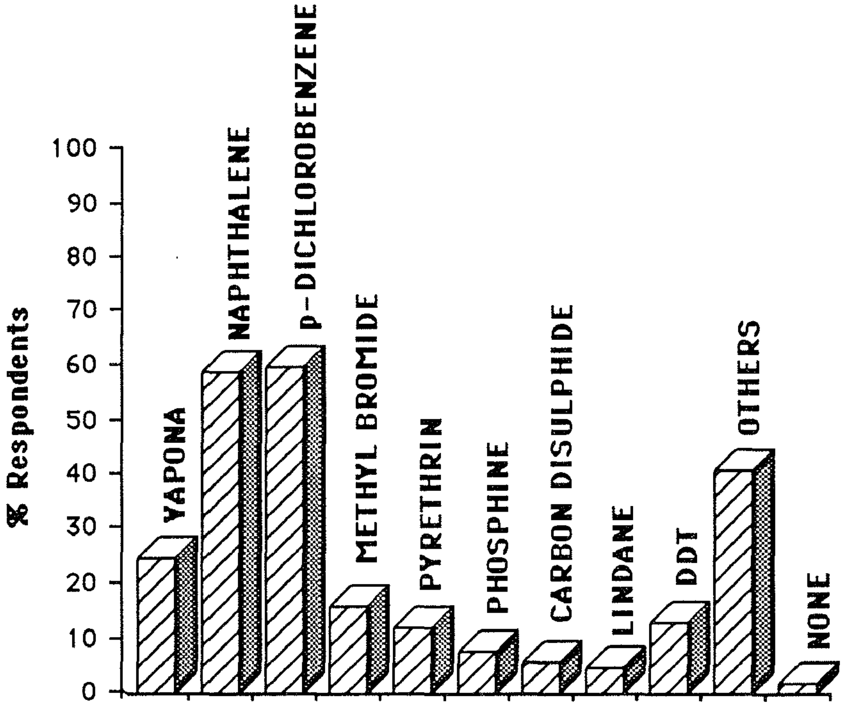

Fig. 5. Chemicals used in museums to protect collections.

Asian and African museums. Other substances recorded but of minor use include, ethylene oxide, magnesium phosphide, eulan, camphor, phenol, alcohol, formaldehyde, cobalt acid, creosote, aluminium phosphide, carbon tetrachloride, magnesium chloride, silica gel and thymol.

One account of arsenic was reported and 13 per cent of respondents reported the presence of DDT in collections but it is not clear if these substances are still being applied. DDT, an organochloride insecticide received considerable use in museums in the past but has now largely been withdrawn because of associated health and environmental risks. However, because of its persistent, residual properties it may remain in museum objects for considerable time (Dawson, 1987). Studies into the use of DDT have shown that trace amounts of hydrogen chloride and chlorine can be produced by this substance under normal conditions. The rate of production can be increased by light, heat, and the presence of catalysts such as aluminium, chromium and certain iron salts (Metcalf and Flint,1962; Martin and Worthing, 1977).

Despite the number of infestations attributed to new accessions (47%), only 37 per cent of respondents routinely fumigate or otherwise screen incoming material for potential pests , while 37 per cent treat collections 'only if infestation is suspected'. Pesticides are replaced or topped up 'only when needed' by 38 per cent and between three and six months by 30 per cent. While 45 per cent of respondents apply pesticides in predetermined quantities or concentrations 42 per cent do not specifically control or measure the amounts used. Respondents choose pesticides and other chemicals used for a variety of reasons including apparent effectiveness (66 per cent), availability (36 per cent), ease of handling (36 per cent), traditional reasons (30 per cent), safety (30 per cent), economical reasons (22 per cent), and legal obligations (13 per cent).

Effects of pesticides on museum specimens and materials.

Thirty four per cent of respondents reported 'noticeable' changes in specimens related to the use of pesticide treatments while 36 per cent recorded adverse effects on storage and display materials. Accounts of specimen discolouration were attributed to PDB (2 accounts) and with naphthalene, formalin, phenol, carbon tetrachloride, DDT and carbon disulphide (single accounts). General deterioration of specimens was reported by 5 per cent and was associated with naphthalene, arsenic acid, phenol, formalin and neocidal 60. Recrystallisation of pesticides (mainly PDB and naphthalene) onto specimens was reported by 28 per cent of respondents. Paper discolouration reported by 10 per cent of workers was linked with naphthalene and naphthalene impurities, arsenic, phenol, camphor and PDB.

Ten per cent of respondents reported the melting of pinning foam associated with the use of PDB. Single occurrences of melted pinning foam were also linked with carbon disulphide, phenol and carbon tetrachloride, while adverse effects on plastics also including melting, were observed by 12 per cent. These were attributed mainly to PDB (8 per cent), but also phosphine, phenol, carbon disulphide, carbon tetrachloride, and vapona. Corrosion, mostly affecting pinned insect collections was reported by 11 per cent of respondents and linked with PDB, carbon disulphide and vapona. Other effects reported include the 'fogging' of glass in display and storage cabinets caused by PDB and 'unsightly' brown deposits caused by naphthalene.

Health and Safety.

Respondents were also requested to provide information on personal medical ailments which they associated with their particular occupational conditions and practices. The results are primarily drawn from the personal experiences and opinions of the particular respondents and not on actual medical reports. Where diagnosis has been confirmed by medical opinion, this is stated in the text.

Respondents claimed to be of satisfactory health ranging from 'average' to 'excellent' although 71 per cent attributed some form of medical ailment to working conditions, while 46 per cent reported more than one recurring ailment. Complaints included digestive disorders, headaches, sore throat, sore eyes, chest pains, dizziness and dermatitis. Factors attributed to these conditions include ambient temperature (17 per cent), ambient humidity (17 per cent) and pesticide and chemical usage (47 per cent). Other contributory factors but considered of minor importance include prolonged microscope use, dust particles, specific allergies, fluorescent lighting and ambient pollution.

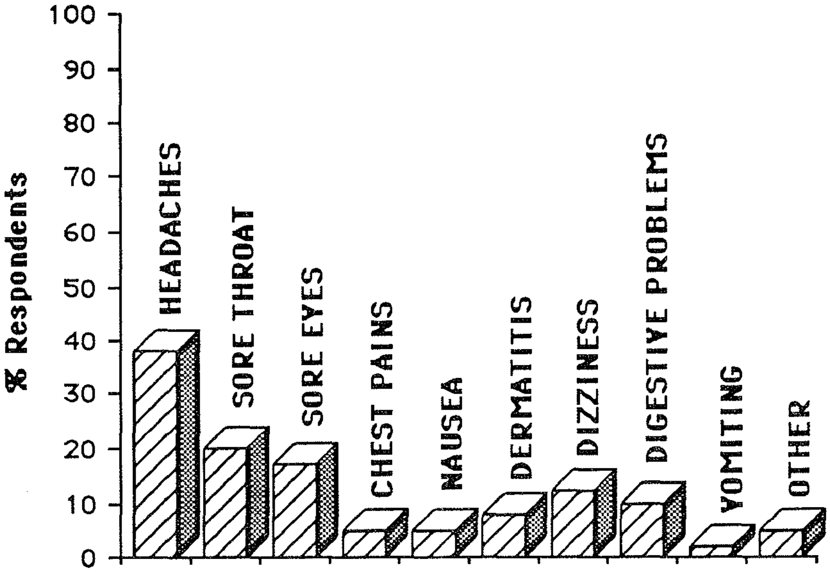

Fig. 6. Medical complaints associated with use of chemicals.

Pesticide and chemical usage were frequently associated with headaches, sore eyes, and sore throat (*Figure 6*) while other complaints included dermatitis, loss of smell and sensitivity to naphthalene, dizziness, digestive disorders, skin and nasal irritation, breathing problems, chest pains and general body weakness. One incidence of hepatitis was associated with pesticide usage and another worker reported a severe glandular throat reaction after exposure to methyl bromide following chamber fumigation of specimens (medical diagnosis). Twenty six per cent of respondents reported medical complaints in colleagues associated with the use of pesticides. The main complaints noted in other workers include headaches (15 per cent), dizziness, dermatitis, sore eyes and sore throat, while reports of nausea, chest pains and digestive orders were also reported. Of major concern was one report of exposure to phosphine which induced vomiting and chest pains and resulted in lung, heart and immune system damage (medical diagnosis). Other incidents included the loss of consciousness in one worker caused by exposure to naphthalene, while two cases of vomiting caused by exposure to PDB and naphthalene were also reported (medical diagnosis). Symptoms associated with pesticide usage generally occurred when working in particular areas or when working with particular materials. Thirty per cent of workers associated their medical complaints with the application of pesticides, the handling of museum material previously treated with pesticides and with working in close proximity to areas of pesticide usage.

PDB and naphthalene being the most widely used substances were also associated with the majority of complaints particularly in relation to headaches, sore eyes, sore throat and dermatitis. Other substances associated with medical complaints include dichlorvos, phosphine, phenol, and formaldehyde.

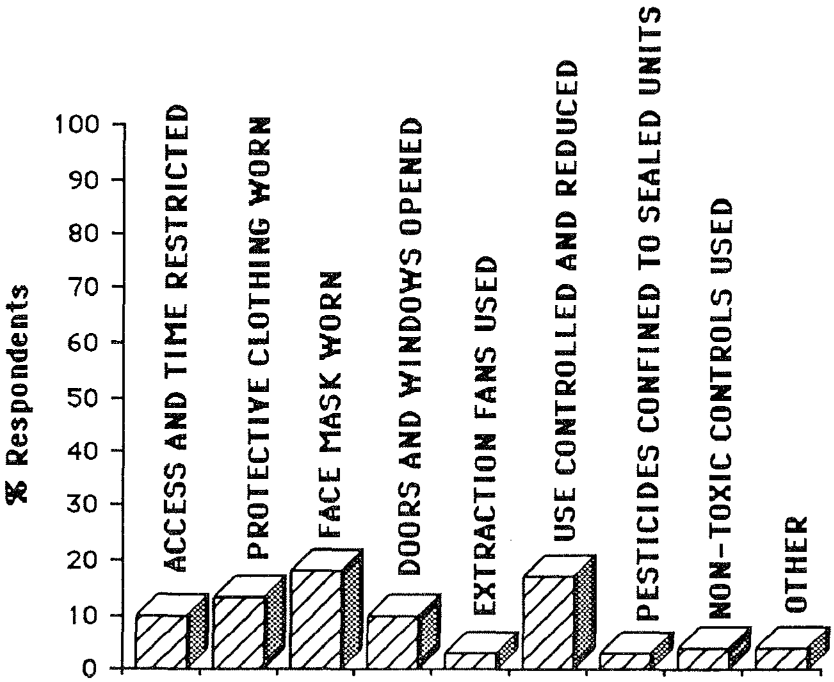

Fig. 7. Precautions taken to reduce exposure to chemicals

Precautions taken to minimise health risks associated with pesticide usage were taken by 67 per cent of respondents and included the use of face masks, protective clothing and the ventilation of work areas (Figure 7). Other measures taken involved controlled or restricted access to storage areas and the provision of special drinks (usually milk) after work with pesticides. Alternative control methods using sub-zero temperature, microwave and gamma radiation were also reported but did not produce adverse symptoms.

Discussion

The quantity and value of museum specimens and materials damaged or destroyed by pests is difficult to assess, however information gathered in this and recent surveys suggests that many important collections are under serious threat of irreversible damage through attack by pests, particularly insects. Various authors have proposed integrated pest management schemes for use in museums (Story, 1986; Zycherman and Schrock, 1988; Pinniger, 1989). These are designed to minimise the use of chemicals through a targeted approach concentrated on preventive rather than remedial action and although some are restricted to specific collection types, they contain common guidelines which may be applied to collections generally.

The results indicate that by introducing more stringent requirements for the treatment of incoming museum material, and improving the pest proofing of buildings, the potential for the entry of pests into the museum environment could be significantly reduced.

The majority of respondents expressed concern over the use of chemicals in museums, particularly in relation to potential adverse health effects. While this has highlighted the need for research into non-chemical methods of prevention and control, virtually all of the museums surveyed continue to use chemical methods for the protection of collections against pest attack, despite chemical usage being linked with a range of medical ailments by 47 per cent of respondents. These complaints were most frequently associated with p-dichlorobenzene and naphthalene.

Despite variations in legislative policy regarding the use of chemicals in museums throughout different countries, there is a general trend towards a gradual reduction in usage. Several substances previously cleared and considered safe for museum applications are now recognised as hazardous to health (Hall, 1988) and as safety threshold limits move increasingly downwards (Health and Safety Executive, 1985) this may lead to a reassessment of collection management policies. Against this background, there is now an urgent requirement to research safe, workable methods of both chemical and non-chemical pest control methods feasible for museum situations and to provide sufficient resources to allow implementation of integrated pest control strategies.

Acknowledgements

I would like to thank Dr. R.D. Goodhue for his comments and assistance in the preparation of this paper.

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PEST CONTROL IN MUSEUMS SURVEY

INDICATE ANSWER BY INSERTING A TICK IN THE APPROPRIATE BOX E.G. ☑

Section A - General Information

1. Name:

2. Museum Address:

3. How long have you been employed in the museum?
   Less than one year ☐ 1 - 5 yrs ☐ 5 - 10 yrs ☐
   10 - 15 yrs ☐ 15 - 20 yrs ☐ more than 20 yrs ☐

4. Indicate type(s) of collections you are personally involved with.
   Zoological ☐ Botanical ☐ Anthropological ☐
   Other ☐ (please specify)

5. Indicate size of museums holdings (perishable dried material only)
   Less than 5,000 specimens ☐ 5 - 10,000 specs. ☐ 10 - 25,000 ☐
   25 - 50,000 ☐ 100 - 500 ☐ 500 - 1 ml. ☐ Over 1 ml. ☐

Section B - Environmental Conditions

6. Indicate types of storage containers used:-
   Exhibition type cases ☐ Metal storage cases ☐
   Wooden storage cases ☐ Enclosed drawers within cases ☐
   Open shelving ☐ Other ☐ Please specify.

7. Indicate environmental conditions in the museum

	Entire Building	Storage Area	Display Area
Is the temperature controlled	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐
Is the relative humidity controlled	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐
Is the air filtered	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐
Is the air recirculated	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐

8. Are there access doors opening directly to building exterior?
   Main building Yes ☐ No ☐ Storage area Yes ☐ No ☐ Display area Yes ☐ No ☐

9. Are there windows opening directly to building exterior?
   Main building Yes ☐ No ☐ Storage area Yes ☐ No ☐ Display area Yes ☐ No ☐

Section C - Museum Pests

10. Have your collections ever been attacked by pests? Yes ☐ No ☐

11. List pests encountered in your museum
    Dermestid Beetles ☐
    Anobiid Beetles ☐
    Tenebrionid Beetles ☐
    Mites ☐
    Cockroaches ☐
    Moths ☐
    Silverfish ☐
    Psocids (Book Lice) ☐
    Fungi ☐
    Unspecified pests ☐
    Others ☐

12. Indicate pest which posed the greatest threat to the collections:

13. Indicate damage caused:-

14. Indicate suspected mode of entry of pests you have encountered -

Integration of new material ☐ Through ventilation system ☐

Return of loan specimens ☐ Unknown ☐ Other ☐

15. Have you noticed any seasonal variation in pest infestation?

Yes ☐ No ☐

Section D - Pest Control Procedures

16. Does the museum have a specific pest control strategy Yes ☐ No ☐

17. Does this strategy involve any of the following? Please specify.

Spot fumigation ☐ Chamber fumigation ☐

Pesticides in storage cases ☐ Pesticides in display cases ☐

Trapping devices ☐ Freezing techniques ☐

Humidity control ☐ Temperature control ☐

18. How often does the museum fumigate its collections?

Never ☐ Regularly ☐ Occasionally ☐

Only when infestation is suspected ☐

19. Does the museum fumigate incoming specimens?

Always ☐ Never ☐ Occasionally ☐ Only when infestation is suspected ☐

Section E - Pesticides

20. Indicate pesticides currently used in your museum

Vapona ☐ Pyrethrins ☐

Napthalene ☐ Phosphine ☐

Paradichlorobenzene ☐ Carbon Disulphide ☐

D.D.T. ☐ None ☐

Methyl Bromide ☐ Others ☐ Please specify

21. If used as a preventative measure, how often are they replaced?

Every 3 months ☐

Between 3 - 6 months ☐

Only when needed ☐

Very irregularly ☐

Other, please specify. ☐

22. Are these pesticides applied in specific concentrations or quantities?

Yes ☐ No ☐

23. Indicate reasons for using the pesticides you have listed

Effectiveness ☐ Safety ☐

Ease of handling ☐ Economy ☐

Tradition ☐ Availability ☐

Legality ☐ Other:- ☐

Section F - Effects on Specimens and Materials

24. Indicate pesticides used in your museum that have caused any of the following adverse effects on Specimens only

	Pesticide(s)
Discolouration of specimens -	____________
Deterioration of specimens -	____________
Condensation on specimens -	____________
Recrystallization on specimens -	____________
Others -	____________

25. Indicate pesticides used in your museum that have caused any of the following adverse effects on storage or display materials

		Pesticides
Paper discolouration	-	
Pinning foam melts (entomology)	-	
Plastic melts	-	
Glues/adhesive melts	-	
Textile discolouration	-	
Metal corrosion, pins etc.	-	
Others: Please specify	-	

Section G - Health and Safety

26. Do you work in close proximity to where pesticides are in constant use?

Same building Yes ☐ No ☐
Same room Yes ☐ No ☐
Same section Yes ☐ No ☐

27. Approximately, how much of your time is spent in this area?

Over 75% ☐ 25% - 50% ☐
50% - 75% ☐ Under 25% ☐

28. How many other people work in this area?

1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ 8☐ 9☐ Over 10?☐

29. Which of the following categories describes your health?

Excellent ☐ Good ☐ Average ☐ Bad ☐

30. Do you suffer from any of the following symptoms while at work?

	Often	Sometimes	Never
Digestive disorders			
Headaches			
Sore throat			
Sore eyes			
Nausea			
Dizziness			
Chest pains			
Dermatitis			
Vomiting			

Others, specify if you wish

31. Do you think that any of the following factors contribute to these symptoms?

	Yes	No	Perhaps
Ambient temperature	☐	☐	☐
Ambient humidity	☐	☐	☐
Pesticide useage	☐	☐	☐

Others, please specify.

32. Do these symptoms appear when working in any particular area?

Yes ☐ No ☐ If yes, please specify ____________

33. Do these symptoms appear when working with any particular materials?

Yes ☐ No ☐ If yes, please specify ____________

34. What safety precautions do you take to minimise health hazards caused by certain pesticides?

Please specify:- ____________

35. Have you observed any adverse physical effects on other museum staff caused by use of pesticides? Yes ☐ No ☐

If yes, please specify.

THE MOTHS AND BUTTERFLIES OF GREAT BRITAIN AND IRELAND
Volume 7, Part 2

Editors: A Maitland Emmet and John Heath

Paperback edition, revised with minor corrections. 400pp. 8 colour plates, 7 figs, 28 maps.

ISBN 0 946589 42 9. Published by Harley Books, Martins, Great Horkesley, Colchester, Essex, CO6 4AH (1993).

Price £27.50 net.

The publication of this superb long-awaited volume in hardback form, two years ago, was hailed by lepidopterists and naturalists as an invaluable standard reference. Now, in a cheaper stiff laminated paperback form it should reach a wider market, and deservedly so.

The Systematic Section occupies only 60 of the book's 400 pages. It follows the standard layout established in earlier volumes - keys to species followed by species accounts. Nomenclature, description of imago, life history, distribution, including 10 km. square dot maps of high quality, are all masterly reviewed by Barry Goater, one of the most active amateur field lepidopterists in Europe.

As a non-lepidopterist natural history curator, I find the information in this volume (indeed in the series so far) satisfies 99% of my enquiries.

The distribution maps are as up-to-date as possible. I know that Basil Harley (publisher and also Associate Editor) has taken a great personal interest in maintaining accurate modern maps.

Species texts combined with beautifully clear colour plates (by Richard Lewington) will greatly assist all biology curators charged with curating a British moth collection, or answering enquiries from the public.

Volume 7, Part 2 follows on from butterflies in Volume 7, Part 1, and covers some very elegant moths in the Lasiocampidae, Saturniidae, Endromidae, Drepanidae and Thyatiridae (Eggars, Drinkers, Lappets, Emperors, Hook-tips, Lutestrings etc).

The bulk of this volume (243 pages) is a chart showing the life history and habits of all British Lepidoptera. This is nothing short of an epic undertaking. Each species has a two-page spread, including a month by month life history, status, regional distribution, coded principal habitat preferences, flight times of the adult, foodplants and conservation status (Red Data Book categories). This life history chart will prove to be invaluable for those curators involved in ecological, wildlife conservation or habitat management work. A special index to foodplants and other food substances is particularly useful.

For those of us not well-acquainted with the checklist order there are two more special indexes, by English name and scientific names, in addition to the volume's general index.

I wondered why the enormous Life History Chart appears in Volume 7 of an 11 volume series. The editors explain that it seems appropriate at this stage to look back to the Microlepidoptera (we await Volumes 3 to 6 with anticipation) and to look forward to the Macrolepidoptera (Volumes 8 and 11 still to come). So, it seems that Volume 7, Part 2 is the key work to the entire series.

Chapters 1 and 2 in this volume also deserve special remarks. M.J. Scoble's review of lepidoptera classification is very thorough, with a good bibliography. M.W.F. Tweedie and A.M. Emmet's review of resting posture, with 64 colour photos, is absolutely fascinating, and very useful to everyone who spends time in the field recording or observing these beasties.

No doubt the real lepidopterists in BCG will find a few faults here and there, and no doubt the frontiers of ecological and taxonomic knowledge are moving faster than the author's pen and the printer's press. Indeed pages 302 and 303 are provided as a blank template to update the Life History Chart.

For the rest of us, this volume stands as an essential reference and should be in every museum library. For those with dwindling book budgets the paperback edition represents even better value for money. Furthermore, it is worth buying Volume 7, Part 2 as a stand-alone, even if you do not have the rest of this excellent series.

Derek Whiteley

Instructions to Authors

Manuscripts should be submitted to: Charles Pettitt, Keeper of Invertebrates, Manchester Museum, Manchester University, Manchester M13 9PL, England.

Tel: 061-275 2666 FAX: 061-275 2676

Preference will be given to papers in the following subject areas:

- collection management
- documentation, particularly advances in computer-based systems
- natural history interpretation, particularly display planning, execution and evaluation
- biological recording; collection, storage and dissemination of data
- curatorial techniques in the preparation and conservation of biological material
- experimental investigation into the permanence of stored collections
- description of collections and institutional holdings, from the UK and abroad

This list is not meant to be exhaustive or exclusive. Papers on related subjects will also be considered, but the products of purely systematic research will not be accepted unless they throw significant light on any of the subject areas listed above.

All papers submitted will be expertly refereed using a double-blind protocol, so the author's name and address should be given on a separate sheet and not repeated on each page of the manuscript. Authors should refer to previous issues of the *Journal* for a guide to format; headings should be labelled [A] [B] or [C] to indicate the desired hierarchy. Authors are reminded of the high cost of printing, and are therefore expected to write concisely and to make maximum use of the available page area when designing art-work and tables.

The typescript should be on A4 paper, single-sided, double-spaced and with a wide margin. It will speed publication if material is submitted in machine readable form; such material can be accepted on IBM format 3½" (720k or 1.44Mb.) or 5¼" (370k or 720k) disks, preferably as WordPerfect, WordStar or ASCII files. Illustrations should be black ink on white paper or card. Photographs should be black and white glossy prints.

Full scientific names, including authority, should be given for all organisms on first mention. Subsequently the generic name should be abbreviated to an initial. Scientific names should be underlined in the typescript. Measurements should be in metric units, and should follow the Institute of Biology publication *Biological Nomenclature: recommendations on terms, units and symbols* (1989). Dates should be written in full: 31 June 1989.

References should be in the form:

Jeffreys, J.G. (1858). Gleanings. *Ann. Mag. Nat. Hist.* **2**, 130

Babington, C.C. (1839). *Primitiae Florae Sarnicae.* Longman, London.

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Editor's note.

Part Five completes Volume One of the *Journal of Biological Curation*, and is the issue for the subscription year 1993.
The Committee of the Biology Curators' Group plan to amalgamate the *Journal* and the *BCG Newsletter* into a new publication, *The Biology Curator*, which will commence publication in subscription year 1994.
The new publication will contain a mix of short notes and news alongside substantial academic articles.