programs in America. He was greatly surprised when Noguchi turned up penniless in Philadelphia, where Flexner was head of pathology at the University of Pennsylvania. A small grant for the study of snake venoms was obtained for Noguchi, who pursued that study intermittently for years, publishing some 20 scientific reports on the subject.

In 1904, following a year on a fellowship study with Madsen in Copenhagen, Noguchi was appointed to a staff position at the Rockefeller Institute. He remained with the Institute for his lifetime.

Noguchi attacked his research problems with energy and developed great skill in laboratory procedures. He was by preference a lone worker and rather secretive about his investigations. Over a period of just over a quarter of a century, Noguchi published some 200 scientific papers. Some of his studies were of high quality, such as: confirmation of *Treponema pallida* as the cause of syphilis; discovery of *T. pallida* in the brains or spinal cords of patients with paresis or tabes; cultivation of the agent of *Bartonellosis* and the proof that Oroya fever and verruga peruana were different manifestations of the same disease; and studies on the morphology and cultivation of various spirochetes including *Leptospira icterohaemorrhagiae*.

On the minus side, Noguchi's claims to have cultivated the organisms of syphilis, rabies, poliomyelitis, and trachoma were not confirmed by others. His claim to have established *Leptospira icteroides* as the agent causing yellow fever proved to be a fiasco and led indirectly to his fatal infection with yellow fever virus.

Flexner became a "father figure" to Noguchi, and some believe that Noguchi held that stern administrator in such awe that he felt pressured to turn out a steady stream of brilliant results.

Perhaps the chief lesson to be learned from a study of Noguchi's career is that the eminence of an investigator should not preclude a thorough testing of his scientific reports.

In producing a credible picture of Noguchi's personality and a fair assessment of his professional career, Plesset has succeeded admirably. In Japan, Copenhagen, and New York, she interviewed Noguchi's surviving relatives, friends, and former colleagues. The book is well written and carefully documented. Students of the history of microbiology and those interested in the early days of the Rockefeller Institute will find it a valuable source of information.

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Metal Artifacts

Pre-Columbian Metallurgy of South America. Papers from a conference, Washington, D.C., Oct. 1975. ELIZABETH P. BENSON, Ed. Dumbarton Oaks Research Library and Collections, Washington, D.C., 1980. x, 208 pp., illus. $11.

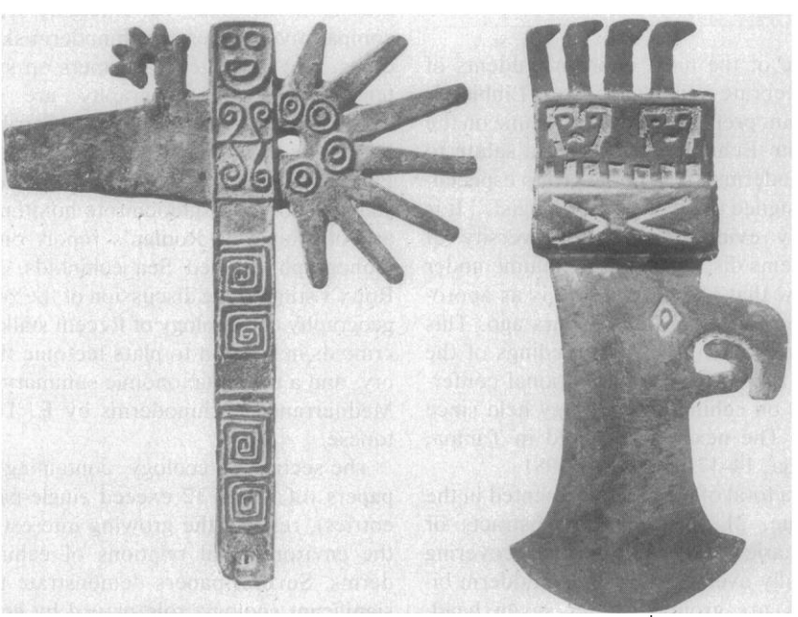
Despite gaps in the coverage resulting from the omission of some of the papers given at the original conference, this volume manages to convey a very good idea of current research directions in South American metallurgy. It also makes clear, by indirection, the monumental problem facing scholars attempting solid research in this field.

The first of the six papers in the volume, by Lechtman, is an outstanding example of an approach now being essayed in many studies of ancient technology, in which technical analyses become first a means of reconstructing technological processes and then a source of information on the history and socioeconomic significance of the craft, and on broader aspects of prehistory.

In an examination of the shift from copper to bronze and the use of the harder metal in the Middle Horizon (around A.D. 600 to 1000), Lechtman is able to provide convincing documentation for the development of two separate metalworking centers in the northern and southern Andes. Though data on the south are scarce, she discerns a center of copper-tin bronze production there, while arsenic bronze was utilized in the north, apparently the result of local innovation. In addition to describing the smelting techniques involved in the two types of bronze production, she discusses ore sources as a determinant of the development of the separate traditions. She then addresses the matter of near-universal use of tin bronze under the Inca, concluding that the phenomenon must be explained in political rather than technological terms. Turning from bronze to copper-silver and copper-gold (tumbaga) alloys, Lechtman examines in depth the development and persistence of techniques of surface enrichment in the Andes. Here, as with bronze, she views metalworking within the framework of the ideological system, and provides explanations for the invention and distribution of the alloys that go far beyond mere technical analysis of artifacts. She suggests that the study of metallurgical traditions may provide a basis for the general interpretation of Andean technology; her paper is clearly a giant stride toward such interpretation.

Fortunately Lechtman was able to limit her study very largely to material from controlled excavations, as was González in a survey of metallurgy in northwest Argentina that combines data on contexts and associations with typological and technical analyses and presents an organized overview of metalworking on the southern fringe of the Andean zone.

The other major paper in the volume is an extensive study by Jones of Mochica metal artifacts, among the best known in a metallurgically rich area. Jones deals with the artifacts as objets d'art, summarizing the tremendous variety of



Ceremonial axes from northwest Argentina, Late Period. The ax on the left has its handle in one piece with the blade; that on the right has a socket for a handle. [Museo de La Plata, Universidad Nacional de La Plata; from A. R. González's paper in *Pre-Columbian Metallurgy of South America*]

forms and decorative techniques employed by the Mochica. The difficulties that beset studies of Andean metalwork are indicated in Jones's figure captions, which more often than not include such phrases as "said to be from . . . ," and "collection of Mr. and Mrs. . . . ." It is, as Jones's work demonstrates, possible to deal with metal artifacts that in the preponderant number of cases have been stripped of their contexts and associations, but it is possible to deal with them only as art objects. The irremediable loss of data on Andean metallurgy must reduce the value of any effort to bring order to the subject.

One leaves the volume with, on the one hand, hope engendered by the solid studies rooted in excavation data, and, on the other, despair born of the knowledge that such studies will always be limited as a result of wanton destruction of evidence. The saddest thought of all is that many other kinds of study in the Andes are similarly restricted, and indeed we run the risk of seeing the prehistory of numerous other regions similarly shot to pieces by looting.

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Invertebrate Biology

Echinoderms: Present and Past. Proceedings of a colloquium, Brussels, Sept. 1979. MICHEL JANGOUX, Ed. Balkema, Rotterdam, 1980 (U.S. distributor, MBS, 99 Main St., Salem, N.H.). xviii, 428 pp., illus. $45.

One of the most eminent students of invertebrate animals, the late Libbie H. Hyman, prefaced her 1955 volume on the phylum Echinodermata with a salute to echinoderms as "a noble group especially designed to puzzle the zoologist." It is clearly evident from the diversity of problems discussed in the volume under review that Hyman's salute is as appropriate now as it was 26 years ago. This volume contains the proceedings of the most recent of five international conferences on echinoderm biology held since 1972. The next will be held in Tampa, Florida, 14–17 September 1981.

Of a total of 80 papers presented in the volume, 21 are one-page abstracts or summaries. The contributions, covering virtually every aspect of echinoderm biology, are grouped under seven headings: Paleontology; Skeletal Structures; Systematics and Zoogeography; Ecology; Morphology, Functional Morphology; General Physiology; and Reproduction, Embryology, and Larval Biology. As might be expected, the contributions vary in degree of general interest and quality. I shall comment only on the papers exceeding abstract length that seemed outstanding to me. Consequently, this review will reflect my own inclination toward paleobiology, ecology, and other aspects of whole-echinoderm biology; the volume deals with a wealth of topics that will interest a wide readership.

The majority of the 12 papers on paleontology and of the 11 papers on systematics and zoogeography deal with specific taxonomic or faunal problems and thus will be of interest mainly to specialists. It would be unfortunate were the systematic contributions and other regionally oriented reports not to be presented in the more widely circulated literature in a more complete form. The papers by R. Haude presenting a new interpretation of Cretaceous pseudoplanktonic crinoids, by D. Stephenson on symmetry and suspension feeding in pelmatozoan echinoderms, and by H. and G. Termier on early Paleozoic echinoderm evolution are of the greatest general paleontologic interest, as each deals with subjects of ongoing controversy. I was disappointed that four of the five contributions on skeletal structures are single-page entries, particularly in view of the great potential echinoderm skeletal microstructure holds for taxonomic, functional, and constructional studies. The summary by A. Smith indicates that common features of plate microstructure, soft-part anatomy, and growth modes may be emerging from comparative studies of echinoderm skeletons. The more general papers on systematics and zoogeography are A. Guille's account of ophiuroid distribution along the continental margin in the Philippine-Indonesian region, Y. Liao's summary of the aspidochirote holothurians of China, J. Roman's report on a monograph on Red Sea echinoids, M. Roux's stimulating discussion of the zoogeography and ecology of Recent stalked crinoids in relation to plate tectonic theory, and a useful taxonomic summary of Mediterranean echinoderms by E. Tortonese.

The section on ecology, containing 17 papers (of which 12 exceed single-page entries), reflects the growing interest in the environmental relations of echinoderms. Several papers demonstrate the significant ecologic role played by echinoderms: A. Hulbert on *Asterias vulgaris* in subtidal communities, B. Keegan and G. Könnecker on echinoderm aggregations, J. Lawrence on biomass and abundance of tropical holothurians, C. Massin on selective sediment ingestion by a holothurian, and K. Traer on the role of echinoids in Mediterranean seagrass beds. Studies of population dynamics through long-term diving surveys are reported by D. Nichols, on the echinoid *Echinus esculentus* in British waters, and by other authors (J. Guillou and R. Robert; also B. O'Connor and D. McGrath), on ophiuroids. In contrast to the widespread notion that echinoderms are stenohaline, R. Pagett reports low salinity tolerances in ophiuroids in a Scottish marine loch. Adaptive features and bathymetric distribution of deep-sea echinoderms are discussed by M. Sibuet in a particularly useful analysis. An intriguing contribution by J. Vasserot on the ecologic significance of venomous echinoderms is included with the papers on physiology.

A wide range of subjects is covered by the 10 papers on morphology and functional morphology. Outstanding among these are J. Woodley's study of the biomechanics of ophiuroid tube feet, which possess spirally wound collagen fibers, Massin's description of the holothurian digestive tube, in which secretion of a protein and glucid gel and mucus protects the gut from attrition by ingested sand grains, and a study of changes in sea star pyloric caeca in relation to the annual reproductive cycle by A. van der Plas and others.

Among the 10 papers on physiology, the report by D. Johnson and others on hydrolases in the digestive tracts of holothurians and other echinoderms is noteworthy because there appears to be a lack of protein-splitting enzymes although various carbohydrate-splitting enzymes are present. Two contributions by R. Oudejans and others deal with annual biochemical variation in the pyloric caeca of *Asterias rubens* and its relation to the reproductive cycle. The developmental biology of echinoderms is treated in 15 contributions. Of particular note are studies on annual reproductive cycles by P. Dehn *(Luidia clathrata)* and P. Magniez (brooding echinoids), the report by J. Pavillon on temperature effects on riboflavin and carbon-14–labeled glycine absorption in echinoid pluteus larvae, and a survey of reproductive patterns in deep-sea ophiuroids by P. Tyler and J. Gage.

This volume will be of particular interest to non-European workers because practically all the contributions come from Europe and the United Kingdom. Most of the papers are in English, with 23 in French and one in German. There