lems in treating the chemical arts as an integral and independent branch of effective knowledge. The result is a view of chemistry as an abstract system comprising coherent categories, divisions, and definitions, divorced from its applications and so organized that it provides a foundation for pedagogic techniques.

This is a good book. It enhances the historian's art, and it deserves readership. Here is another sign that history of science is reaching its majority.

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Marine Chemistry

Analytical Methods in Oceanography. Papers from a symposium, Atlantic City, N.J., Sept. 1974. THOMAS R. P. GIBB, JR., Ed. American Chemical Society, Washington, D.C., 1975. x, 238 pp., illus. $26.50. Advances in Chemistry Series, 147.

The editor of this book gives its purpose as "to acquaint land-locked chemists with the accomplishments and problems of marine chemists so that the accomplishments will be more widely honored and the problem solving shared." The book is not, he further says, "designed to inform sea-going chemists of recent advances by shore-based chemists." Gibb has assembled contributions from an interesting group of researchers that nicely accomplish the stated goals as applied to the study of trace metals and, to a lesser extent, to the study of nonbiological organic material.

Hume briefly describes the chemical nature of the oceans and the variety of unique problems encountered in work at sea. The next eight chapters discuss trace metal work. The three on sampling problems and techniques all point up the low concentrations encountered and the severe problem of contamination associated with sampling and processing in the oceans. Two chapters discuss the techniques for concentrating trace metals, a procedure that is generally necessary because of the low levels encountered in the oceans. Three chapters cover the analytical techniques: two on flameless atomic absorption and one on anodic stripping voltammetry. These eight chapters will be indispensable reading for anyone contemplating doing any trace metal work in seawater.

The other chapters of the book that will be of particular interest to chemists pertain to studies of hydrocarbons in the oceans. A well-rounded status report on the techniques used and the concentrations of the hydrocarbons in the oceans is given in three chapters. The techniques range from simple gas chromatography to computer-coupled gas chromatography and mass spectroscopy. Wangersky gives an enlightening summary of organic carbon analysis in seawater, with attention to the pitfalls.

Two chapters on studies of radioactive material in seawater give the concentrations of the radioactive substances encountered as well as details of techniques used. Livingston, Mann, and Bowen cover the transuranic elements and Silker discusses beryllium, zirconium, ruthenium, cerium, thallium, radium, and thorium.

The book falls short of completeness in that it fails to present methods for determining major constituents, nutrients, and man-made organic and inorganic pollutants. On the whole it can be especially recommended to scientists having an interest in the trace metals and hydrocarbons in the oceans.

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Primate Studies

Phylogeny of the Primates. A Multidisciplinary Approach. Proceedings of a symposium, Burg Wartenstein, Austria, July 1974. W. PATRICK LUCKETT and FREDERICK S. SZALAY, Eds. Plenum, New York, 1975. xiv, 484 pp., illus. $39.50.

The authors of the 17 papers collected in this book review various kinds of evidence used to draw inferences about the phylogeny of primates, ranging from the structure of fossil teeth to the structure of DNA molecules, from anatomy to behavior. The articles I found most stimulating were those by M. Cartmill (for approaches to interpreting morphology), F. Szalay (for new information on fossil prosimians), and M. McKenna (for new ideas on early mammalian evolution).

Cartmill analyzes morphological evidence of the lemuriform-lorisiform dichotomy and the phylogenetic relationships of cheirogaleids. On the basis of differences in cranial anatomy, lemuriform prosimians (Malagasy lemurs, indris, and aye-ayes) have long been considered a distinct group from the lorisiforms (lorises, pottos, and galagos, found in Asia and Africa), and cheirogaleids (mouse and dwarf lemurs) until recently were classified as a subfamily of the Lemuridae. However, recent reassessment of old information has suggested that cheirogaleids are actually more closely related to lorisiforms. How does one weigh the evidence? Cartmill demonstrates that the unusual "anterior carotid" artery found in lorisiforms and cheirogaleids is not a neomorph, but rather an enlarged ascending pharyngeal artery, a vessel found in most placental mammals. Why did it replace the internal carotid stapedial and promontory branches, seen in other prosimians, as a major pathway for blood to the brain? The presence of a rete mirabile on the ascending pharyngeal artery in lorisiforms leads Cartmill to suggest that it serves a thermoregulatory function, allowing short bursts of intense activity to raise body temperature without triggering the hypothalamus to initiate heat-dissipating, but dehydrating, panting reactions. The absence of that rete mirabile in the tiny cheirogaleid *Microcebus* must be explained, and Cartmill invokes allometry, suggesting that in such a small animal mere contact between the ascending pharyngeal artery and nasopharyngeal veins would be enough to cool cerebrum-bound blood. One way of testing that hypothesis, suggested by Cartmill, is to find out if a rete mirabile is present in the larger relatives of *Microcebus*, or lacking in the smallest lorisiforms.

One of the traditional diagnostic characters of lemuriforms is the presence of a tympanic ring suspended "free" within the auditory bulla, rather than forming part of its lateral wall (as in lorisiforms). Cartmill argues that the main difference is not a "free" ring (the ring is attached to the bulla by the sometimes ossified annulus membrane), but rather that the tympanic cavity has expanded laterally beneath the tympanic ring in lemuriforms. That perspective allows new interpretations of early fossil primate ear regions. Cartmill notes that at least some plesiadapiforms (*Plesiadapis*) and tarsiiforms (*Necrolemur*) share with early lemuriforms (*Adapis*, *Notharctus*) the subtympanic expansion of the middle ear cavity seen in modern lemuriforms, which thus appears to be the primitive condition. Ontogenetic studies show that the lorisiform condition occurs as a stage in the development of the lemuriform middle ear (it can be seen in newborn lemurs), and therefore would be easy to retain into adulthood. From allometric considerations of middle ear morphology, Cartmill suggests that the lorisiform ear region would be expected in any lemuriform lineages undergoing reduction in body size. (That hypothesis can be tested by examining allometric relationships

of such quantities as middle ear cavity volume, tympanic ring area, and body size in living and fossil prosimians.) The last character Cartmill examines, exposure of the ethmoid in the medial orbital wall of cheirogaleids and lorisiforms but not lemuriforms, is also shown to be at least in part conditioned by allometry (as well as orbital approximation).

Cartmill concludes that the available evidence suggests that lorisiforms are more closely related to cheirogaleids than to the other Malagasy lemurs, but declines to modify the existing classification. He argues, "Since the lorisiform configuration of the bulla and carotids represents modified and functionally significant retention of fetal lemuriform morphology, and since the orbital exposure of the ethmoid is largely conditioned by factors of allometry and orbital orientation, most of the traits shared by lorisiforms and cheirogaleids might easily have been acquired independently" (p. 350). And further, "The time is not ripe for attempts to make our classificatory units mirror our ideas about phylogeny. If we wish to go on communicating intelligibly with each other, with our students, and with future generations of primatologists, the best course of action is to continue using paraphyletic (or 'wastebasket') taxa where phylogeny is acknowledged to be uncertain. Because we lack early Tertiary fossil strepsirhines in Madagascar and Africa, the taxon Lemuriformes is one of the most useful wastebaskets we have to work with" (pp. 349–350).

I have elaborated on Cartmill's paper because to me it is something all too rare, a well-done analysis of the implications of morphological differences for phylogenetic interpretations. Particularly in view of the current enthusiasm for cladistics (seen in several of the other papers in the book), I find Cartmill's functional perspectives and taxonomic restraint refreshing.

Two papers by Szalay, an examination of basicranial evidence for phylogeny of primate higher taxa and a review of fossil tarsiiforms, provide a wealth of information on the morphology of fossil prosimians. The figures of the ear region of the ancient tarsiiforms *Rooneyia* and *Necrolemur* are superb, and the illustrations of dentitions of such early prosimians as *Tetonius*, *Teilhardina*, *Omomys*, and *Chumashius* are the best yet published. For the nonpaleontologist particularly, these papers will be excellent sources of information on morphology of fossil prosimians and serve as good entrees to the literature. I find the value of these papers diminished by a lack of adequate justification for some of the important arguments and conclusions, however. For example, Szalay should have spelled out the evidence for the reconstructions of ancestral eutherian and ancestral primate ear regions. (Such evidence is important for justifying the exclusion of microsyopids from Primates.) Szalay follows most previous workers in arguing that a promontory branch of the internal carotid artery that is larger relative to the stapedial branch distinguishes Eocene tarsiiforms from lemuriforms, but does not deal with Gingerich's contradictory findings, though he cites them. What is needed in this case is data on variation in relative sizes of those vessels in living and fossil prosimians plus, for arguments on functional significance, data on allometry of blood vessel diameter and brain, eyeball, and body size.

McKenna presents a provocative reassessment of the relationships of the orders of mammals, based in part on the hypothesis that primitive eutherians had five premolar loci and three molars. Macroscelidids (elephant shrews), lagomorphs (rabbits), and some fossil groups are united by their retention of the primitive three molars and loss of P3 and other premolars. Several other orders are considered to have lost M3 but retained DP5 in adults to produce what we usually call M1. A variety of morphological data are cited to support the suggestion that the edentates (sloths, armadillos, and anteaters) diverged early from other placentals. McKenna presents a new classification of the orders of mammals, based on strict cladistic rules, and introduces 20 new terms for taxa above the ordinal level and several new taxonomic ranks, among them legions, magnorders, and mirorders. I found the new ideas on phylogenetic relationships fascinating and thought-provoking but the new taxonomic names and terminology more a hindrance than a help. I wish McKenna had expressed his ideas on phylogeny with diagrams alone and hope that the unfamiliarity of his formal taxonomy will not discourage readers from studying the paper. McKenna is one of the foremost students of mammalian evolution, and his hypotheses deserve serious consideration.

Other articles that struck me as particularly useful in providing evidence on primate phylogeny are on placental and fetal membranes (W. P. Luckett), molecular data (M. Goodman), and recent and fossil catarrhines (E. Delson and P. Andrews). I found the articles on behavior and neuroanatomy less helpful in providing evidence on primate phylogeny, although interesting in other respects. I recommend G. G. Simpson's brief but comprehensive review of contemporary approaches for inferring phylogeny for a lucid introduction to the subject.

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