many questionable notions are explicitly presented. The first two chapters are most stimulating to the adrenals and would awaken many a drowsy seminar in physical anthropology. The first chapters are full of statements such as the one found on page 9: "The most successful primates in terms of population members and territorial spread *are those that have departed least from the ancestral pattern of structure but furthest from the ancestral pattern of behavior*" (author's emphasis). Ancestral patterns of behavior simply are not known, and the lay reader is misled if he retains the impression that they are. Whether we can infer them from fossils is a most exciting and highly debated question. Napier's discussion of the concepts specialized and unspecialized, as used by anthropologists and evolutionary biologists, probably makes these notions clearer to the layman than do the explanations of most other writers.

The book is well illustrated, with many excellent line drawings and photographs. Napier's point of view is evident throughout the book. It is not difficult to determine where he stands on many of the issues that beset students of human evolution, and for that the reader should be grateful. I happen to believe that Napier sometimes accepts a point of view that is wrong. I do not think he gives a sufficient discussion of alternative points of view. (Had he done so, the book would have been too long.) However, where the issues are critical, as in the discussion of the australopithecines, he covers a number of points of view. The section on the evolution of the hand is good.

A number of important points would have more force had Napier used language more precisely. For example, he lists 14 major structural and behavioral trends in primate evolution (pp. 40–41). The number has grown from the nine that LeGros Clark presented in 1959. The list of 14 includes several redundancies, statements with no substantive or logical content, and others that are stylistically horrid. Any reader will come to a full stop if he reads the list with care.

Nevertheless, the reviewer recommends this book to the nonspecialist because it is bound to be controversial and is written in a way that should annoy an intelligent layman into reading more about the subject. Furthermore, the author's general point of view that research in physical anthropology and human paleontology is fundamental to understanding man is unexceptionable.

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Russian Natural Philosopher

Mikhail Vasil'evich Lomonosov on the Corpuscular Theory. Translated from the Russian, with an introduction, by Henry M. Leicester. Harvard University Press, Cambridge, Mass., 1970. viii, 296 pp., illus. $10.

These translations of Lomonosov's writings were made from the Russian-language collections published in the 20th century and were checked against the 18th-century Latin originals. There is thus a touch of irony in the fact that Lomonosov wrote in Latin in order that his ideas could gain a reading in the Western world. But the 18th-century community of scientists was much more international than the one of today, and Russia particularly was dependent in large part on the importation of German scholars to sustain a creditable reputation in, for example, the St. Petersburg Academy of Sciences.

Lomonosov, a native Russian of exceptional promise, was sent to Germany for his advanced education. Through his experience with Christian Wolff in Marburg, he gained familiarity with the philosophy of Leibniz, as well as with the work of such other mechanical philosophers as Newton, Descartes, and Boyle. He became a thoroughgoing mechanistic thinker himself, adding some of his own views to those derived from earlier writers.

Eighteenth-century mechanism was more an attitude toward nature than a coherent system that we might recognize in the kinetic molecular theory today. Nearly every writer had his particular views, variously rejecting or accepting action at a distance, or differing from his colleagues concerning the nature of the internal motion they all associated with heat. Lomonosov found gravitational particles more satisfying than action at a distance, and explained heat in terms of purely rotational motion of the particles of matter.

The writings of Lomonosov translated in this book effectively illustrate the clarity and precision of a strong mind. They also illustrate the wondrous naiveté of 18th-century rationalism. The modern reader gains the impression that Lomonosov (typical of his contemporaries) believed that when a rational explanation for a natural event had been devised it constituted proof that nature herself was equally rational. Examples cited to support his conclusions seem to have been chosen more to confirm than to challenge this view. That another thinker might with equal rationality offer a different conclusion with equally convenient supporting evidence bothered very few 18th-century natural philosophers.

Leicester has included an excellent introduction giving a brief life of Lomonosov, something on the sources of his ideas, a summary of his corpuscular philosophy, and comments on the historical significance of his writings (which was rather little). Russian historians of science have recently made Lomonosov the hero of 18th-century science, and it is good to have this eminently readable selection of his writings available in English. Claims for the historical influence of the writings are dubious, but as products of a first-rate mind wrestling with problems of its own time and circumstance they are well worth reading for their own sake.

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Fitness at the Molecular Level

Molecular Biology and the Origin of Species. Heterosis, Protein Polymorphism and Animal Breeding. CLYDE MANWELL and C. M. ANN BAKER. University of Washington Press, Seattle, 1970. Cloth, $10.50. Sidgwick and Jackson, London, 1970. Cloth, 80s; paper, 25s. xx, 394 pp. + plates.

This book is diffuse, repetitious, and in many respects superficial. That notwithstanding, it should not be ignored by the serious student of populations, genetics, or evolution. Manwell and Baker have brought together, out of a dispersed and disorderly literature, some key elements from qualitative genetics, population biology, molecular biology, and physiology. They have combined these, albeit loosely, into a consistent explanation of phenomena as diverse as speciation, regulation of clutch size in birds, hatchability in fowl eggs, hybrid vigor in sunfish, and resistance to pollution. They are urging that a study of the molecular basis for heterosis is central to our understanding of

problems in animal and plant breeding, pollution biology, and evolution. What they have done, more than anything, is to show what *might* be known if this line of investigation were pursued with diligence and perception. To this end a strong argument, critically developed and forcefully presented, could well catch the imagination of present-day biologists. I am afraid this treatment will fall short of that mark. Not all of the authors' arguments are sound, not all of their observations are sufficiently critical, and they try to do too much for too many areas. The supercilious or hypercritical reader will almost certainly abandon reading and dismiss the book before its message becomes clear to him. This is regrettable, because the book's major theme has merit, and the authors are attempting to share with the reader a vision that contemporary biology should profit from. I hope that most readers will bear with the authors' lapses and stick with the exposition until they glean the substance that is there.

The first chapter begins with an introduction to the concept of heterosis. It is treated in the traditional manner, which is to say, with all the opacity of midparent values, inbreeding depression, and so on. This is discouraging. The authors, being in a position to lead, have chosen to follow. They might have formulated a strong and concrete definition of heterosis founded directly on considerations from molecular mechanics. Instead they repeat the customary formula and lament its vagueness, but they leave the concept no better than they found it, still vague, still contradictory, still unsatisfactory. They do, however, depart from tradition in a most important fashion. They place appropriate emphasis on negative heterosis. This is where heterozygotes, through deleterious interallelic and interlocus interactions, are less fit in some environments than the homozygotes. It is through balancing positive against negative heterosis that Manwell and Baker achieve their most useful insights and open up new areas of explanation.

From the first chapter through chapter 8, the subjects dealt with are population genetics (from the standpoint of the protein devotee), the molecular biology of proteins, and patterns of protein polymorphisms. The treatment of the last topic, stretching over 146 pages, is a patiently tedious summary of the literature, with good but far from complete coverage to around 1968. References to data from plants are more scanty than their relative contribution to the literature of this subject would justify. In chapters 9 and 10, considering allosteric effects and relationships among protein subunits, the foundation is laid for development of the primary theme, which takes up the last two chapters of the book. This theme can be presented succinctly, and I paraphrase it here mainly from the preface (p. xvii). Protein polymorphisms originate through mutation and gene duplication. They may persist with heterozygote advantage resulting from complementation between subunits of functional proteins. Alternately, heterozygote disadvantage may result from miscomplementation, in which case diverse mechanisms may come into play to reduce or eliminate the consequences of deleterious subunit interactions. Race and species formation are among the most interesting, and perhaps the most significant, of the means by which populations adjust to negative heterosis.

Different readers will find fault with different passages in this book and, page by page, I sympathize with them. Much of the text seems to have been written hastily or from hastily prepared and not always accurate notes, and some of the interpretations are not always carefully thought out. For example, there is a question of the interpretation that is to be given when data show an excess or deficiency of heterozygotes for a marker locus. To what extent can departures from random expectation be assigned to the metabolic or physiologic consequences of the one marker locus? To what extent might these more realistically be assigned to the net effect from a set of linked loci? Need the effect, the excess or deficit of heterozygotes, be assigned to the marker locus at all? For the case Manwell and Baker wish to make, these are clearly important questions. Equally clearly, their treatment of them is haphazard and contradictory. On pages 11–25 they ostensibly consider complications of exactly this sort. On page 16 they point out that the individual, not the locus, is the unit of selection. On page 17, in a discussion of segregational genetic load, they remark that "adaptive value had been referred to each locus and not to the individual as it should have been." Then in chapter 8, apparently sensing no contradiction, they use population data from single marker loci as evidence in support of their case for the reality of heterotic interactions. They cannot have it both ways. They berate population biologists for too directly assigning adaptive values to marker loci. Then they do the same thing themselves, for that is exactly what they do when they interpret an excess or deficit of heterozygotes at one marker locus in terms just of the interactions of the products of that locus.

Fortunately for the book's major thesis, interpretations of population data, while important, are not the most central issue. Models of protein interactions are. So also is the exposition of the ways in which protein interactions may contribute to phenomena ordinarily studied and *explained* only at the organismic level. It is here that novel interpretations are presented and it is here that the reader, casual or professional, can have his horizons broadened and his insights sharpened. For example, the possibilities that may exist for in vitro investigation of the adaptive properties of protein variants seem very promising. We may realistically anticipate learning more about whether alleles are adaptively neutral, or of how or when they exhibit advantage, by test tube studies than we may soon learn otherwise. Considering the refractoriness of the problem at the population level, and the extended public debate on the issue, this potential, even if not fully real or never fully realized, is welcome. It is for such insights primarily that I recommend this book to the reader, but always with the cautions implicit in my earlier remarks. We are yet too ignorant, both of population phenomena and of molecular interactions, for one treatment to authoritatively encompass both. This treatment does not, but if the reader realizes and discounts for that he cannot be lead too far astray, and what he gains will be worth the effort.

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Control of Temperature

Comparative Physiology of Thermoregulation. Vol. 1, Invertebrates and Nonmammalian Vertebrates. G. CAUSEY WHITTOW. Academic Press, New York, 1970. x, 334 pp., illus. $17.50.

Here is the first of three volumes which the editor has planned to survey the ways in which organisms regulate their internal temperature. Subsequent volumes will deal with mammalian regulation and general principles of heat exchange and temperature regu-