Book Reviews

Imperial Connections

The Inka Road System. JOHN HYSLOP. Academic Press, Orlando, Fla., 1984. xx, 381 pp., illus. $69. Studies in Archaeology.

There has been a recent surge of interest in pre-Columbian road networks throughout the New World. The most extensive of these road systems has, however, been the subject of comment and wonder since the first European invaders reached the fringes of the Inca empire and used its own roads to speed to its destruction. The Inca road system comprised not only well-built roads but a system of relay runners (*chaski*) posted along the road to carry official messages, regularly spaced rest houses (*tampu*) supplied for travelers, storage depots containing food and goods to supply the army and other official travelers as well as for redistribution throughout the empire, and control points assuring that only state-approved traffic moved along the arteries. The Inka Road Project spent two years studying this system, which reaches into Ecuador, Peru, Bolivia, Chile, and Argentina, with a maximum length of over 5600 kilometers and comprising some 23,139 kilometers of interlinking roads. Only one previous field study, carried out three decades ago and published only in popular form, has even approached the scope of this project.

The Inka Road Project did not, of course, cover the entire system on the ground. Rather, 12 sample segments were surveyed. Detailed reports of each of these surveys form the first part of this volume; the second part contains a synthesis of what is known about the Inca road system that is reasonably complete, if unreliable in detail. Sampling techniques have not previously been used on archeological remains of this nature and extent, and there were inevitable weaknesses in the first attempt to do so. It is still questionable whether a network of this sort can be effectively studied by such techniques, for though we may now know more of what lies along the roads we do not know how the roads actually linked the empire into a coherent unit. The Project's expressed emphasis on the systemic nature of the roads and associated sites is an important corrective to earlier tendencies to concentrate on the two north-south routes, one on the coast, the other in the highlands. However, only one lateral, coast-highland route was followed (Pisco), and that not far enough to link it with the highland road. Moreover, only in the Cañete Valley (where most of the roads were no longer visible) was "a road network rather than a single lengthy segment . . . studied."

"A causeway, a raised earth roadbed, passes through a small lake by the Inka center Huánuco Pampa in the central Andes of Peru." [From *The Inka Road System*]

Historical sources contain valuable information on Inca communications, and it would probably be impossible to study the road system without them. Careless use of such sources, however, can be very damaging, as it was here, leading to errors in road placement and in descriptions of *chaski* posts and techniques of cutting steps in rock. The discrepancies between eyewitness descriptions of functioning sites along the roads and remains on the ground today provide tantalizing mysteries that are not effectively solved. Historical sources do not offer enough detail to permit identification of ancient *tampu* and *chaski* posts from among the many small sites lining the roads, but there are still many toponyms that include the words *Inca* or *tambo*. Anyone attempting to use such clues should be wary, however, in an area where almost all ancient remains are attributed to the Incas and the word *tampu* is still in use. If the Inka Road Project did not find the answer to how to identify small roadside sites, it did point out the problems for future research.

Although *tampu* were built on orders from the state and presumably to state specifications, they were constructed by local craftsmen under local control and probably in the local architectural style. Thus, architectural style will not always identify state installations. However, since *tampu* had to meet certain needs of the state, there should be enough patterned similarities relating to their functions to identify them in spite of local differences. Recognition of such patterns could best be achieved through a study of readily identifiable remains at the core of the empire near its capital, Cuzco. Unfortunately, the road system is as poorly studied around the capital as anywhere else in the empire, and the Inka Road Project did not approach Cuzco closer than 300 kilometers to its south and 600 kilometers to its north. However much its periphery needed studying, it is hard to see how the road system could be thoroughly understood without some knowledge of its core manifestations.

As a result of the Inka Road Project, we have a better grasp of the general condition of the road system today and the amount of research that has been done on it in the area surveyed. Though it does not, and does not claim to, present a definitive description of the Inca road system, this work will serve as a key to future research and should en-

courage other investigators to undertake to answer the questions it raises before all the evidence is gone forever.

I would be remiss as a reviewer should I fail to mention that both the author and the publisher have been unforgivably careless in the production of this volume. There appears to have been no editing and no proofreading, at least in the first part, where proper names especially suffer. One should not have to pay the high price charged to read raw field notes with greatly reduced freehand sketches presented as "site plans."

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Correlates of Movement

Neurophysiological Approaches to Higher Brain Functions. EDWARD V. EVARTS, YOSHIKAZU SHINODA, and STEVEN P. WISE. Wiley, New York, 1984. x, 198 pp., illus. $39.95. The Neurosciences Institute Publications Series.

This book arises from discussions held during two conferences at the Neurosciences Institute. The book takes the well-established point of view that all behavior requires movement for its expression and its communication and that therefore "higher brain functions" may be examined by studying the neural correlates of movement execution. The proposition is that the output neurons in the primary motor area of the cerebral cortex, which Evarts has studied so fruitfully, are closely linked with motor behavior in advanced animals. On the other hand, sensory signals that trigger behavior are not tightly coupled to that behavior, and an identical stimulus can trigger a variety of different behaviors under different circumstances. To study how the brain controls these different behavioral responses in a flexible manner is to study the foundation of higher brain functions.

The work makes no attempt to be exhaustive in its coverage of the background of or the experimental observations that relate to this general proposition. Nevertheless, the views of the authors themselves and their interpretations of the contributions that their own studies have made to the understanding of "preparatory set" (to make a movement) and motor output are described in some detail. Hammond's 1956 demonstration that prior instruction of a subject could dramatically modify an apparently involuntary (automatic or reflex) neuromuscular response is at the basis of many of the investigations that are described. It is made clear that many motor actions that would appear to be completely automatic are, in fact, greatly influenced by changes in central excitatory state that are "set dependent." The flexibility of the response is attributed to functional changes in the cerebral cortex.

This is not a work to be consulted for detailed information about the cellular or regional organization of the cerebral cortex, although these are reviewed in a summary manner, as are the connectional relationships of the sensorimotor regions of the cerebral cortex. Most pertinent to the topic under review are the physiological observations made in monkeys and in humans under conditions of flexible motor responsiveness and from regions of cerebral cortex not closely linked to the motor output itself, for example from frontal regions of the forebrain. Yet the section of the book that discusses these observations provides little information. It presents very selective observations and describes them rather uncritically.

The penultimate section of the book has the attractive title Behavioral Correlates of Identified Cell Types in Cerebral Cortex. It reviews methods that might be employed to give more precision to the understanding of the meaningfulness of physiological responses recorded from the cerebral cortex or its connections. The review is a most unsatisfactory one that does less than justice to a number of the methods it explores. For example, it is concluded that the spike-triggered averaging method for revealing the functional significance of cell-to-cell connections is unlikely to find substantial application beyond the search for connections to motoneurons. Such a conclusion fails to acknowledge the wealth of detailed functional and connectional information that has already been obtained in many other neural systems using such approaches.

One can have little disagreement with the final conclusion of the book, that, by monitoring the function of cortical neurons with identified relationships to motor output, it should be possible to observe the influences on the neurons of the continuously changing activity in many other brain regions and circuits, some local and some remote, as an animal modifies its behavior in relation to changing situations. Sherrington, in concluding his Silliman Lectures, *The Integrative Action of the Nervous System* (1906), saw the cerebral cortex "as the organ of, and for, the adaptation of nervous reactions." But the connections of the sampled cerebral neurons will have to be known, and inputs and outputs will need to be specified precisely in terms of their quantitative contributions of excitatory or inhibitory influences to the local neuronal state, if any sensible interpretation is to be provided of their observed responses. This book does not help to define the need for this detailed knowledge to be evaluated for the individual connections of each of the identified neurons whose contributions to behavior are being evaluated.

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Gerontology in the U.S.S.R.

Physiology of Cell Aging. VLADIMIR V. FROLKIS, Ed. Karger, Basel, 1984. viii, 206 pp., illus. $89.25. Interdisciplinary Topics in Gerontology, vol. 18. Translated from the Russian by Alexander Lipinsky.

This book reviews some of the extensive studies done during the past decade at the Institute of Gerontology in Kiev, U.S.S.R. The Institute, perennially directed by D. F. Chebotarev, is the major Soviet group for gerontology and geriatric research and is a unit of the prestigious Academy of Medical Sciences of the U.S.S.R. (Department of Clinical Medicine). Like the National Institute on Aging, it runs a broad extramural program and also has its own experimental and clinical research groups; the groups comprise about 100 full-time scientists. (After more than ten obvious sources in the United States could not supply current information about the Institute, I tried to telephone two English-speaking colleagues at the Institute. After a minute's hubbub in Russian, the Institute's switchboard unexpectedly deflected me to the director's office and Chebotarev himself came on the line to graciously answer my questions.) Vladimir Frolkis, the editor of the book, is head of the Laboratory of Physiology, one of eight in the Section of Experimental Medicine. Frolkis's name is familiar to experimental gerontologists for his physiological and biochemical studies of the nervous systems of aging laboratory animals. He is first author of seven of the ten chapters.

The volume represents many Soviet scientists who are little known in the