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The cultural impact of natural science collections

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INTRODUCTION

Natural history collections have a major role to play in many aspects of life today; they can and do contribute significantly towards defeating disease, combating environmental pollution, understanding the "greenhouse effect", and to other scientific studies vital to human society and to life on planet Earth (Pettitt 1991). Oldfield (1985) estimated that by the end of the 20th century between a half and one million species would become extinct. For some groups and parts of the world, museum collections will soon represent the only record of biodiversity.

Ultimately the true worth of Natural History collections will be judged by their demonstrated use to society (Pettitt 1989). This value to society is enormous, but is poorly understood by the public and by politicians (Howie 1986; Ingrouille 1989; McAllister 1991). Too often people say of large collections, "but what good are they if we can't see them?"; these people fail to understand the value that large research collections have as objective data banks with an irreplaceable historical dimension. The gradual loss of interest in the world of nature by the scientific community and the public during the first part of this century has progressively downgraded the resources devoted to natural history in museums. We must ask ourselves why society considers spending several million pounds for a painting is a public benefit, while a few thousand pounds to maintain a natural history collection is seen as a drain on the public purse (Edwards 1985). This paper gives examples of a number of ways in which the expertise of natural history curators is called upon in public life.

Although several other papers in this volume address the value of Natural History collections to Scientific Research, it is worth reiterating the essential underpinning of research that they represent. Natural history collections are an irreplaceable database of information on species diversity and habitat changes. Hounsome (1984) points out that the basis of all science is that observations by one worker can be verified by others. With taxonomic, distributional and ecological observations, verification is usually only possible if the relevant specimens have been deposited in an accessible and suitable museum collection. He indicated the difficulties in verification that arise for sensitive groups, such as birds, where it is illegal or unethical to collect "voucher" material.

CURRENT LEVEL OF USE

McAlpine (1986) examined 1,350 papers in 12 natural history journals and found 12.7% used collections and no less than 44.4% *made* collections in the course of the work. For taxonomic or systematic studies authors either consulted collections, made collections, or did both in 90.4% of the papers. However, Cato (1988) analyzed the contents of ten similar journals for 1985-86, and found only 24 articles related to natural history collections (119 pages in 15,510 = 0.8%). In six museum journals he found there were 34 articles (302 pages in 3,166 = 9.5%) on natural history. Steve Garland (1990 *in litt.*) checked three major entomological journals for 1989 and 1990, and found that, ignoring small notes, of 251 papers, 105 (42%) used collections in some way in arriving at their results.

Non-biologists and administrators often fail to appreciate the necessity for obtaining accurate identification of biological material, or the difficulties of so doing without access to good reference collections. The strange fact is that, even as the demand for assistance with identifications threatens to submerge those able to provide the service, research funders still regard taxonomic work with a jaundiced eye (Brinkhurst 1985).

ENVIRONMENTAL STUDIES

Many studies in the fields of ecology, evolution, pollution and climatic changes require museum specimens. Provided selective collecting is allowed for, museum collections are logical places for life history studies. Using existing collections for such studies often enables large amounts of data to be accumulated in a short time on such things as fecundity/mortality patterns, host-parasite relationships, estimates of breeding seasons, diurnal/tidal micro-growth increments, food pests, life-cycle duration, larval growth pattern, migration (museum collections have been used to locate locust outbreak sites and to track traditional migration patterns), species that mimic other animals, and other polymorphisms, plant fecundity, flowering and fruiting dates, periods of dormancy, and correlations of plant growing sites with rainfall or altitude (Allen & Cannings 1985). Brakefield (1987) used a collection assembled in 1905 to establish that small temperature changes during development can regulate the form of the adult butterfly, *Melanitis leda*. Systematics collections provide a wealth of historical information on habitat composition, and on biogeography, that is invaluable to those predicting ecological shifts due to global climate change (ASC 1989). Gates (1990) detects signs that in the UK plants and animals are already adapting to a new, warmer climate. Svensson (1978) used clutches of the chaffinch, *Fringilla coelebs*, to establish that the egg-laying period is now four days earlier than in 1900, correlating this with climatic change. Local ecological adaptations can also be studied using museum collections. Pettitt (1977), studying a snail endemic to a small North Atlantic island, showed that living organisms can be sensitive indicators of micro-climatic change. Herbarium specimens, accumulated over the past centuries (the earliest extant herbarium dates from 1523 (Ogilvie 1985)) remain the most readily available source of information on structural variation and geographical distribution of plants. Seel (1984) used museum collections extensively to map the distribution of the cuckoo, *Cuculus canorus*. Voucher material can be important in genetic polymorphism studies (Pettitt 1971).

Nature Conservation**:** The collection of research specimens may appear to conflict with the conservation ethic, but does not. Museum curators as a profession are deeply committed to conservation, and in many instances are the only experts on particular groups, and most are able to advise regulatory or conservation agencies on measures and actions required to preserve species and ecosystems. Often the information to define conservation programmes can only be obtained from collections (Ouellet 1985). Data from survey collections can be used to predict what is likely to be on other, similar, sites; one can feed in the physical data of the new site, see what "ought" to be there and then it needs only a single visit to confirm. This technique applies particularly to marine sites, which makes this method is valuable because marine sites contain some of the most threatened ecosystems (David Erwin 1990, *pers. comm.)*.

Field biology increasingly reflects the growing demand for information and prediction in support of ecological management decisions (Brinkhurst 1985), but such work needs the objective backing of voucher specimens. Mapping the distribution patterns of animals and plants, essential to protect the environment, and for the adequate assessment of planning applications, also needs natural history collections; maps of rare and critical species can be reliably prepared only from museum (voucher) specimens. Reliable maps of common species need voucher specimens, particularly for islands. Many erroneous records are found, made by distinguished visitors who record what they expect to see rather than what is there. Vouchers are especially important for introduced species or those from limited habitats, and for ecological surveys (Perring 1977). Steve Garland (1990 *pers. comm.*) found that the Military Orchid was recorded in old flora's as occurring in Kent, but most modern flora's dismissed these records as misidentified Lady Orchids; however, there is a Kentish specimen of the Military Orchid in the Bolton Museum collection! Checking identifications and distribution data against museum collections is essential for groups that present difficulty in identification, such as the pea mussels, *Pisidium* (Kuiper *et al.* 1989). Lee *et al.* (1982) gives a valuable overview of the need for, selection and preparation of, and costs of acquisition of voucher material.

Two large and expensive surveys, one the San Francisco Bay Project (Lee 1979), and one for an oil company (Derek Rushton 1987, *pers. comm.*), failed to preserve voucher material in a permanent collection. Both surveys were carried out by recent graduates with little taxonomic experience, and their findings have since been successfully challenged; without the voucher material these surveys were largely a waste of money. But accessioning and maintaining voucher collections costs money, and, as is now generally the case in America, such costs should be built into survey funding (Lee *et al.* 1982).

The Royal Society for the Protection of Birds (RSPB) discourages the use of bird mounts in public displays. One museum which put on a display to celebrate the recent centenary of the RSPB readily agreed to use a model of an Avocet prepared by an RSPB recommended modeller, in place of a mount; a short time later the modeller telephoned the museum to request the loan of a mounted Avocet to enable him to make an accurate model (Steve Garland, *in litt.*, 1991). Often it is only by studying bird mounts and eggs from museum collections that artists are able to paint the colour plates in the plethora of bird identification guides used by bird lovers; such artists still account for a large number of loans from the major bird collections.

BIOCHEMISTRY AND THE HISTORICAL DIMENSION

As technology develops, specimens can contain undiscovered or potential information, the need for which may not yet even have arisen. Natural history collections should be regarded as "scientific data in waiting". After nuclear devices were tested in the Pacific, there was much concern about radioactive contamination of the environment, especially of resident plants and animals. But how could anyone guess what were the levels in these organisms before the tests? Specimens in collections provided the answer (Cowan 1969). The spread of radioactive strontium and caesium throughout the world can be monitored by analyzing bone tissue collected by museums since the first nuclear explosion (Challinor 1983). Other researchers needed dated samples of earth for analysis of historical levels of heavy metals; the only source they could find was the earth adhering to herbarium specimens (Peter Davis 1989, *pers. comm.*). The deleterious effect of pesticides such as DDT on the thickness of the shells of eggs of birds of prey was only shown because of the existence of well-documented egg collections (Klass *et al.* 1979). With new techniques the DNA of long-dead specimens can be sequenced, such as that from the Quagga, from Mammoth remains, and from a 20 million-year old magnolia leaf. In theory there should be no limit on how old tissue can be for analysis (Connor 1987).

The Quagga results have led to an attempt to re-create this extinct zebra (the last specimen died in Amsterdam Zoo in 1883) by selective breeding from Plains Zebras (Anon 1989). The chemistry of feathers has shown past levels of environmental mercury (Thompson, Furness & Walsh 1991; Thompson, Hamer & Furness 1991), and can also establish the probable origins of bird specimens. Current concern with tributyltin antifouling paint on boats required pre-1950 samples of the dogwhelk to study the long-term imposex effects (Bryan *et al.* 1988). Research at Manchester Museum has shown that the shell of the common winkle can be used to establish an accurate measure of some critical levels of radioactivity in coastal waters. The work required dated and localised winkle shells from the past 50 years to establish historical levels; these shells were provided from museum collections in the region (Akbarian-Kalajahi 1980). Very few objects have no data available to the informed eye (*see* section 6.4) (Wheatcroft 1987). The importance of natural history collections has been recognized by the US Government: "Research collections, such as exist in museums, contain the only record readily available for study of life on earth before, during, and after events such as the industrialisation of society. The specimens found in museum collections provide the opportunity to refer back to a time and place in history. One cannot predict which specimens will ultimately be needed and when, but if preserved, they will be available when needed. Museums are the keepers of knowledge about the biota. They contain the biological inventories and the baseline ecological, historical and evolutionary information on which future studies must be based" [US Congress, House of Representatives Committee on Science and Technology 1986 Chairman's Report, 99th Congress, 2nd session, Committee Print.]

EVOLUTION AND BEHAVIOUR.

The broad aspects of the study of evolution depend upon carefully assembled scientific collections for data, comparative analysis, and verification. The study of vertebrate phylogeny through comparative anatomy, for example, would be almost impossible without museum collections (Raikow 1985). Classified museum specimens are essential for studying the relationship between different groups of animals, variation within a single species and between the sexes, variation with climate, latitude, and with isolation on islands, character displacement, niche-variation hypotheses, and predator-prey relationships. This last involves identifying dismembered and partly digested stomach contents, which cannot easily be done without reference collections with which to compare the remains (Fitzpatrick 1985).

The study of museum specimens can suggest hypotheses which are later tested by field observation, for example, crest and facial markings of Stellar's Jays suggested an hypothesis about communication which was then tested and proved in the field. Alternatively field observations often need museum specimen follow up, for example, the elucidation of sonic communication in baleen whales required a study of the anatomy of their larynx using museum specimens (Miller 1985). Other studies include Felidae skulls used to study brain evolution in carnivores; a host-parasite study using follicle-mites from pocket mouse specimens, and estimating litter-sizes from nipple number in small marsupials (Allen and Cannings 1985). Mounted mammals have been used for identifying casts of footprints from game and nature reserves, and for establishing from photos that Himalayan "Yeti" tracks were in fact made variously by the red bear, *Ursus arctos isabellinus*, or by the langur monkey, *Prebytis entellus achilles* (BMNH 1956).

ARCHAEOLOGY AND ETHNOLOGY

Archaeologists need bone, shell and insect fragments from archaeological burials and excavations identified, to assist the correct interpretation of the site. Ethnologists also require bits and pieces of feather, fur, skin, bone, shells and botanical material such as gourds identified in human artifacts. These identifications would be impossible without extensive reference collections. In the study of the development of colonial cultures, older collections enable an understanding of the role of the undisturbed biota upon which the colonists depended and with which they contended (Cowan 1969). Cultural changes and shifts of settlement sites in Predynastic Egypt have been linked to paleo-temperatures established by studying the incremental growth structures on museum specimens of the Nile Perch, *Lates niloticus* (Brewer 1991). At Liverpool Museum dried plant material from the 1st to 4th century AD has been used for fragrance research in the Egyptology department, using gas/liquid chromatography (Edmondson & Bienkowski 1991).

HISTORICAL STUDIES

Collections can yield information of importance in historical studies. The collecting data attached to specimens collected during expeditions and campaigns have assisted in fixing other historical events in sequence. The history of anatomical preservation, and of taxidermy, can only be studied using museum specimens. The "rather strange wombat" in the Hancock Museum on research turned out to be the first specimen to reach the UK in the 18th century (Wheatcroft 1987). Biographers often require information about natural history material collected and deposited in museums by the subject of a biography (Norris 1988; Derek Whiteley 1990, *in litt*.). There is also a growing interest in the social history of natural history (Barber 1980).

GENERAL ENQUIRIES

Well organised and adequately documented systematic collections are an essential reference tool if a museum curator is to be able to answer authoritatively enquiries received each year from public bodies, companies, organisations and members of the public (Derek Whiteley 1991, *in litt*.). A recent survey revealed that approximately 19% of the quarter of a million enquiries received annually by UK museums were "collection based". This figure was remarkably constant across national, local authority, university and independent/society museums (Hayhow 1989).

EDUCATION

Museum exhibits, lectures and publications in natural history are popular, and fortunately they are also widely regarded as contributions to society valuable enough to justify the costs of museums. Unfortunately the delivery system (galleries and catalogues) attracts most of the support, while the creative source of the goods delivered (curatorial research) receives small encouragement. But without research only a partial and inaccurate interpretation of the specimens is possible (Edwards 1985). Nowadays most museums fulfil the education role with reasonable success; ecological displays help explain the diversity of the life forms that sustain us, show the major patterns of geographic dispersal, and demonstrate the interrelationships between organisms. Visitor surveys prove that these are the most popular displays in museums (Derek Whiteley 1991, *in litt.*). Natural history specimens are used for school loan services, and provide a range of specimens for identification in biology examinations at all levels. Natural history material has proved useful in demonstrating material science in the UK national curriculum.

MEDICINE

A large reference collection is needed to assist the rapid identification of accidentally ingested toxic plant material, to enable the medical team involved to apply the appropriate, sometimes life-saving, treatment. Accurate identification of a poisonous animal is vital after a bite, as poisons (and therefore their antidotes) are usually specific to a given species (BMNH 1956). A dental professor, studying cleft palate in humans, made considerable use of crocodile skulls. The study of the cochlea areas of mammal skulls helped decide suitable species in a medical research programme (Genoways *et al*. 1976). A hospital found "abnormal larvae" of the parasitic worm, *Ascaris lumbricoides,* in some pathological tissue; museum identification proved these to be the normal young from a harmless roundworm, which was then traced to the tank supplying the water to wash the specimens (BMNH 1956). Near-Eastern hamster specimens were used in a medical study on toxoplasmosis. In America mammal collections have yielded information on Chaga's disease and haemorrhagic fever (Genoways *et al*. 1976). The control of other diseases such as bilharzia, bubonic plague, malaria and river blindness, all depend for cost effective treatment on very precise identification of the animals transmitting the disease, using reference collections. For example, the ticks, *Ixodes reduvius* and *I. hexagonus*, are superficially similar, but the former carries bovine piroplasmosis (red-water fever), the latter is harmless. With the easily confused mite species, *Trombicula akamushi* and *T. autumnalis*, the former transmits "rural typhus" or "japanese river disease", the latter does not. The incorrect identification of the very similar looking freshwater snails of the genus *Bulinus*, only some of which carry bilharzia, can lead to futile and costly attempts at eradication (BMNH 1956). Museum identification is often needed to determine if the fungus causing skin lesions is ringworm, rather than psoriasis, impetigo or secondary syphilis. If ringworm it is then also important to distinguish between the various species of *Microsporum* that cause ringworm; some, from animal sources (*M. canis*, *M. gypseum*) are easily cured or may even disappear spontaneously, but other species, such as *M. audouini*, need X-ray therapy. Psychiatrists regularly use specimens of birds, bees, butterflies, small mammals and so on from museums for the treatment of phobias; by controlled gradual increased exposure to the specimens, patients learn to control their irrational fear of the living animals (Logsdail 1987; David Erwin 1990, *pers. comm*.; Calder 1991). Human skulls in museums have been used for studying the history of "trepanning" (Martin 1989). Museum animal skulls have been used extensively in a standard work on variation and diseases in animal teeth (Colyer 1936), currently under revision.

Half the worlds medicinal products are not synthesised, but obtained directly from plants. Only a small fraction of plants have been screened for pharmaceutically useful compounds, and even fewer invertebrates, even though several species have yielded potent anti-cancer drugs (Oldfield 1965). With the accelerating extinction of species, material in museums will increase in importance for this work.

LOCAL AUTHORITIES

Health: Another success story for natural history collections: environmental health officers with their mangled, cooked or partially digested animal remains, a snail in a can of peas, a slug in raspberry jam (author's experience), fish teeth in bread (BMNH 1956), or the cat bones in a tandoori curry (Mike Hounsome 1990, *pers. comm.*), all need careful identification plus expert opinion upon where the "foreign body" entered the process, often with legal proceedings pending; usually such identifications can only be done using reference collections. These officers also rely heavily on their local museums for help identifying infestations.

Planning: Environmental impact statements made in response to local planning applications need the backing of voucher collections else they are likely to prove worthless at a public enquiry (John Mathias 1991, *pers. comm.*). The defence of SSSI's and other sites of biological interest depends upon ecological information verified by voucher material (Ely 1994). In the US national legislation now requires the evaluation of environmental consequences whenever major governmental projects are undertaken. This has resulted in heavy demands being placed on natural history museums for access to records and specimens that document environmental processes (Malaro 1991). Growing public concern could well result soon in similar European national and EEC legislation, increasing still more the importance of well documented *local* collections.

Weights and measures: Museums have identified Canadian salmon being sold as European salmon, and mock halibut sold as halibut, to assist inspectors in prosecutions.

LAW ENFORCEMENT

Police: "Aiding the police in their enquiries", museum reference collections can tell the age and race of an unearthed human skull, accurately identify hairs as evidence in prosecutions over badger hunting (Bowler 1991), and identify biological materials for "scene of crime" forensics, all of which can only be done with the authority of a reference collection. Examples include the museum identification of feather fragments helping to convict a wife-murderer who also killed her pet chicken (Alan Knox 1990, *pers. comm.*) and museum identification of grass fragments from body orifices enabling the disputed scene of a rape to be determined (Sean Edwards 1991, *pers. comm.*). The museum identification of skulls of rare breed sheep was needed in a case of theft from a zoo. The bones of the fish, *Chirocentrotus doras*, in material submitted for museum identification indicated that a theft under investigation took place in the Indian Ocean region. When concrete was substituted for air-freighted gold bullion, the airport at which the exchange took place was pin-pointed by the museum identification of locally-characteristic shell fragments in the concrete (BMNH 1956).

Import controls: Collections also help customs officers detect illegal animal and plant imports: horn or ivory objects, or pelts and leathers - often as made up goods. Sometimes only a tuft of feather or hair, or a small piece of skin is available, and without considerable expertise backed by extensive reference collections the task of positive identification would be impossible. The public is usually quite unaware of this activity. Without it, the legislators could legislate about the control of export or import of animals and plants until they were blue in the face, but to little effect. Again, effective application of quarantine regulations sometimes requires museum identification of organisms, for example the human flea (*Pulex irritans*) is relatively harmless, but the very similar plague flea (*Xenopsylla cheapis*) can carry a lethal plague (BMNH 1956). Several similar-looking species of Giant African landsnails (*Achatina*) are imported for food now, but one species, *A. fulica*, is a pest and forbidden; museum malacologists occasionally have to check suspect animals.

COMMERCE

Advertising agencies and television companies borrow material for use in the background of "shots",and, as mentioned above, many of the highly popular colour-plate nature books are almost entirely illustrated using museum specimens. Stores have required bone and ivory chessmen to be authenticated by curators (Genoways *et al*. 1976). Natural history specimens have inspired architects. Perhaps the best known example is the Crystal Palace in London, whose architect Paxton used the Giant Waterlily, *Victoria amazonica*, seen in the Kew collection, as inspiration and guide (Bird 1976). Another unusual commercial use of the biological collection was illustrated by the college of textiles students who used patterns occurring on shells as inspiration for designing a cloth, which won a prize (D.Heppell 1989, *pers. comm.*). Then there were the industrial design students who used armadillo skeletons as the inspiration for "comfort chairs", and the top yacht designer who spent much time studying tunnyfish specimens as an aid to designing faster yachts (J.Peake 1989, *pers. comm.)*. The next generation of airliners will have less drag because the designers studied preserved shark skin, and have copied the surface structure that makes the shark such an efficient swimmer (Gavaghan 1987). A lecturer in a university engineering department routinely instructs students who need to solve a novel engineering problem to go and find an animal which has already solved it; the museum collection often provides the answer (David Erwin 1990, *pers. comm.)*. Such use of collections is not new; J.G. Wood wrote a book about it in 1877, and Isambard Kingdom Brunel is said to have gained inspiration for designing the tunnelling shield from examining museum specimens of the shipworm, *Teredo*. Following planes hitting birds, airlines have required feather fragments from aeroengines identified by museums to determine the species responsible (A.Knox 1990, *pers. comm.*). Herbarium specimens are used in researching new fragrances (Edmondson & Bienkowski 1991).

AGRICULTURE AND FISHERIES

Insect pests, and suspicious weeds and seeds, all need the collection for reliable identification. Museums have been asked by farmers to identify chicken coop raiders from hair tufts (Genoways *et al*. 1976). Crop pests can be studied in part by examining pest-damaged material in herbaria (galls, etc.); potential control organisms for weeds can be identified by studying "habitat" details of insects as recorded on museum labels. The prickly pear invasion in Australia was successfully controlled following a study of this kind (Williams 1987, App.II). Phytogeographic information from herbaria can give a good indication of the climatic potential of an area for agriculture and sylviculture. Such information can also help to determine the environmental range of introduced weeds, and allow predictions of how the plant will spread. The harmless grasshopper, *Gastromargus nigericus*, is only distinguishable from the migratory locust, *Locusta migratoria*, by critical examination and reference material. It lives in the same habitats, eats the same food, but is non-gregarious and non-swarming, so it does not need the same degree of control as *Locusta*. Otolith collections give information on the historical age distribution of populations of fish, as can the "earplugs" of whales, and the results can demonstrate whether the stocks are declining. A pre-1920s collection of fish tumours, rescued by Liverpool Museum, have been re-assessed in a recent study funded by the Ministry of Agriculture and Fisheries, which has thrown new light upon the effect of modern pollution (Heron 1989). Museum identification of planktonic plants has been very important in managing food fish stocks in the Great Lakes of East Africa (BMNH 1956). "Pure research" on the African cichlid fish *Tilapsia (SL)* and *Haplochromis (SL)* have greatly benefitted African fisheries officers in developing these genera as a food source (Peake 1986). Genes from wild relatives of domesticated animals and crop plants are constantly used for improving the strains, and museum material will become an important source for genetic recombinant research (Oldfield 1985).

ART

A student photographer recently based her dissertation on imaginative photos of various scorpion and centipede specimens in Manchester Museum, and the extensive shell displays are in almost daily use for inspiration by students from colleges of art and graphic design; a number of loans are made to these organisations every year. Similar usage has been reported to me by fellow curators in other museums. A Swiss researcher required shell material for a study of the history of art (Gordon Reid 1991, *pers. comm*.).

[B] RECREATION

As mentioned above, many of the highly popular colour-plate nature books are almost entirely illustrated using museum specimens. "There are a number of leisure activities, from amateur horticulture to bird watching, in which an extensive research base underpins the hobby activity of a large number of people. The reliable identity of a rare bird or beetle, or a particular houseplant variety offered for sale, are products of ... systematic research" (House of Lords, 1992, 22-1 p14).

THE "CONSUMABLE" COLLECTION

There is no such thing as "rubbish" in a natural history collections, only different grades of specimens requiring differing curatorial attention and with varying uses (Wheatcroft 1987). Dangerous notions are found in the "corridors of power": "Central Government ... should ... allow the appropriate disposal of duplicate and other unwanted material [in local authority museums]" (Audit Commission 1991). It cannot be emphasised too strongly that every natural history specimen is unique; there is *no such thing* as a duplicate natural history specimen. It is never safe to assume a specimen has no data; data can turn up in an unexpected way over a century after the acquisition of the specimen (Norris 1988). All specimens have *some* data, if only in the mind of the curator: e.g. "This landsnail was in that collection of British shells when I took post in 1968"; such a specimen would be ideal for anyone wanting pre-1970 pulmonate shells for tests. A headless, legless bird "mount" can still yield feathers for electron microscopy or biochemical analysis, and the investigation may only require identification to family or genus (Willard & Scott 1990). Gordon Reid (1991 *pers. comm.*) had been about to incinerate a collection of "greasy old bird specimens" when he received a request for samples from the legs of the birds for a study in environmental fluorides (Seel *et al*. 1987; Seel, 1991). He now "keeps everything"! A collection of fish tumours was rescued from its previous owners, where it lay neglected in a cleaners cupboard, by a FENSCORE member; later the collection proved scientifically valuable (*see Fisheries* above) (Ian Wallace 1991, *pers. comm.)*. These stories emphasises the importance of the MGC *Standards* (Paine 1991) on disposal, which suggest that even if they are unlabelled, unidentified or damaged, all specimens have potential use and should be retained, albeit un- or de-accessioned and at a lower level of care, but retaining any information that is available. Original containers should always be retained with such material; the shape and nature of these, or even the colour and quality of cotton wool used can sometimes enable the origin of the material to be traced at a later date. Specimens in the consumable collection can be stored in a compacted way (provided this does not jeopardise any inherent information) and given a low priority for conservation resources. This collection can provide material for destructive analysis and/or be used to develop techniques for use later on more valuable specimens (Diamond 1990; Willard & Scott 1990). Always remember, if the *Venus de Milo* had been a natural history specimen it would probably have been thrown away in the past; our damaged specimens are just as unique and irreplaceable and could well turn out to be even more valuable to mankind!

COLLECTIONS RESEARCH; COLLECTIONS AS A NATIONAL RESOURCE

The natural history collections in British institutions represent a great national resource; a resource the vast extent of which is only now becoming apparent through the work of the Federation for Natural Sciences Collections Research [FENSCORE] (Pettitt 1986). Some two-thirds of all natural history collections in Britain are housed outside London (Hancock & Morgan 1980; House of Lords 1991, p.138). It is only when scattered collections are considered as a unified whole that they "become encyclopaedic" with respect to organisms and geographical coverage (Williams 1987, App.IV). Already the work of

FENSCORE has lead to several "orphan collections" (Wheatcroft 1987) being transferred to museums with natural history curators. There is considerable scope for regional or local agreements, along the line of the Morton agreement between the BMNH and Kew to rationalise their collections (Cannon 1986). In most museums certain groups are well represented, but other collections are small and fragmentary, and on their own offer little potential for research. Curatorial agreements, ratified by management, should be sought for each participating museum to receive the fragmentary material of one or more groups in return for a contract to provide material for display, etc., to the other participants as and when required. Such rationalisation improves the care collections can receive, allows curators to concentrate their special knowledge, and increases the material readily available for research.

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