(osteoclasts) situated in typical Howships lacunae generally have been considered the sole culprits of destruction. Yet it was shown that the osteocytes of deeper areas of bone (well removed from bone surfaces) responded by resorbing the walls of their lacunae in a number of systemically accelerated resorptive states (brought about, for example, by the administration of parathyroid extract, cortisone, and the intravenous infusion of ethylenediaminetetracetic acid). This phenomenon was termed "osteolysis." If substantiated, these findings may represent the first step in delineating such a definite function for the osteocyte.

Two reports explored the degree to which resorbability is dependent upon the precise characteristics of the tissues being resorbed. In one study, the authors reported the results of experiments in which devitalized pieces of bone were implanted subcutaneously. The findings suggested that bone matrix need not be calcified in order to undergo resorption as long as it was calcified at some time in the past. Resorption of the implants was associated with the presence of an osteoclast-like cell, which appeared to be related to (or possibly identical with) foreign body giant cells. Histochemical studies demonstrated obvious similarities in enzyme reactions in these multinucleated cells, with the exception of acid phosphotase which appeared more highly concentrated in the bona fide osteoclasts.

In another study the author examined sites of preferential resorption in normal young rats and in comparable animals in which resorption had been stimulated by administration of parathyroid extract. In the latter group, the acceleration of resorption appeared to represent an exaggeration of this process in areas normally characterized by resorption. Combined histological, autoradiographic, and microradiographic analyses indicated that neither the age, degree of calcification (excepting uncalcified matrix, which was not studied), histological organization, nor chemical variations in the resorbable matrices was critical in determining sites of preferential resorption.

New information emerged regarding the ultrastructural characteristics of the osteoclasts. Electron-microscopic observations on osteoclasts in undecalcified preparations illustrated morphological differences in the cell membrane at the cell-bone interface, presumably related to functional differences in cellular activity. Among the most interesting findings was the observation that typically striated collagen fibers, evidently denuded of their inorganic crystallites, were present within the infoldings of the ruffled cell membrane juxtaposed to the resorptive bone surface. In terms of the mechanism of bone resorption, this may indicate that solubilization of the crystallites may precede lysis of the collagen component of the organic matrix.

Several in vitro studies dealt with biochemical aspects of bone destruction, including experimental resorption in tissue culture. When cranial vaults of immature mice were incubated in roller tubes, the addition of a number of substances to the culture medium, including parathyroid extract, vitamin D, and vitamin A, evoked an appreciable resorptive response, provided the oxygen tension of the medium was kept at a high critical level.

In tissue slices of resorbing bone, lactic acid rather than citric acid was found to be more concentrated in the supernatant end product of the system. While there is no question that bone cells can produce citrate, some question was raised as to whether significant concentrations of citrate accumulate and also whether parathyroid hormone influences this accumulation. It was suggested that the rate of operation of the Krebs cycle is controlled by the entry of metabolites through the pyruvic acid-oxidase complex to acetyl coenzyme A and through the condensing system or "citrogenase." There appears to be no real accumulation of metabolic citrate since the reactions of the Krebs cycle follow in sequence. If more citrate is produced in the cell, more is oxidized. The real consequence of increasing the flow through the bottleneck is a greater production of carbon dioxide.

As yet, there are not sufficient data to establish which of the two enzyme systems between pyruvate and citrate is the actual controlling factor. The fact that lactate, which accumulates in large amounts, is the major end product suggests that the crucial point in the sequence (the site of hormone action) is in the pyruvic acid-oxidase complex. Tentatively, it was proposed that an excess of parathyroid hormone induces an increased production of carbon dioxide from glucose or metabolites of glucose by cells in bone.

The appropriate research tools for making the next step toward understanding these destructive processes at the chemical level are now at hand and will undoubtedly be exploited with increased imagination and vigor by representatives of many fields of science.

Grateful acknowledgement is made to the National Institute of Dental Research for a grant which made it possible to invite a number of speakers from abroad to participate in this symposium.

For the next 4-year period (1963–66) Seymour Kreshover, scientific director of the National Institute of Dental Research, will serve as the new secretary of the Dentistry Section. Paul Boyle, dean, School of Dentistry, Western Reserve University, was elected vice president and chairman for the Cleveland meeting in December 1963.

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Evolution of Behavior

Evolution has a fascination for all biologists, for all scientists. Since it is the all-pervading concept of biology, every worker is able to categorize his findings, somehow, into an evolutionary framework. Thus a symposium entitled "The Evolution of Behavior" could become a *carte blanche* to its participants and might result in a disconcertingly diverse program. Such was not the case with the symposium organized by William Dilger (Cornell) and presented on 27 December at the Philadelphia meeting of the AAAS. Although the offerings were broad, the result was a coherent program.

Two general approaches were evident. The one most commonly used might be termed the functional orientation; the investigator decides upon an activity and seeks stages of its development within a systematic group. The objective is to reconstruct the evolution of the given activity by comparing existing forms; problems of convergence and direction of evolution are of little importance in such a first approximation.

In this way Richard Alexander (Michigan) followed the evolution of fertilization in arthropods. He started with a stage featuring synchronous release of gametes in water which was followed by an increasingly intimate association between a particular male and particular female. Later a spermatophore probably was deposited on the female by the male; copulation without a spermatophore would be the next and final stage of development.

Alexander's comments on the evolution of wings in insects in relation to the copulatory position should draw much attention. He suggested that the ancestral position is for the female to mount the male. The male, he further argued, developed scent glands on his back where the female would be exposed to them. The glands were protected by flaps, and still are, in extant species. Alexander contends that these flaps, originally courtship devices, subsequently developed into wings.

In the same vein George Barlow (Illinois) speculated on the evolution of parental care in fishes. The early lack of separation between sexual and parental activities was noted. In this stage overlapping broods occur, and the result is an unfavorable situation. Selection favored well-defined sexual and parental phases with increasing synchronization of the male's (the usual parent) activities to the physiology of the developing progeny. In some fishes the female remains after spawning and aids in parental care. This has led to specialization of roles; the male defends the territory and the female cares for the offspring. The ultimate stage is for one large male to defend an extensive territory that contains several small females in various phases of the reproductive cycle.

John Eisenberg (British Columbia) restricted his discussion chiefly to the heteromyid rodents. The main theme was the pervasive influence of moving into an open arid environment. In a large nocturnal rodent this usually results in bipedal, saltatory locomotion; it has been evolved independently in rodents at least five times. Concommitant modifications in morphology are appreciable and influence behavior, such as fighting and sandbathing. Within the Heteromyidae, sandbathing evidently originated as a territory-marking act. This developed into refined sandbathing after the invasion of arid regions; rodents living in such areas have a dense, fine pelage and an increased accumulation of sebum, which commits them to cleansing with sand.

The functional approach was also pursued by Richard Andrew (Yale). Rather than comparing species, however, he concentrated on developmental stages in the vocalization of the domesticated chicken. Chicks treated with testosterone were compared with controls. Testosterone facilitates all of the calls. Andrew speculated that primitively there may have been a simple alarm call. Eventually the call may have become largely restricted to the reproductive period by virtue of testosterone facilitation. The role of environmental differences in producing stereotyped displays was also mentioned.

Peter Marler (Berkeley) directed attention to the problem of species specificity. As such he was naturally interested in isolating mechanisms. The particular facet of the problem that he explored was diversity versus monotony in auditory signals of birds. This led smoothly into a discussion of the whole problem of variability in signals. Variation was categorized as intraindividual, interindividual, and interpopulational. Marler stressed that little sense can be made of such studies without considering the functional significance of such signals. Some sparrows, for instance, have but one territorial song, while some thrushes may have hundreds. The adaptive significance, he contends, can only be understood through combined field and laboratory investigations.

While the functional approach to the study of evolution predominated, one speaker, William Dilger, followed the more classical attitude by utilizing a strict taxonomic frame of reference. In the end, the functional-taxonomic dichotomy breaks down; it is mostly a matter of emphasis. The speakers reverberated between the two approaches. None of the functionally oriented participants operated out of a context exceeding the limits of a phylum; usually they discussed animals within a class or a lower taxon.

Dilger explored numerous trends within the parrot genus *Agapornis* and its close relatives. Among the significant changes in behavior are younger pairing, female dominance, reduction of sexual dimorphism, and increase in sexual diethism. The development of nest building is especially illuminating because of its general absence in parrots; most nest in cavities in trees. The different *Agapornis,* however, build nests to varying degrees. In the simplest form, nest material is tucked in feathers all over the body for transport to the nest site; a simple pad nest is built. In the advanced form, long strips of nest material are carried in the beak; a complex nest is built and refined building movements have evolved. Moreover, the species that tucks builds most of its life. The advanced species has peaks of building coinciding with egg laying and with parental care; this calls to mind Andrew's comments on the evolution of a restricted time for calling in birds, facilitated by changing testosterone levels.

The paper by Robert Ficken (Maryland) provided a broad overview of evolutionary phenomena in birds. Findings of the morphologists were intertwined with those of the ethologists. Birds are particularly suitable for such an analysis because their behavior is so accessible in the field. It was possible to cite examples of geographic clines though admittedly often dependent on morphological evidence. But Alexander and Eisenberg also brought out the reality of interpreting in a limited way the behavior of an animal as revealed by its morphology. Ficken discussed behavioral differences, however, that exist in the absence of readily perceptible morphological dissimilarities.

In summing up and integrating the symposium, Barlow urged the retention of at least one course in the systematics of an animal group in the training of ethologists who plan to study evolutionary phenomena. Also, ethology was seen as becoming a highly experimental discipline; while laudable, there is also the inherent danger that detailed comparative studies will be forsaken. Ethologists cherish the impetus that such comparative studies and field studies have provided for the recrudescence of interest in animal behavior. Actually, there remains a paucity of such investigations.

The symposium was presented jointly by the Division of Animal Behavior and Sociobiology of the American Society of Zoologists, and the Section of Animal Behavior and Sociobiology of the Ecological Society of America; it was cosponsored by the Psychology Section (I). Dilger briefly and informally introduced the symposium and presided over the afternoon session; Marler chaired the morning session.

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