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VERIFICATION AND REVERIFICATION: PROBLEMS IN ARCHAEOFAUNAL STUDIES

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ABSTRACT.—Biological materials from archaeological excavations, particularly faunal remains, are of most lasting scientific value if they are properly handled, individually numbered, and adequately reported in published accounts. Archaeologists are urged never to put bones in plastic bags. Authors of faunal accounts are encouraged to publish reasons for their determinations, to mention comparative materials used, and to give individual identifying numbers and element descriptions with their proveniences to aid subsequent study and reverification. Knowledge of the local fauna enhances the validity of interpretations. Better appreciation of the culture and its particular technology would improve biologists' accounts. Archaeological bones have been used in reconstruction of past diets and environments. They are of use to both paleontologists and neontologists. A significant contribution of biological materials is the demonstration of human-wrought modifications (particularly insular extinctions and extirpations) in species densities. Existing comparative osteological collections are weak in quantity and sometimes poor in quality; 82% of the world's *ca.* 9,000 bird species are represented by ten or fewer skeletons in museums worldwide.

INTRODUCTION

The very basis of science is empirical evidence. The taxonomic disciplines are based on specimen documentation, publicly available, subject to reverification. Ethnobiological studies are no exception. The biological specimens that a native consultant associates with her or his ethnotaxonomic identifications (voucher specimens, see Bye 1986), together with that person's critical comments, should be available to future workers once the research is published. Seemingly insignificant or casual comments later prove not to be so, but rather psychological criteria by which a native speaker delimits some ethnotaxon. With the onsaught of cultural homogenization, often the ethnobiologist is doing salvage ethnography, dealing with a small remnant of knowledgable native speakers; there may be no future generation to ask.

While ethnobiological voucher specimens are deliberately collected with supporting ethnographic information, the archaeozoological specimen has been preserved fortuitously, only to be recovered by modern excavators, now increasingly aware of the significance of biological remains. In an earlier stage of the evolution of archaeology as a science, only worked bones—artifactual materials—were considered important. Later, all archaeological bones were analyzed, but only artifacts were saved. With the expansion of contemporary research techniques, it is now realized that *all* biological materials collected from dated proveniences are of potential research value.

I direct my remarks here primarily to vertebrate remains and my examples are mainly from bird bones, with which I work, but the principles apply more generally.[1]

SOME METHODOLOGICAL CONSIDERATIONS

Handling and Packaging. When I asked a number of colleagues what topics to include in this paper, the first and most important response invariably was a plea for the proper handling of fragile bones by excavators. All other problems pale by comparison. In particular, bird, amphibian, and reptile bones are fragile and easily damaged, especially after years in the soil. More often than not, archaeologists bag in the field bones with lithic artifacts. After preliminary laboratory sorting, bones, often several together, are carelessly thrown into small plastic bags designed for sandwiches, then these "baggies" are all dumped into a paper sack. Finally, the loosely packaged materials are mailed to the faunal analyst. By this time fresh breaks in the bones are usually evident everywhere and often the diagnostic features have crumbled. Gilmore's (1946, 1949) early pleas for better handling of materials are still apropos.

A simple rule: *never put an archaeological bone into a plastic bag*. Each bone should be wrapped carefully in cotton or some fine paper. (A soft paper, 11.5 x 11.5 cm, excellent for this purpose, is commercially available, in rolls, plain or scented; it is available on virtually every archaeological dig.) The individual bones should be packed so one cannot damage another and put into sturdy containers such as small cardboard boxes or plastic vials that are sufficiently long that the well-padded articular ends will not be damaged. The possibilities of the bones being identified to species will be enhanced greatly by this simple procedure.

Each individual specimen should be marked permanently with a unique identifying number, letter, or combination of these. In this way the faunal analyst will recognize the individual specimen when it is laid out in comparative series during identification and can coordinate the specimen later with matching individual data sheets or slips provided by the archaeological team. Any published report should include this individual identifying number as well as the element name so that future workers, wishing to verify a determination, will know specifically which fragment or element had been so identified. Editors overly concerned with space would make this concession to science. The old (but unfortunately not yet fully abandoned) practice of simply putting data-bearing bits of paper in plastic bags or vials with the specimens, or, still worse, attaching paper scraps directly to the bone with rubber bands that eventually disintegrate, is a disservice to science! If each artifact from a site merits an individual identifying number, certainly archaeological bones deserve no less.

A word to the technician cleaning and numbering vertebrate remains: when possible, avoid marking over such critically diagnostic areas as the articulating ends, muscle scars, and tendinal tubercles; bare sections of shafts are the best for numbers.

The archaeological literature is replete with tantalizing early reports of animal remains, often analyzed and reported by workers unfamiliar with the local fauna, unaccompanied by any critical comments or provenience details within a site, and usually lacking specimen numbers. The retrievability of *individual* specimens is critical to science. Many questions may arise not thought of by original workers. Some examples with turkeys, *Meleagris* spp., illustrate this problem.

Steadman (1980) presented a comprehensive study of the subfamily Meleagridinae beginning in the Lower Miocene. The collection numbers and institutional depositions of all recovered and reidentified specimens were included. Ranges were delimited through geologic time to the historic era.

Grayson (1977) questioned the enormous range extension implied by Bedwell's (1971) report of "large quantities of turkey bones" excavated from Connley Cave in the northern Great Basin, dated 3,000-11,200 years B.P. The bones had been identified by well-known ornithologists at a major museum. Because the bones had not been individually numbered and details published, the entire avifauna had to be reassembled and reanalyzed in an attempt to determine which elements had been identified as turkey. Quantitatively, Grayson was able to demonstrate that the reported number of *Meleagris gallopavo* corresponded closely to the number of male Sage Grouse, *Centrocercus urophasianus*, and the general category reported as grouse conformed to the reassembled number of female Sage Grouse in the sample. Sexual dimorphism had been misinterpreted as taxonomic differences.

Rea (1980) showed that the reports turkeys in the Southwest U.S. applied to two different species, one a paleospecies, *M. crassipes*, the other a neospecies, *M. gallopavo*, appearing locally subsequent to the development of sedentary agriculturalism. However, in the hot low-desert sites occupied by the Hohokam culture, few turkey bones have been recovered (McKusick 1980; Rea 1983:140). Most of those reported (Fewkes 1912; Gladwin *et al.* 1937; Greenleaf 1975) cannot now be found among artifact collections. Apparently few workers have appreciated the potential confusion between turkey and fragmentary elements of Sandhill Crane, *Grus canadensis* (see Hargrave and Emslie 1979).

McKusick (1980) identified three strains of turkey from southwestern archaeological sites, two domesticated, one presumed feral. In completing her monographic work on these forms, she has experienced repeated frustration in relocating reported archaeological bones, often not saved "because they were just turkey" (McKusick, *pers. comm.).*

Humans, directly or indirectly, have been agents in the spread of vertebrates into new areas, as we know so well in our own time from the Common Starling, *Sturnus vulgaris*, House Sparrow, *Passer domesticus*, and House Mouse, *Mus musculus*. Polynesians were aided in their simplification of Pacific island biota by the dogs, pigs, and rats they introduced (Olson and James 1982a, 1982b, 1984). The role of Indians in the spread of animals outside their natural ranges has generally been underestimated; but the archaeozoologist must be alert to the possibility of finding imported species in archaeological sites. Bird trade in the Southwest is now well known through Hargrave's (1970) study of macaws and McKusick's (1976) and DiPeso's (1976) analyses of the Chichimeca trading center in Chihuahua, Mexico. Additional species are still to be reported. Haemig (1978) used ethnohistoric and documentary evidence to explain the presence of the Great-tailed Grackle, *Quiscalus mexicanus*, in the Aztec capital. (Haemig's [1979] interesting suggestion of the jay *Cyanocorax dickeyi* being in Mexico as a descendent of a human-introduced population of the Ecuador-Peruvian *Cyanocorax mystaclis* needs to be checked by comparative osteology; Hardy [1983] noted differences in their vocal repertoire.) In Puerto Rico and the Virgin Islands Olson (1982) has found the extinct rodent *Isolobodon portoricensis* only in the context of cultural deposits, never in Pleistocene cave deposits on these islands. Hamblin and Rea (1985) found rather extensive evidence of bird importation to Isla Cozumel. The Common Turkey, *Meleagris gallopavo*, has been carried aboriginally both to the north and south of its natural range (Rea 1980 and unpublished notes). These are only a few examples of prehistoric peoples spreading animals to new areas, but they should serve to jar archaeozoologists out of provincialism.

Contamination. Healthy debate has been a hallmark of archaeology and in archaeozoology is productive when specimens can be retrieved and the particulars of provenience and association known. An example will illustrate this.

Old World chickens, *Gallus gallus*, became widespread in the New World so quickly that their Hispanic introduction has been questioned (see summary in Gilmore 1950:393-394). Carter (1971) proposed, primarily on linguistic evidence, that the chicken preceded the Spaniards. In places the archaeozoological record appears to support this hypothesis, at least superficially. At the Las Colina site in Phoenix (A.D. 1100-1450, Hohokam), chicken bones were common, but accompanied with Muscovy Duck, *Cairina moschata*, domestic Mallard, *Anas platyrhynchos*, Chinese Goose, *Anser* cf. *cygnoides*, domestic cat, *Felis cattus*, and domestic pig, *Sus scrofa* (Johnson 1981; Rea 1981). At Pueblo Grande ruins, a similar site in Phoenix, I identified chicken, as well as the European Rock Dove (domestic pigeon), *Colmba livia*, in the small archaeofauna. Wasley and Johnson (1965) recovered chicken bones in a Hohokam platform mound in western Arizona, but noted they (as well as a shotgun shell base) were from the bottom of an area disturbed by pot hunting. At Mayan sites on Isla Cozumel dating up to the historic period, chicken bones (1.1% of the avifauna) were recovered from the top levels of pits (Hamblin and Rea 1979, 1985; Hamblin 1984). In all these cases it is either certain or highly probable that the chicken bones were intrusive. (See Hargrave 1972:6-14 for suggested leads on early chicken research.)

PUBLICATIONS AND INTERPRETATIONS

While papers are often filled with seemingly endless extrapolations and interpretations (anthropologists are not noted for brevity, as a review of journals demonstrates), editors and manuscript referees should insist that faunal analysts mention the related species they considered but rejected in reaching some identification. For instance, does an identification of *Buteo jamaicensis* mean that that was the only species of large *Buteo* the analyst happened to have for comparison? Were other expected species eliminated? Was the analyst aware of the potential range of species that once may have occurred within hunting range of the site? Readers are entitled to this information. Much more convincing would be a statement such as: the tarsometatarsus conforms in characters to *B. jamaicensis*, a species common in the area; the similarly sized *B. regalis*, *B. lagopus*, and *Parabuteo unicinctus* were eliminated on characters of the trochleae; *B. niditus* and *B. swainsoni* were eliminated on size. No skeletons of *B. albonotatus* or *Buteogallus* were available for comparison.

Certain species are of significance because of the temporal occurrence documented by the archaeological context. Many bird species have been extending their ranges northward during historic times (Phillips 1968; Rea 1983:87-90). The discovery of the Northern Cardinal, *Cardinalis cardinalis*, in several archaeological contexts in the Southwest merited careful analysis (Ferg and Rea 1983). The possibility of its being a trade item from the ancestral southern range could not be eliminated. A reader, coming upon such a report without comment and careful substantiation, should indeed be skeptical.

Recently, after five attempts with an anthropological editor from a major U.S. university, I failed to reinstate an introductory sentence in my faunal report to indicate country, location, cultural horizon, and approximate date of the site. The reasons he gave for his veto were that the site was well known (it is on another continent) and if I included such an introduction, then others might want to do likewise, contributing to redundancy in the overall work. Why not? Individual chapters and appendices by faunal analysts are often reprinted and circulated to specialists in the area. Such reports should be comprehensive in themselves, without reference to the whole work.

While archaeologists are often satisfied with a mere catalog of recovered taxa and perhaps a bit of "interpretation" (the amount usually inversely related to the quantity of bone recovered!), biologists may sometimes be faulted for thinking in terms of generic "man" and "his" effects on environments, as if "man" somehow came devoid of all complexities of culture. In the Southwest, for instance, one could not equate the types of habitat modifications resulting from the town-dwelling Pueblo Indians, the nomadic Athabascans, the riverine rancheria Pimas, and the two-village, maximally xeric-adapted Papago bands. Each has a different language and classification system, a different set of taboos, a different relative reliance on hunting, gathering, and agriculture. Even in this arid region, cultures could afford to be selective (Rea 1981). Islanders, perhaps, could not. "Panhuman" explanations of faunal and floral changes and extinctions are too sweeping, particularly where a diversity of technologies existed. L. Marshall (1984:805) has cautioned overkill enthusiasts to view extinction on each landmass as a discrete event. Archaeologists may be able to fine-tune this picture even more precisely in time and space.

Perhaps the most frequent use of vertebrate remains from sites, both paleontological and archaeological, has been in paleoenvironmental reconstructions. While each method of interpreting data has its pitfalls (see the extensive discussion in Grayson 1981), the presence of indicator species in a site will always remain a primary value of archaeozoological studies. The validity of any interpretation depends on two factors: the fidelity of an organism to a particular habitat or microhabitat and the interpreter's familiarity with the behavior and ecology of that organism.

Some species are such generalists or are so mobile that presence in a site yields little ecological information (e.g., Great Horned Owl, *Bubo virginianus*, Coyote, *Canis latrans*). The Red-winged Blackbird, *Agelaius phoeniceus*, and Sora, *Porzana carolina*, may indicate mesic habitats, but do not have high fidelity during migrations, for instance. But the Least Bittern, *Ixobrychus exilis*, and Water Shrew, *Sorex palustris*, are indicators of well-developed emergent or other low surface vegetation in riparian habitats. Suites of species with narrow preferences are ultimately the most informative. Sometimes two closely relates species replace each other in response to habitat alterations. In the Southwest, for instance, the Gambel's Quail, *Callipepla gambeli*, and Scaled Quail, *Callipepla squamata*, are almost invariably allopatric. Degradation of desert grasslands by overgrazing and consequent invasion of thornscrub increases Gambel's Quail habitat at the expense of the other (Phillips et al. 1964; Rea 1973).

Archaeozoologists (and this point is not limited to them) may be quite adept at species identifications in laboratories, but may have very little experience with the species in life. Unless the interpreter has had actual field experience hunting, trapping, netting, or fishing in the appropriate types of habitats, the interpretations will likely be naive at best. (No examples need be cited.) Familiarity with the habitat and the species found there should be a prerequisite for interpretations. Additionally, it would be appropriate if archaeologists in charge of team projects would arrange visits to their site by the biologists who will analyze floral or faunal materials.

More questionable, in my mind, are some of the attempts to extrapolate prehistoric diets from archaeofaunal samples, even though many elaborate models for analyzing bone have been devised. Often only a mere handful of vertebrate remains may be recovered from a site, sometimes because of poor recovery techniques (too coarse screening), more often because very little material was preserved. Without direct evidence of cooking, it is hazardous to equate presence in a site with food or even with human agency. Rodents and reptiles, for instance, find ruins excellent localities for burrows, where some may die. Pot hunters, picnickers, and ranchers may contribute to the faunal assemblage. In my own experiences with peoples on a subsistence economy in the tropics and deserts, dogs seem to be the primary filterers of discarded bones. It is only by accident that anything survives. Overinterpretation of faunal remains is a futile exercise.

Excavated biological material may serve purposes not originally anticipated by the archaeologist. Stanton's Cave in the Grand Canyon, Arizona, was originally excavated to learn something of the enigmatic people who cached there split-twig figurines (the Society of Ethnobiology's logo). But the 43,000-year accumulation of materials recovered in the meticulous fine-screened excavation ultimately proved of greater paleobiological interest (Euler 1984).

Paleontology and archaeozoology may overlap, even in the relatively younger contexts of the New World sites. In the West Indies, for instance, several extinct birds are known only or primarily from middens: a crow, *Corvus pumilis*, a macaw, *Ara autochthones*, and a rail, *Nesotrochis debooyi*. The unidentified *Ara* sp. and *Aratinga* sp. from Postclassic Mayan sites on Cozumel Island are either new species or long-distance imports (Hamblin and Rea 1985). On the Pacific coast Morejohn (1976) recovered the extinct Pleistocene flightless duck, *Chendytes lawi*, from early middens. Extinct species of Hawaiian birds are just being discovered and described, many overlapping with Polynesian colonization. Olson and James (1982a, 1982b, 1984) so far have documented the extinction of 54% of the endemic species of Hawaiian land birds, extinctions attributed to pre-European habitat changes and hunting.

Dated archaeological faunas have always been an important source of specimen documentation for the former distributions of species now extinct, endangered, or geographically restricted. Parmalee has been prominent in documenting former ranges of both birds and mammals in North America (Parmalee 1958, 1960, 1961, 1967, 1971, 1981, etc., Parmalee and Perino 1970).

Perhaps the most significant theoretical implications have arisen from such analyses of vertebrates recovered from islands, particularly those faunas permitting pre-human and post-human comparison. Such work is generating responses that seriously question the baselines used in the voluminous biogeographical studies of supposed fauna equilibrium and "turnover" on islands (see Olson and James 1982, 1984:777-778, Steadman and Olson 1985, Steadman 1986, ii, 88; see also Rea 1983: 14 on deserts).

COMPARATIVE COLLECTIONS: THE WEAK POINT

Growth. Curators and other managers of collections used in faunal analyses should continuously upgrade their osteological collections, both in species numbers and the number of individuals in each series. I know of some analysts who regularly work with only a small number of species represented from their geographic area. One must be skeptical of their scientific results. Collections must grow if they are to be useful research tools, and state and federal permit agencies as well as museum and university administrators must continuously be educated to this fact. Most have never had the practical experience of having attempted identifications. Archaeofaunal analysts might help remedy such ignorance by regularly supplying reprints and copies of reports to agencies and administrators.

Certain researchers, particularly some "field" ornithologists and theoretical ecologists whose studies are unverifiable, have proposed in various recent publications that museums have sufficient numbers of specimens already, particularly of birds. Any working archaeozoologist, paleontologist, or taxonomist knows the falsity of such statements (see Olson 1981). In a worldwide inventory of avian anatomical skeletons, Zusi and others (1982) discovered that about a third of the species of birds of the world (2,706 species) are not represented anywhere by even a single skeleton. Of the approximately 9,000 avian neospecies, over 7,400 (82.3%) are represented by ten or fewer skeletons worldwide. Only 2.1% of the species are represented by over 200 skeletons in the world's museums. Quantitative studies of avian skeletons are virtually impossible. Those who appreciate the use of osteological collections should be aggressive in their conservation and expansion. Only rarely should a specimen be discarded. What may be superfluous in a local collection will likely be missing in some other.

Frequently it is necessary to borrow skeletons to complete a faunal analysis. When possible it is best to request the specific element needed rather than trust an entire valuable specimen to the mails. An updated listing of avian skeletal holdings in the world's major museums is available (Wood and Schnell 1986).

Quality. The mere existence of a skeleton does not assure its utility. The quality of extant osteological preparations in many university and museum collections is often so poor that the materials are nearly useless to the archaeozoologist or paleontologist. Poor cleaning and grease saturation are two major problems. Shot or impact damage and loss of elements through misguided use further reduces the utility of specimens.

Skeletons cleaned by dermestid beetles often have diagnostic features obscured by adhering bits of tendons and cartilage, and they are sometimes more greasy than skeletons cleaned by other methods. Bacterial maceration usually provides the cleanest skeleton. However, cranial elements usually become badly disarticulated or lost. Such parts as the quadrates, pterygoids, lacrimals (ossa prefrontalia), larynx, syrinx, and sclerotic rings are most useful to phylogenetics if preserved *in situ*. My personal choice of preparation methods is maceration for post-cranial skeletons and dermestids for all cranial parts (including trachea and hyoids). Fat birds are best cleaned entirely by dermestids because the lipids may cause bone disintegration during maceration.

Grease, which may saturate the bone walls from the inside, often renders the normally opaque external surfaces translucent. Working collections must systematically be checked for grease. Degreasing is expensive, time consuming, and dangerous. Ammonia water will sometimes remove light saturations, but will usually take off the carbon ink specimen numbers as well. Heavier saturations usually require lengthy soaking in a solvent such as acetone or gasoline, with rinsings in several progressively cleaner baths.

Bones of young animals occur in archaeofaunal assemblages. This is not surprising because they are seasonally more abundant and often more vulnerable to human predation. The rearing of young birds and mammals is a widespread practice among many North and South American tribes, particularly tropical ones. Nestling birds and juvenals still growing are very rare in osteological collections. Those in charge of building comparative collections should make a special effort to salvage juvenal and young. Hargrave (1970, 1972) was one of the few ornithologists who consistently collected skeletons of juvenal birds, illustrating their diagnostic specific and generic features. Using his materials for comparison we were able to distinguish two species of turkeys even in young not fully grown (Hamblin and Rea 1985).

SUMMARY

It may appear that I have belabored some points here that seem obvious. Would that this were so. The archaeologist who walks into my laboratory with a bunch of unprotected, unnumbered bird bones in a "baggie" is the rule rather than the exception. Reports that give no collection numbers and fail to mention how an identification was arrived at or what species were compared still continue to be published, but are becoming fewer.

If archaeozoology is to maintain itself as a science, the *specimens* on which it is based must be permanently stored and retrievable for reverification. The scientific value of dated faunal materials may far exceed that originally envisioned by the archaeologist. Biologists have much to learn from archaeologists to the betterment of their studies and vice versa. In general, a true synthesis of the disciplines is a goal still to be achieved.

NOTE

[1]Drs. David W. Steadman and Storrs L. Olson suggested critical topics for discussion in this paper on the basis of their extensive experience studying biological materials from archaeological sites. David Steadman and Philip Unitt kindly reviewed the manuscript, making various suggestions for its improvement. Authors who have kept me supplied with reprints will find their papers cited most frequently here.

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