function of both the probability of contact in an extended social network and the conditional probability of cultural change given contact. Thus, nonvertical transmission is intrinsically frequency-dependent. Combinations of vertical and nonvertical inheritance and the kinetic effects of various evolutionary forces are considered in detail. Extensions to discrete traits with more than two states are also provided. The most important conclusion from the stability analyses of discrete traits is that stable internal equilibria are frequent under vertical transmission; that is, cultural traits are likely to have multiple forms at any one time. In contrast nonvertical transmission is usually associated with a flux of innovations that are rapidly accepted and rapidly replaced.

Cultural transmission of continuous traits is formulated in terms of linear models that take into account differential contributions of the two parents, some types of assortative mating, social stratification, and the various evolutionary forces mentioned earlier. There is a cogent discussion of historical ideas about "blending" and "particulate" inheritance. The key result is the intuitively plausible conclusion that the stabilization of cultural variance within a population is intrinsic to the process of cultural transmission itself. More specifically, as long as there is learned transfer of information across generations, the cultural variability within a group reaches a finite upper bound that is a small multiple of the mutation variance. Also noncommunicating groups diverge under cultural drift linearly with time.

Although relevant data are scanty, the applications of the models are illustrated with many interesting examples about the spread of infections like kuru and hepatitis and about the evolution of surnames and languages. Because of the dearth of adequate data about cultural traits, the authors and their colleagues also collected questionnaire data about some behaviors and beliefs of Stanford University biology students. These data are extensively used to illustrate the models. Unfortunately, any interpretation of them is dubious because of a low response rate to the survey and the lack of test-retest reliability data. Furthermore, interpretations of all the data analyses are questionable because the models neglect gene-environment interaction and individual differences in learning ability.

The work of Cavalli-Sforza and Feldman on cultural transmission has already had a major impact directly in theoretical population biology and indirectly in behavior genetics. This new synthesis of their decade of effort demonstrates that it is possible to extract the answers to many key mathematical questions about cultural transmission despite cautious modeling assumptions. Nevertheless, geneticists will be greatly disappointed that they have deferred treatment of individual differences and gene-environment interaction. Social scientists will be disappointed that the integration phase of cultural change has been neglected. Perhaps the analogy between cultural and biological evolution could be extended usefully to consider cultural epistasis and cultural speciation. However, it is more likely that we need to know more about the mechanisms of cognitive development, behavior genetics, and socialization before further mathematical modeling of cultural evolution can be fruitful.

The book is highly recommended for mathematically oriented scientists, especially population biologists and economists. Its prose and logic are lucid, but its emphasis on stability analysis may be tedious for many social scientists and nonmathematicians. The book could be used as an introduction to population genetics for social scientists with the appropriate mathematical prerequisites, including matrix algebra and stochastic processes.

Overall, Cavalli-Sforza and Feldman have given us a sound mathematical foundation for the study of cultural evolution. Much exciting empirical and theoretical work remains to be done.

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Primate History

Evolutionary Biology of the New World Monkeys and Continental Drift. Proceedings of a symposium, Bangalore, India, Jan. 1979. RUSSELL L. CIOCHON and A. BRUNETTO CHIARELLI, Eds. Plenum, New York, 1980. xviii, 528 pp., illus. $49.50. Advances in Primatology.

This book is the expanded proceedings of a symposium held during the seventh congress of the International Primatological Society. The major problems addressed are the questions of platyrrhine origins and the relationship of platyrrhines to catarrhines in light of plate tectonic theory. Illustrating the complexity of these problems is the diversity of topics discussed: geological and geophysical evidence relating to paleogeography; the biogeography of Tertiary land mammals; the primate fossil record; and primate dental, cranial, postcranial, integumentary, developmental and reproductive, karyological, and biochemical evidence relating to platyrrhine origins. Behavioral and paleoclimatological evidence is not presented.

Nearly all the authors deal completely with biological evidence, giving passing mention to plate tectonic evidence that supports one or another phyletic argument. Tarling's paper, however, deals wholly with plate tectonics and the possibility of Cretaceous and Tertiary land faunal transfer to and from South America. One problem that I see with his reconstructions is that, although contact between the plate margins took place until the late Albian between the Falkland Plateau of South America and the Cape region of Africa, subaerial conditions cannot yet be proven, and this land route remains hypothetical. Tarling also postulates that Tertiary sweepstakes dispersal routes between Africa and South America could have existed in the northern, equatorial South Atlantic. He avers that oceanic islands hundreds of square kilometers in area existed offshore of Brazil and West Africa until the end of the Eocene. The original reports of the volcanic origin and structure of the Ceará and Sierra Leone rises in this region yielded no samples indicating subaerial conditions. Sweepstakes dispersal of organisms across the late Eocene South Atlantic is therefore advanced as more likely than available evidence seems to warrant. Tarling's further reconstruction of parts of the Mid-Atlantic Ridge widely exposed by a fall in sea level during the beginning of the Oligocene results in the marine barrier between South America and Africa being transected by hypothetical emergent structures. The result is that many authors in the volume unhesitatingly use Africa as a source area for both platyrrhine primates and caviomorph rodents, sometimes postulating a multiple series of invasions (Chiarelli, Sarich and Cronin).

The majority of authors hold that higher primates arise from omomyids, but adapids (Gingerich) and tarsiids (Cartmill) are also advanced as the anthropoid ancestral group. I was confused by the fact that Delson and Rosenberger use "protoanthropoid" to refer to a basal anthropoid, rather than to a prosimian stock ancestral to anthropoids. Most of the authors emphasize platyrrhine monophyly, but Chiarelli on karyological studies and Perkins and Meyer on integumentary traits are exceptions. The latter two authors suggest that adapid prosimi-

ans are ancestral to the Aotinae and Callicebinae and that omomyids gave rise to the other platyrrhine lineages.

One interesting point is that South Asia is emphasized by a number of authors, either as the area of origin of the first anthropoids or as the source of prosimians ancestral to both platyrrhines and catarrhines. New finds of *Amphipithecus* and *Pondaungia* from the late Eocene of Burma and paleontological similarities between Africa and Asia seem to be responsible for this.

The issue of anthropoid origins seen from a platyrrhine perspective remains unsettled. No persuasive arguments are offered about whether the last common ancestor of the platyrrhines and catarrhines had achieved an anthropoid level of structural organization or whether the platyrrhines and catarrhines developed in parallel from a prosimian ancestor. The authors who unhesitatingly affirm the monophyly of the anthropoid grade also accept the high probability of trans-Atlantic crossing, which makes the plate tectonic evidence significant in phylogenetic reconstruction, although inconclusive by itself. The available fossil material does not document the prosimian-anthropoid transition (though it would have been appropriate to include a chapter on fossil platyrrhines and perhaps one on Oligocene catarrhines), and so the morphology of extant anthropoids becomes of paramount importance. The problem is to achieve a level of analysis that allows one to distinguish between convergent structures developed in parallel, homologies caused by symplesiomorphy, and homologies caused by synapomorphy. Delson and Rosenberger, summarizing evidence of this volume, list certain anthropoid characters that they believe are uniquely derived, but, with the exception of the developmental and reproductive traits investigated by Luckett, the characters listed do not persuasively seem to be synapomorphies uniting platyrrhines and catarrhines rather than convergent, nonhomologous similarities developed in parallel, and the authors do not explicate their method of categorizing traits. In the case of Bugge's work on the carotid circulation, it is even unclear whether characters examined are individual variations, because his anthropoid data set comprises only four catarrhines (one taxon) and four platyrrhines (two taxa).

In summary, this volume will be a major reference work for researchers interested in platyrrhine morphology and such important topics in primate evolution as the origin of higher primates and the origin of platyrrhines. As the editors stress, it is a preliminary attempt at understanding the relationships among higher primates. As such it stands as a significant contribution to primate evolutionary biology.

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Fisheries: Collapses Assessed

Resource Management and Environmental Uncertainty. Lessons from Coastal Upwelling Fisheries. MICHAEL H. GLANTZ and J. DANA THOMPSON, Eds. Wiley-Interscience, New York, 1981. xx, 492 pp., illus. $42.50. Advances in Environmental Science and Technology, vol. 11.

In the 1960's the Peruvian anchoveta fishery expanded to become the world's largest single fishery. Then in 1972 the anchoveta stock collapsed, and today anchoveta constitute only one of several modest fisheries off the west coast of South America. Similar collapses occurred in the California sardine fishery in the 1950's, in the North Sea herring fishery in 1969, and in the South West African/Namibian pilchard fishery in 1970. This volume tells the fascinating and troubling stories of these collapses and explores the causes and consequences of such events. Why do they occur? Was the anchoveta collapse due to the environmental perturbation known as El Niño that took place in 1972–73? Or was it due to heavy fishing? This volume offers evidence and arguments on each side. Even the consequences are not clear. The Peruvian anchoveta collapse is often cited as causing a number of drastic problems for Peru and the rest of the world, but a number of other events occurred in the early 1970's to confound the picture. One of the more interesting questions is posed by Warren Wooster in his foreword to the volume: "How then should one manage a fishery to accommodate not only environmental uncertainties but also their biological and social consequences?" This question, too, is left unresolved, though some attempts are made to address it.

Obviously, the real value of this volume is not in the answers it provides. Rather, its value is in the hard questions it poses, its demonstration of the complex physical, biological, economic, social, political, and administrative relationships associated with the problem of stock collapse.

The volume is organized in four parts. Part 1 consists of six background papers on the stock collapse phenomenon. Following Glantz's introductory chapter, Thompson presents an excellent overview of the primary physical relationships among climate, upwelling, biological productivity, and fisheries. The third chapter is a reprint of the late Gerald Paulik's 1971 paper "Anchovies, birds, and fishermen in the Peru current." Though the Paulik paper presents valuable information on a wide variety of issues, the account of the biological aspects of the anchoveta and El Niño effects is dated. For a more recent discussion of biologists' understanding of these issues see the *Proceedings of the Workshop on the Phenomenon Known as "El Niño"* (UNESCO, 1980). Not only is the next chapter, by Robert Murphy, dated (it was written in 1954), it is full of subjective analysis and casual observation. I did not find it useful. In one of two chapters in the volume that do not concern the El Niño phenomenon off the west coast of South America, John Radovich provides an interesting account of the collapse of the California sardine fishery and reviews the debate on the cause of the collapse. In the other such chapter, David Cram presents a brief account of the rise and fall of the South West African/Namibian pilchard fishery. These two chapters are dissatisfying in that they offer us few answers but are at the same time useful for demonstrating that the physical, biological, economic, social, and administrative problems associated with stock collapse are not peculiar to Peru or an El Niño event.

In part 2, which is devoted to scientific aspects of El Niño, James O'Brien *et al.* provide an excellent introduction accessible to neophytes to the physical oceanographic aspects of El Niño events. The majority of the chapter presents upwelling models that are not made accessible to nonoceanographers, however. Readers interested in the oceanographic and biological aspects of El Niño are advised to supplement their reading of this part of the volume with the UNESCO volume cited above.

In many respects the papers in part 3 addressing the societal implication of El Niño are the most valuable in the volume. In one, economist John Vondruska analyzes the trends in fish meal production, consumption, and prices. The anchoveta, pilchard, sardine, and herring, of course, have been principal raw products for fish meal. By examining the behavior of the fish meal market since World War II, Vondruska provides us with a good appreciation of some of the economic effects of the collapse of the