Letter from the Desk of David Challinor
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Many visitors to the Smithsonian's Natural History Museum's Silver Hill Facility are awed when shown the enormous assemblage of specimens and artifacts that represent the research and collecting skills of generations of scientists. I was often asked when giving my special tours, why on earth do you keep all this "stuff?" What good is it? These are not unreasonable questions from a layperson, and most people were quite satisfied when I explained their value. This month's letter concerns the value of retaining collections, not only man-made ones, but both living and preserved natural history specimens. Such artifacts are an incredible store of knowledge about the natural and man-altered world. New techniques consistently appear to glean ever more valuable insight from objects around us so that well-curated national history collections resemble a library where knowledge is stored, not in books, but in the objects themselves. To extend the analogy, these "books" contain potentially unlimited new chapters waiting to be read with each newly discovered means to do so.

For example, some museums have collections of birds and mammals more than 100 years old. Properly curated, each specimen will have on its identification tag where and when it was collected and by whom. Suppose at some time in the future officials needed to know when radioactive strontium reached the Antarctic after the detonation of the first atomic bombs. Strontium 90 concentrates in bone tissue and, by examining skeletal material collected after 1945, curators could study the first bone tissue from Antarctic birds and know when the bones first contained this element. Although I do not believe this question has ever been asked, similar inquiries have been proposed.

Twenty years ago The National Museum of Natural History was asked to analyze muscle tissue of tuna and swordfish caught far offshore before about 1900 to determine whether any contained evidence of methyl mercury (CH_3Hg). This query was triggered by the mercury poisoning of young Japanese who had been steadily eating fish caught near an outfall of a manufacturing plant that flushed this mercury into the bay. Mercury in this form occurs naturally in the oceans and in special circumstances can be concentrated in large pelagic fish at the top of the food chain. As I remember, the results from sampling 80 year old tuna and swordfish specimens showed that some had mercury levels greater than that deemed safe today, which they had acquired from eating naturally contaminated prey. The analysis was not conclusive, however, because the testers could not unequivocally determine the effect of the formalin preservative, in which the samples had been stored, on the methyl mercury concentration in the fish tissues. However, analytical techniques have since improved and what was not definitive then might easily become so today.

One museum collection series that proved essential involved bird eggs used to monitor the effects of spraying DDT on the environment. Scientists determined that certain elements of this chemical insecticide concentrated in the tissue of the animals that ate contaminated soil, such as earthworms or further up the chain, the birds that ate the worms. At the top were such birds as peregrine falcons and eagles whose food was doubly contaminated. In these raptors the contaminants concentrated in the fatty deposits around their livers and so affected the calcium metabolism of the females that their eggs were too fragile to brood. Shortly after the connection between DDT and eggshell thickness became universally accepted, the spraying of this insecticide ceased in the United States.

With computer application the extraction of new knowledge from collections advanced rapidly. The computer allowed enormous amounts of data to be stored and easily retrieved and it was a boon to the rapidly emerging science of dendrochronology--the dating of wooden objects or events from tree rings. In the temperate zone, trees lay down a growth ring annually, although occasionally unusual growing conditions may cause more than one ring. Curious people for centuries have counted rings on cut stumps in order to age felled trees. By mid-twentieth century, however, the Swedes had devised a new hollow increment corer that enabled foresters to easily extract a five millimeter diameter core by reversing the twist after penetrating the tree. This corer allowed foresters to determine age and growth rate without sacrificing the tree. Since most growth in temperate zone trees occurs in the spring, the core shows a wide pale band, followed by a dark one, caused by slow diameter growth in the late summer and fall. The latter rings are easiest to count. The width between dark rings is directly dependent on each year's growing conditions; therefore, a wet spring interspersed with sunny warm days produces wide diameter growth and thus wide rings. Because weather conditions vary annually in different parts of the temperate zone, the width pattern of tree growth rings correlates with the weather cycle of the area. All the trees exposed to the same weather, therefore, have almost identical ring width patterns. In contrast, most tropical trees grow steadily throughout the year and thus lack the clear rings of temperate ones.

Dendrologists store growth-ring-patterns in computers for different tree species in various parts of the temperate world. Among the most successful uninterrupted sequences is the one developed for southeastern Europe and Asia Minor where wood has been used as a building material for millennia. For example, since 1973 Peter Kuniholm and his colleagues at Cornell have been dating structures built in the days of the Ottoman Empire. Today their tree ring sequence begins with trees still growing in Turkish forests and extends with no gaps to AD 366 for all oak timbers, to AD 743 for pine and to AD 1037 for juniper. Such sequences give not only the age of the wood when it was cut, but the evidence is still useful to date construction. By knowing ages of the wooden material used researchers can confirm the construction date of most important buildings from historical records. Cornell's Aegean Tree-Ring Chronologies go back to 7,000 BC, but there are still gaps to be filled, especially from about 6500 to 5500 BC. It will take many years of searching and considerable luck to complete the missing sequences, but with the growth of dendrochronological research both in North America and Europe many gaps will inevitably vanish with new discoveries of ancient timbers or buried logs. Sunken or buried logs unexposed to the oxygen necessary for decomposing organisms will last indefinitely and are a timeless source for tree ring sequences.

Tree rings are not only useful for dating ancient buildings but also are used to plot times of such natural phenomena as droughts or even insect epidemics. In the most recent issue of *ECOLOGY* (Vol. 82, No.3, March 2001, p.679) there is a fascinating account of determining heavy infestations of Pandora moth larvae on old growth Ponderosa pine in Oregon. These caterpillars eat the two and three year old needles in the spring just as new ones are emerging. The infested tree thus goes through its spring and summer growth season with only one set of needles rather than the normal three years worth. The tree survives--but barely--for conifers, unlike broad-leafed trees, cannot sprout new foliage once defoliated by insects. However, having only one year's crop of needles for photosynthesis during the summer, the tree's growth rate declines precipitously for two or three years until it enjoys a whole growing season with its normal three year's worth of needles. Three years of minimally spaced rings could thus indicate Pandora caterpillar infestation.

Pandora caterpillars do not eat fir needles, so to eliminate other causes for such a slow growth sequence, such as drought, scientists cored various species of fir that grow amongst Ponderosa pine trees. By comparing ring width patterns of fir and pine for the same period of years, slow growth in the pine could be attributed to insect defoliation, if the neighboring firs showed normal wide ringed growth during the same period. When the authors of this paper finished sampling in fourteen old growth Ponderosa sites in south central Oregon, they had the longest reconstruction of forest insect population dynamics ever developed for North America (1374 to 1995). In individual stands of Ponderosa they found that outbreaks of Pandora moth larvae were variable and ranged over intervals of as little as 9 years to as long as 156 years, but when all data were pooled, there appeared to be two overlapping cycles of differing intensity--one of about 20 years and the other of 40 years.

This research could only have been done if there still remained enough uncut old growth Ponderosa to measure. Scarcely 50 years ago, few had any idea how much you could learn from living and dead plants and animals. It is costly to store dead material, less so the living trees, but collections in the natural history museums of the world are indeed an invaluable and vast global record of the natural dynamics of our planet. From this storehouse an ever increasing knowledge of our natural world is gained with each new device, technique or other yet undreamed of key that mankind may find to unlock the still hidden riddles in our collections.

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