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A skeletal survey of Physical Anthropology in the US

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In seeking answers to questions about human biology, culture, and evolution anthropology offers a rich area for interdisciplinary inquiry. Most promisingly, anthropology provides a perspective on contemporary institutions, beliefs, and practices across the world's cultures. Although a branch of the social sciences, anthropology overlaps with the biological sciences in cross-species studies of anatomy and behavior. Such comparisons reveal the continuity of humans with other primates and highlight the differences in adaptation. The investigation of physical remains from ancient populations expands the comparative aspect of anthropological studies. The study of prehistoric material culture remains connects lifeways of ancient people to modern cultural practices. The incorporation of the time dimension, then, gives the discipline a unique approach and range of subject matter.

This essay briefly reviews the history of physical anthropology as a subdiscipline in the US. These comments derive from my educational and teaching experience during the last four decades of the 20th century, a time of "modernizing" anthropology, within the context of new directions in the biological and geological sciences.

Early history to 1950: Boas and Hooton

Anthropology in the United States unites, under a broad umbrella, several "subfields": physical (or biological), archaeological, sociocultural, and linguistic. Early in the twentieth century, anthropology became a formal discipline at Columbia University under the mentorship of Franz Boas (1858-1942), who in some respects was the "father of American Anthropology." Boas had a background in physics and approached anthropology as "the science of man." He emphasized the study of other cultures through the collection of factual data. He and his students focused intensively on the language, folklore, material culture, beliefs and practices of native Americans as "disappearing cultures" to be preserved.

Boas's research interests included physical anthropology. He studied growth and development in children of recent immigrants to the US and documented that as adults, they came to resemble long-established American residents in body size and head shape and to resemble their parents less. Boas attributed this plasticity in the human body to better health care and nutrition in the US and challenged typological ideas that linked physical traits with ethnicity (Boas, 1912; 1940). Boas maintained that the environment exerts a major influence and that physical characteristics are independent of language and culture. Nonetheless, his physical anthropology was descriptive, and like most scientists of the time, he rejected evolutionary change through natural selection.

Ernest Hooton (1887-1954) taught physical anthropology at Harvard University and his students were to have a major influence on anthropology in the second half of the century. Hooton's approach to the study of human biology was typological and descriptive. His physical anthropology focused on classification of races derived from measurements of skull shape and disregarded variation between individuals or within populations. He viewed physical characteristics of humans and other primates as nonadaptive, as simply biological traits of the species.

Between 1925 and 1950 Hooton taught several generations of students, and 40 received advanced degrees (Spencer, 1997). Among them were Alice Brues, William Howells, Fred Hulse, Lawrence Angel, Joseph Birdsell, Gabriel Lasker, Stanley Garn, James Spuhler, William Laughlin, and Sherwood Washburn. Most studied traditional skeletal biology and human variation, and population genetics. Washburn was the only one to look seriously at nonhuman primates (Washburn, 1942). Few jobs were available for teaching physical anthropology. The situation was to change dramatically after WWII, when these students and their students moved into teaching positions in physical anthropology in anthropology departments.

In the development of physical anthropology as a research area, museums became an important component. They housed collections of artifacts and material culture, initially from Native American societies, human skeletons, and in the natural history museums, nonhuman primate skins and skeletons collected from the tropics. New York housed the American Museum of Natural History, Harvard and Yale, the Peabody Museums, Washington D.C, the Smithsonian. When Alfred Kroeber, a Boas student, expanded anthropology at University of California Berkeley, he developed the Lowie Museum as part of the department.

Physical Anthropology and the modern era

The evolutionary synthesis

Prior to 1950, few studies in physical anthropology made reference to natural selection, or considered variation and populations as worthy of study (Bowler, 1988). Hooton had no interest in questions about function or evolutionary origins of biological features. Even though these traditional ideas were part of their background, many of Hooton's students were to make the transition into the "modern era" of physical anthropology.

The unification of biology occurred during the 1930s and 1940s with the formulation of the evolutionary synthesis. By about 1950 these ideas began to influence physical anthropology. The new synthesis brought to the study of human evolution an emphasis on process that recognized several biological levels from genes, to organisms, to populations, all as important components. Quite simply, the synthesis was the integration of classical genetics, field biology, and population genetics. The classical geneticists drew on the work on *Drosophilia* of Thomas Hunt Morgan and his colleagues. Their research investigated genes and their phenotypic expression, the contribution of genes to variation, the effects of mutation, and the mapping of genes on chromosomes. Their view was limited to the details of the "small picture" at the level of individual genes and the behavior of chromosomes.

The field biologists, in contrast, studied wild populations. They observed the expansion and contraction of population numbers and composition over time and environmental influences such as temperature, rainfall, and fluctuations in food supply. Natural selection was a concept they accepted, but they were skeptical about the effect of single gene changes within populations. The concept of mutation as the basis for speciation seemed quite removed from the populations of organisms that they studied in the field.

The population geneticists provided a theoretical basis for integrating both concepts. They produced mathematical models of population change or stasis by introducing variation in the form of hypothetical genes, then following their fate over generations with and without natural selection. In the US Sewall Wright emphasized the role of gene recombination during sexual reproduction and mutation as the sources of variation upon which natural selection can act. Along with Ronald Fisher and J.B.S. Haldane in the UK, Sewall Wright demonstrated mathematically that both natural selection and mutation promoted evolutionary change. Furthermore, they introduced the idea that chance at the individual and population levels (now known as genetic drift) could effect variation in populations, and in combination with the other two processes, contribute to speciation. Although natural selection operates on individuals, the population, with its collective gene pool and genetic variation, is the evolutionary unit. The modern synthesis forged a bridge between those biologists who studied genes and those who studied populations. Today evolutionary theory recognizes two steps: the production of variation (recombination, mutation) and the shaping of variation through natural selection. By integrating the biological levels, the modern synthesis attempted to be holistic, rather than narrow and reductionist.

A new framework in Physical Anthropology

From a historical perspective, the "Origin of Man" symposium held in 1950 at Cold Spring Harbor, Long Island charted the direction for integrating "the modern synthesis" with the study of human evolution. Theodosius Dobzhansky, a distinguished geneticist and field biologist, and his younger colleague Sherwood Washburn organized the conference. They brought together distinguished scientists to evaluate the state of physical anthropology and human evolution within the new evolutionary framework. The registered attendance reached 129 (Cold Spring Conference Volume, 1951).

The published volume and accompanying photographs of participants include the old guard "bridge builders" of the modern synthesis: Ernst Mayr and George Gaylord Simpson, in addition to Dobzhansky; geneticists A.E. Mourant and James Neel; descriptive primatologists Adolph Schultz and William Straus; and the younger generation of anthropologists studying genetics, including Hooton's students: Sphuler, Laughlin, Lasker, Birdsell, and Garn. Social anthropologist Clyde Kluckhohn explored population genetics from the point of view of specific cultures. The conference reflected some key themes: the population as a unit of study; the genetic analysis of racial traits and rejection of typology; human diversity in terms of adaptation; and a definition of fossil species that accommodates variation.

At the conference in a landmark paper Washburn (1951a) argued for a new approach to the study of human evolution, one that emphasized comparison, function, and adaptation rather than the traditional listing of isolated morphological traits. His approach defined diagnostic features of the species' adaptation and integrated them into functional complexes. Rather than offering a descriptive classification of the primates, Washburn grouped them by adaptive radiation. In his framework a dramatic shift in locomotion to upright posture and bipedality marked the origin of the hominids. The newly discovered australopithecine innominate bones from South Africa folded easily into the framework. In his analysis of human origins, Washburn interpreted the relationship between the form of the bones and the function of the muscles and joints as a means to interpret fossils. In a vision of the future, he emphasized the importance of both experimental evidence to test hypotheses and of incorporating information from both living species and fossil species.

The 1950 Cold Springs Harbor symposium marked the integration of evolutionary biology with anthropology and the beginning of a new era for anthropology. The events leading to the conference provide a lesson for modern anthropology.

The bridge builders and Physical Anthropology: 1940-1950.

The consolidation of the "new synthesis" and its connection to physical anthropology can be better appreciated by reviewing the intellectual climate of New York during the 1940s. Scholars of diverse backgrounds and from different areas of science worked at Columbia University and at the American Museum of Natural History. The stage was set for each scientist to contribute something important to anthropology.

The New York scholars broke the boundaries between narrow disciplines to ask questions about evolution in general, and human evolution, in particular. Dobzhansky, Mayr, and Washburn all taught at Columbia, and Simpson and William King Gregory were paleontologists at the American Museum of Natural History. This museum and other institutions in the eastern US during this era were centers of scholarship that brought together evolutionists involved in both teaching and research.

Dobzhansky, the geneticist, carried out research on fruit flies under both laboratory and field conditions; he brought his expertise to the study of human variation, natural selection, disease and populations (1955, 1962, 1963). Ernst Mayr, the systematist with a background in orthnithology, applied the principles of variation in species to the classification of hominids (1949, 1951). George Gaylord Simpson, the mammalian paleontologist, approached the history of life in terms of process and incorporated concepts of genetic variation (1944). He used statistics, for example, to document that metric changes over time were not linear and that morphological change was not goal-directed (1949). Simpson grappled with definitions of paleospecies and wrote extensively about adaptation. He also addressed methods and problems in the classification of extant apes and fossil hominids (Simpson, 1951).

In coming to the modern synthesis, the bridge builders transcended their disciplinary methods and reconstituted the totality of species change. They recognized the necessity to embrace many methods in order to comprehensively address evolutionary problems. Postwar enthusiasm gave vitality to these intellectual endeavors, which sowed the seeds of change that were to grow during the 1960s.

As a young colleague, Washburn joined with these senior bridge builders. He was central in planning and organizing the Cold Spring Harbor Symposium and therefore well positioned for his role as a conduit for evolutionary ideas into anthropology. As a graduate student in the 1930s, the Asiatic Primate Expedition to Borneo provided him with field experience in observing live animals. Dissections he carried out there gave him a window into the form and function of joints and muscle-bone relationships. From 1940 through most of the decade, Washburn taught human anatomy at Columbia Medical School in New York and did research on the effects of soft tissue (muscles and nerves) on bone (1947). These experiments illustrated the forces acting to shape bones and the limitations of interpretations based only on fossils.

At the American Museum of Natural History, Washburn came under the influence of William King Gregory. Although approaching the end of his long and distinguished career as a functional mammalian paleontologist, Gregory (1922, 1927) had published prolifically on human evolution and weighed in on debates about the evolutionary history of humans. He interpreted the newly discovered early australopithecine fossils within a comparative functional framework (Gregory 1949). Washburn acknowledged that while in New York Gregory served as a mentor and important influence.

The combination of primate field research, experimental anatomy, and the influence of William King Gregory, contributed to Washburn's key paper "The New Physical Anthropology"(1951b). He laid out his approach: an emphasis on functional complexes and adaptation rather than on isolated traits or typology; incorporation of all the evidence in theoretical proposals; and openness to new methods as ways to solve old problems, an insight that foreshadowed the molecular revolution in human evolutionary studies.

From the 1950s onward, Washburn integrated modern biological thinking into anthropology, through his focus on race and genetics, structural/functional analyses the fossil record, his insights about primate behavior, and his emphasis on connections between the brain and behavior. Washburn, like the other bridge builders, saw issues and problems, not disciplinary boundaries.

New information and methods: 1960s and beyond.

While physical anthropology continued its traditional emphasis on skeletal biology, descriptive anatomy, population genetics, human adaptation and disease, and paleoanthropology, the explosion of new information and new methods during the 1960s began to transform the field. Washburn, now at the University of California, Berkeley was again in the right place at the right time, well positioned both theoretically and physically to incorporate these new directions into anthropology. Through conferences that he organized and sponsored, he contributed directly to synthesizing and integrating the new information (1961, 1963). The modernization of anthropology during the 1961 can be illustrated by a few examples from paleontology, primatology, and molecular anthropology.

Fossil record

After Raymond Dart's discovery and naming of *Australopithecus africanus* in 1925, discoveries continued to come from several cave sites into the 1940s. Although there was considerable interest in the anatomical features of these early hominid fossils and their relevance to human evolution (Howells, 1962), their chronological age could not be well established from cave sites. The discoveries of Louis and Mary Leakey at Olduvai Gorge, Tanzania between 1959 and 1964 marked the beginning of a minor revolution in human evolution. First, there were more than 50 hominid fossils; some were complete crania that provided physical evidence of early ancestors and clarified the South African material. Second, the hominid fossils, numerous other fossils representing many animal species, and stone tools were preserved in relatively undisturbed deposits. Third, there were numerous sedimentary levels spanning a long time frame.

And finally, at Olduvai Gorge the chronology for the study of human evolution was now established. In contrast to the South African cave deposits, the newly developed potassium/argon dating method could be applied to lava deposits. In fact the Olduvai deposits had been dated prior to 1959. The dating of the lavas there was part of the attempt to establish a world wide geochronological time scale based on paleomagnetism, a key to plate tectonic theory and the on-going revolution in earth sciences. Researchers Jack Evernden and Garnis Curtis University of California, Berkeley carried out potassium/argon work at Olduvai and Alan Cox at Stanford, worked on paleomagnetism (Glen, 1982).

The impact of nuclear dating was particularly profound. It not only established a specific time frame, but also doubled the time previously given for human origins, from about 750,000 years, to almost 2 million years for the oldest Olduvai beds. The known ages in combination with the abundant fossils and stone tools marked a new direction in human and nonhuman primate paleontology. During the second half of the twentieth century, the new data continue to pile up through discoveries at sites in Kenya, Ethiopia, Malawi, Chad, and at new sites in South Africa, now better dated through paleomagnetism.

Primate behavior

Dating from the late 1950s another line of enquiry emerged to take anthropology in a new direction, namely the study of wild primates which focused on individuals, their lives, group dynamics and natural history (Ribnick, 1982). This approach was adopted in many countries within a short time. For example, in Japan, primatologists studied their native primate, *Macaca fuscata*; they also undertook field research outside of Japan, for example, on langur monkeys in India and chimpanzees in Africa.

Field researchers in zoology, ethnology, and psychology from Europe and the US began fieldwork at this time. The gorilla study of George Schaller and the chimpanzee studies of Jane Goodall are well known. In anthropology, Washburn promoted and led research on nonhuman primates. With his student Irven DeVore, Washburn studied baboons in Africa during the late 1950s and then sponsored students to do field research on other species. Washburn saw instantly that studying social behavior without the overlay of culture would provide insights into human behavior. The long term data compiled from many of these studies have had a revolutionary impact on the study of both human biology and our place in nature.

Molecular data represent a third major direction (Goodman & Cronin, 1982). About 1960 Morris Goodman applied immunological techniques to primate and human relationships. His findings emphasized the closeness of humans and African apes. In 1967 Sarich and Wilson used advanced quantitative methods and showed not only that humans and African apes were closely related as did Goodman, but also they applied the molecular clock concept. This hypothesis, formulated by Emile Zuckerkandl and Linus Pauling, emerged from their study of amino acid differences in several species plotted against geological time. Sarich and Wilson proposed that the hominid line diverged from pongid lineages as recently as 5 mya. If this were the case, previous interpretations of the earliest hominid ancestor would have to be revised. The then touted human ancestor *Ramapithecus* dated 10-15 million years would have to be removed from human ancestry and demoted to an ape. The results of Sarich and Wilson were understandably resisted, even vigorously, by the anthropological establishment for over a decade, because they challenged the theories and interpretations of paleontologists about human evolution.

In recent decades, new methods, new concepts, and new data continue to influence issues and problems in anthropology. Molecular methods have expanded beyond immunology to include amino acid and DNA sequencing, mtDNA, mini and microsatillites, and the Y chromosome. Data from these studies contribute to many issues related to phylogenetic relationships, human variation and population dispersion, paternity and primate mating systems, forensics, and, in the newest revolution, to the study of DNA and proteins of the fossils themselves.

Even here Washburn was a visionary in seeing the potential impact on anthropology. He facilitated the integration of molecular methods and data into anthropology in the US through training students and engaging the molecular data as part of the debate on human origins and the reinterpretation of fossils. He never ignored or peripheralized this new information; instead he continually reevaluated his previous ideas in light of the molecular data. For example, he shifted his emphasis from climbing to knucklewalking in the interpretation of the origin of bipedal locomotion (Washburn, 1951; 1968; Zihlman, 1990), an idea now being rediscovered (Richmond & Strait, 2000).

Changes in higher education post 1950

After WW II veterans returned home to take up their education with the assistance of the GI Bill just passed in the US Congress, and women entered college in greater numbers. Universities grew with the expanding student enrollments, departments took on new faculty, and positions in anthropology opened up. In addition, new funding opportunities plus the expanded growth of scientific research in all major US universities meant that anthropology became an important part of general education and a bridge between the social and natural sciences. In US universities, introductory courses in human evolution and physical anthropology fulfill general education requirements in the natural sciences while other anthropology courses are part of the social sciences.

During the 1960s, as undergraduate majors in anthropology increased, most universities offered "the four fields" with physical, archeological, sociocultural and linguistic courses. The interrelationship of the fields and the common intellectual thread of anthropology were maintained for several decades. But expansion often meant fragmentation and fission. As graduate students increased in number and became more specialized, training in some universities narrowed and education in the breadth of anthropology eroded. The era of postmodernism has contributed to departmental splits, as recent examples from anthropology at Duke University and Stanford University illustrate.

Lessons and challenges

The past should serve as a key to the present and near future. One lesson of history is that ideas are not bounded. Today anthropology tends to focus on narrower and narrower problems. Since our technology is more productive, physical anthropology seems at times to emphasize methods and quantification to the point that we often lose sight of the key problems and issues, including the broader picture. Unfortunately, universities encourage research along narrow disciplinary lines. Although universities, museums and research institutions are structured according to traditional disciplines, the problems of human variation, behavior, and evolution defy specific boundaries. The lesson from the bridge builders reminds us of the importance of mutual scholarly exchange with those in other disciplines. Anthropology itself offers the broadest scope for such an approach because the discipline addresses so many dimensions of the human species and spans the social and natural sciences.

In investigations of the human species, we must be holists, not reductionists. Anthropology reminds us that we are studying whole individuals within populations, as well as their social, cultural, and biological contexts. It is complete individuals who behave and change over evolutionary time. If understanding human behavior and evolution is to be meaningful, skeletal elements, for example, cannot be studied as single traits, but must be considered as part of a whole body, in the same way that symbols and meanings cannot be disembodied from the people who act.

Anthropology as an area of general education provides a lens through which students naturally reflect on our species in all its complexity. Anthropology offers students the possibility to ponder what is a human being, the meaning of being human to people in a diversity of cultures, and the possibility to learn about themselves, their history, their world, our world.

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