

LETTERS TO THE EDITOR

Museum Policies Concerning Specimen Loans for Molecular Systematic Research

To the Editor:

Biological museum collections have played a crucial role in systematic biology, serving as sources of material for faunistic, taxonomic, and phylogenetic studies and as information retrieval and storage systems for the products of systematic research. In recent years, the use of molecular data for estimating phylogenetic relationships and the population structure of organisms has grown tremendously, complementing comparative morphology as the basis for classification. The development and application of polymerase chain reaction (PCR) technology to systematics (White *et al.*, 1989) has enabled researchers to make use of small tissue samples, small individuals, and even preserved material for DNA comparisons, allowing many museum specimens to be used directly in molecular systematic research (Pääbo *et al.*, 1992). Thus, the major role of preserved museum specimens in systematic studies has increased rather than diminished. The breadth of molecular genetic and systematic research to which museums have already contributed is large, ranging from population structure to plant and animal breeding to higher level phylogeny (Appels, 1992; Barrowclough, 1985; Moritz, 1992). For these and other reasons, museum collections continue to play major roles in comparative biology and are likely to continue in this capacity for the foreseeable future.

Many museum collections contain geographical, historical, and seasonal samples of organismal populations that would be impossible, or at least impractical, for a researcher to duplicate. In the case of many endangered species, justifying additional field samples may be difficult. For simply humane reasons, it may also be difficult to justify the sacrifice of live specimens of even common species if they are already well represented in collections. For many studies, the use of museum collections can save time, money, and effort, allowing a closer focus on areas or seasons not previously sampled.

The potential for future use of museum specimens in molecular systematics is perhaps limitless except for the problem that such research requires partial or complete destruction of specimens. For this reason, Pääbo *et al.* (1992) have provided a list of criteria for

evaluating requests for such destructive sampling, to provide a reasonable ratio of costs to benefits.

Herein, we briefly discuss sampling criteria and other issues concerning the use of museum specimens in molecular research. These issues include suggestions and recommendations for policies concerning the types of information or materials museums should require from researchers who use specimens. These suggestions and recommendations are intended to spur debate and ultimately lead to the development and enforcement of museum policies for specimens used in molecular research in much the same manner that more conventional loan policies are implemented and enforced.

Criteria for Granting Loans

Pääbo *et al.* (1992) suggested that curators use the following criteria for consideration of requests to grant "loans" of museum specimens when destructive sampling is required for molecular systematic research:

- (1) the potential scientific value and feasibility of the project;
- (2) the qualifications of the investigators or laboratory to do the work;
- (3) the availability of samples from living collections or wild populations elsewhere;
- (4) the volume of material present in the museum and/or other collections relative to the volume requested; and
- (5) the museum staff effort required to fulfill the loan.

All these criteria should be considered, but we would add under (3) above that the need to kill or disable wild-caught individuals should also be taken into consideration. Museum specimens, if available, should be favored if there is a need to kill the individuals.

Once it has been determined that the requested loan of museum specimens will be granted, there also must be follow-up measures, not only for the museum to ensure that its specimens are appropriately used, but also to enable future users of the museum to correlate the material used in molecular studies with preserved specimens from the same population(s). Below we make some suggestions about the kind of information and materials museums should expect to be returned by borrowers of specimens for molecular studies, even if the specimens themselves have been destroyed. We then discuss why the return of voucher material or voucher information would be valuable not only to the lending museum but also to future researchers.

What Should Museums Require Back?

We suggest that museums should have, as a part of their loan policy, the requirement that borrowers submit at the end of their projects:

(1) the original specimen labels along with the unused remains of the specimen(s) (if possible), to facilitate association with the original specimen series;

(2) a description of how DNA (or other molecular) samples were extracted and processed and where the samples are kept;

(3) references of published results and (if sequence data) GenBank or other data bank accession numbers, as many journals now require (e.g., Burks and Tomlinson, 1989; Dawid, 1989).

These materials could be stored or catalogued with the other specimens of their respective taxa for easy accession by future researchers. The information requested is standard information required of researchers for publication.

Why Return Information to the Museum?

One advantage of requiring that the above information be returned to the lending museum is that molecular results would then be associated with actual morphological specimens from the same population or sample. Such association may be useful for comparing the relationships between molecular and morphological evolution (e.g., Patterson, 1987, and much recent literature on many groups) or between genetic variation and geographical patterns in morphology. Having all relevant material in one place organized by taxon would be advantageous for these kinds of studies. It may also be potentially valuable to the original borrower if questions arise that require additional information to be gathered about the original series or population from which the specimens originated. This additional information might only be available from the loaning museum, who then would be able to associate the specimens with it.

Further, museums are already intended as repositories for information organized according to the current systematic understanding of taxa. Future researchers on a taxon will find it easier to assess the range of prior and ongoing studies on a given taxon if museums are an expected repository of all information concerning research based on specimens issuing from those museums. Currently, many specimens loaned for molecular research are essentially gone from the collection forever.

Finally, laboratories engaged in molecular systematic research on related organisms may be scattered and temporary. Furthermore, work on unrelated organisms may be going on side-by-side in those laboratories, depending on current interests. Taxonomic museum collections are better for long-term organization because they are intended to be permanent, and a ma-

ajor part of their function is the preservation of information.

Why Not Require Return of DNA Samples?

Major museums (e.g., the Smithsonian Institution, American Museum of Natural History, The Natural History Museum) with associated molecular laboratories are equipped to handle long-term storage of molecular samples. Most museums, however, are not set up for long-term storage, and few curators are currently familiar enough with DNA (or protein) extraction and storage to properly maintain and process returns of such material. The requirements for permanent storage are not easily met by limited-budget museum collections (Dessauer and Hafner, 1984; Dessauer *et al.*, 1990). Consequently, return of DNA samples to museums would not, at present, be a reasonable requirement of borrowers. Most of these borrowers could better handle the samples than all except a few museums.

At present there is little coordination of the storage of molecular systematic data with more traditional taxonomic sources of information, in part because museums have not specified or enforced loan policies for material used in molecular studies. There is a strong need to do so as the acceleration of molecular systematic research will soon require an organizing information-retrieval system that is closely linked to the actual biological material. This new responsibility will also provide museums with a further opportunity to play a continuing major role in organizing systematic knowledge in the molecular age.

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Reply: Molecular Extracts from Museum Specimens Can—and Should—Be Saved

To the Editor:

The Whitfield and Cameron (1994) letter on use of museum specimens in molecular-systematic research focuses on a timely issue, and it should serve to stimulate continued discussion of this important topic. DNA and other molecular extracts (including isolated proteins) taken from traditionally preserved museum specimens are valuable research materials that are normally acquired through partial or complete destruction of the original specimen. Because the source of these materials (i.e., the original specimen) is unique and nonrenewable, it is imperative that every molecular extract obtained through destructive sampling receive maximal usage by the research community. In this spirit, Whitfield and Cameron (1994) suggest appropriately stringent criteria for granting of specimen loans when destructive sampling is planned (see also Pääbo *et al.*, 1992).

It is unfortunate, however, that Whitfield and Cameron consider it impractical for recipients of such loans to deposit molecular extracts into permanent museum collections upon completion of research projects. They argue that because most museums are not equipped to curate molecular samples, the loanee should be required to return only information about the extract (e.g., GenBank accession numbers, extraction protocols, literature citations, etc.), rather than the actual extract itself. This misconception (that there are few museums willing and able to curate molecular extracts) is widespread among molecular biologists and has resulted in loss of countless molecular extracts, either because of neglect or poor curation on the part of individual research scientists (Dessauer and Hafner, 1984). Unfortunately, Whitfield and Cameron's em-

phasis on preservation of *data*, rather than preservation of *molecular extracts*, will only perpetuate this wasteful practice.

Any policy, formal or informal, that allows molecular extracts to be tucked away (and eventually forgotten) in laboratories scattered across the nation is wasteful of this precious resource and should be viewed as unacceptable by the research community. This was the overarching conclusion of a workshop panel (sponsored by the Association of Systematics Collections and funded by the National Science Foundation) convened a decade ago to formulate a national policy on tissue collection management (Dessauer and Hafner, 1984). A major recommendation of that panel was establishment of a national network of collections to serve as long-term repositories for native tissues *and tissue extracts*.

This important goal—a national network of repositories for molecular samples—is well on its way to realization. The upcoming second edition of the book *Molecular Systematics* (Hillis and Moritz, 1990) will include a directory of such collections worldwide. Several of these collections are quite large, and many are willing to serve as repositories for molecular extracts taken from museum specimens, even if the original specimen came from a different institution. For example, the Collection of Genetics Resources at Louisiana State University (LSU) now contains tissues and extracts representing approximately 40,000 specimens. Importantly, the source specimens (vouchers) for many of these tissue samples are maintained in traditional museum collections at other institutions. The staff of the LSU tissue collection (a full-time Ph.D. curator, half-time collection manager, half-time graduate curatorial assistant, and several student workers) is willing and able to curate DNA (and other) extracts donated for long-term preservation. Because this collection, and others, is willing to serve as "at-large" repositories, there is no longer any excuse for valuable DNA extracts to accumulate in lab freezers across the nation, only to be discarded as the research directions of the individual investigator change.

In the context of research museums, I believe that Whitfield and Cameron's (1994) emphasis on molecular-systematic data (e.g., published papers and DNA sequences), rather than the DNA extract itself, is misguided. It has never been the responsibility of museums to serve as repositories for research data based on their specimens, and I see little advantage in expanding the museum's role in this direction. Research museums curate *specimens* and parts thereof (which include—or should include—DNA and other tissue extracts), not data or publications based on those specimens. This distinction between data (which vary in quality and are subject to many kinds of error) and sources of data (i.e., specimens) is fundamental and worth preserving. As the needs for databases emerge,