ANNUAL REPORT
1968-1969

MUSEUM OF COMPARATIVE ZOOLOGY

The Agassiz Museum

HARVARD UNIVERSITY

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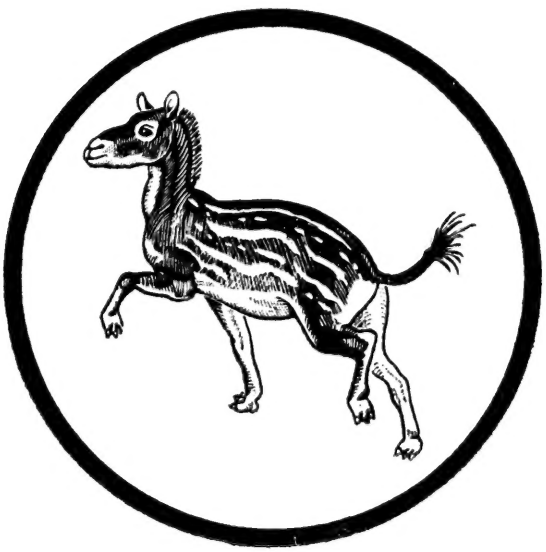

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HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS
1970

MUSEUM OF COMPARATIVE ZOOLOGY

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ROBERT RAKES SHROCK, PH.D., *Associate in Invertebrate Paleontology.*
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MUSEUM OF COMPARATIVE ZOOLOGY

Report of the Director

1968-1969

Science has been attacked in recent years for being the cause of the deterioration of our environment and our institutions. In its sweeping nature this is surely an unjustified attack. Why blame environmental, behavioral and evolutionary biology for the ravages caused by technology and the population explosion? Indeed, it requires precisely the know-how of this part of biology to understand the causes of our environmental ills and no adequate cure can be proposed until the causes are understood. University museums have a well established record of concern for these matters.

One of the reasons for the immense relevance of museum biology in today's world is that the modern systematist studies the diversity of nature in all of its aspects. Behavior, the relationship of the organism to its environment, the evolution of the organism and its traits, the genetic structure of populations and species—they all are part of the scope of his studies and all of these subjects are now in the limelight, owing to the individual American's concern with the quality of the environment and the future of the human species.

As a result, the work done in natural history museums has a far greater relevance to the most acute concerns of our age than does most of the work done in the experimental laboratories. The need to break down the barriers between the traditional disciplines is evident, and in keeping with this sentiment a recent report of the White House Office of

Science and Technology has recommended that the universities be encouraged to establish multidisciplinary "Schools of the Human Environment." The MCZ's *Center for Environmental and Behavioral Biology,* founded in 1967, is clearly in line with these suggestions.

In this, my final report as Director of the Museum of Comparative Zoology, it may be appropriate to present an overall view of the last eight years.

The MCZ has, in my opinion, changed in three major ways: its staff has become more professional in nature, resulting in higher scientific standards; teaching has received greater emphasis; and research has been increasingly directed toward the study of the living animal. These changes parallel the general public's heightened awareness of, and concern for, a growing imbalance of nature.

Perhaps the most interesting development at Harvard during the past academic year was the almost violently expressed wish of the undergraduate students to have more courses in behavior, ecology, anatomy, and physiology than the Biology Department has offered in recent years. Close collaboration between the MCZ and the Biology Department in fulfilling these wishes cannot help but be of considerable mutual advantage. The major outlines of a reorganization of the Department were worked out during the year which promise to implement this collaboration.

Even though the MCZ, as any other institution, is in constant flux, two policies are not likely to change in the foreseeable future. The first concerns the basic task of the Museum which is to study the diversity of living nature and its evolution—the mere accumulation of specimens and the mere description of new species is not our primary task even though a judicious enlargement of the collection in specialized areas greatly facilitates research, and the description of new species is often an inevitable prerequisite of a broad-scale revision, or of an even more ambitious evolutionary study.

A second major task of the MCZ is graduate and undergraduate instruction. Teaching occupies an increasingly larger portion of the time and attention of Museum personnel. This year we reached an all-time high in the number of graduate students (47), although many of them were in their last year and a level of 30-40 is more likely to prevail in future years.

The last eight years have been a period of transition in many respects. While many new projects were initiated, the economic situation was not particularly auspicious to bring all of our plans to fruition. Unquestionably, one of the most important developments was the acquisition of the Estabrook Woods together with the establishment of the Concord Field Station. Even though the field station has not yet been as active as we would like it to be, the magnificent Estabrook Woods was saved for ecological research in the nick of time. If we had postponed our action for one or two years, most of this land might well be in the hands of developers.

Much of the effort of the Director during recent years has been devoted to planning for the new wing and to raising funds for its construction. It is a striking fact that not one brick has been laid for expansion of the MCZ since 1889—a period of some eighty years during which the study of natural history has expanded and altered radically. Thanks to a number of generous grants and donations, which include $625,000 from the National Science Foundation, $500,000 from David Rockefeller, $250,000 from William Coolidge, $100,000 from Henry Shattuck, and $30,000 from Robert Goelet, as well as $500,000 from the Alexander Agassiz bequest, the financial goal is now sufficiently close so that architects have been authorized to start with the detailed planning. It is reasonably certain that ground will be broken before the end of 1970. The need for the new wing is urgent because it will not be possible to fill several vacancies among the Alexander Agassiz Professors until this

new facility is available. The new appointments, which may include specialists in behavior, population biology, environmental physiology, and biochemical evolution, will in turn permit us to broaden our course offerings and will enrich the intellectual atmosphere of the Museum. In making new appointments it has always been our policy to engage the best qualified individuals rather than to place priority upon filling certain specific positions.

Research in the MCZ, as documented in this and previous annual reports, reflects the modernization of systematic research. Classical alphataxonomy, as indispensable as it is, is increasingly supplemented not only by the application of new methods (such as computer analysis, behavioral studies, or protein analysis) but also by extending the purely taxonomic work into such areas as evolution, ecology, and behavior. It has been the aim of the MCZ to serve as one of the centers of excellence in this country, and although handicapped by inadequate facilities we have been reasonably successful in living up to this ideal. We can be proud of the excellent Ph.D.'s which we have produced over the last fifteen or twenty years and their increasingly important role in the scientific life of America. The quality of our staff and the hopefully not too distant availability of new modern facilities, as well as an increasingly close collaboration with the Biology Department, augur well for a promising future. It gives me great satisfaction to turn over the directorship of the MCZ to such an experienced and dynamic successor as is Professor A. W. Crompton, presently the Director of the Peabody Museum at Yale University.

This report gives me an opportunity to express my gratitude to all those who have helped me in my task. It would be difficult to find a more loyal and cooperative staff than that of the MCZ and one that is more single-mindedly dedicated to scientific productivity. My administrative assistant, Mrs. Marjorie Sturm, took a large portion of the administrative burdens off my shoulders and was a most

effective troubleshooter in all cases of emergency. I owe it to her efficiency and dedication that so much of my time was freed for research and teaching. And I thank the members of the Visiting Committees and the Friends of the MCZ, the latter group now totalling seventy-nine members, for their constant encouragement and their many-sided support.

ERNST MAYR, *Director*

STAFF

New staff appointments during this reporting year include: Julie Wattenberg, Cataloguer in the Library; Ronald Baird, Assistant to the Curator of Fishes; Jarmila Kukalová and Roy Albert Crowson, Alexander Agassiz Lecturers in Zoology; and José Fernando Bonaparte, Associate in Vertebrate Paleontology. Charles P. Lyman, Research Associate, was appointed Curator in Mammalogy. Elizabeth Pfohl, Editor of Publications, resigned in May of this year to be married, and Mrs. Penelope Lasnik, formerly a member of the library staff, has taken over the editorial duties.

Some of the more important awards and honors received by staff members include a Guggenheim Fellowship to Dr. Evans which (with additional assistance from the National Science Foundation) will permit him to spend the academic year 1969-1970 in Australia. Dr. Mayr received an honorary (Ph.D.) degree from the University of Munchen in Germany; he was Hans Gadow Lecturer at Cambridge University in England; and both he and Dr. Simpson were awarded the American Museum of Natural History's Centennial Gold Medals. Dr. Simpson also received the Wilbur Lucius Cross Medal of the Yale Graduate Association. Dr. Romer was elected a Foreign Member of the Royal Society (London), a Corresponding Member of the Senckenbergische Naturforschende Gesellschaft (Frankfurt), a Fellow of the Association for Tropical Biology, and an Honorary Member of the Society of Vertebrate Paleontology.

Staff members continued their cooperation with scientific organizations, national and international. New duties were assumed by Dr. Boss, who was appointed a member of the Advisory Committee on Mollusks for the Smithsonian Oceanographic Sorting Center; by Dr. Gould, who served as Secretary-Treasurer of the Harvard-Radcliffe chapter of Sigma Xi; and by Dr. Mayr, who was appointed chairman of the National Academy of Science's Committee on Ecological Research for the Interoceanic Canal (Panama). Dr. Lawrence was elected councilman of the Society for the Study of Coleoptera, and Dr. Mead was appointed a Trustee of the New England Aquarium. Dr. Levi was elected a councillor of the Society of Systematic Zoology and to membership on the Board of Advisors of the Organization of Tropical Studies.

TEACHING

Biology of the Invertebrates (Biology 10A) and Biology of the Vertebrates (Biology 10B) were again the most popular courses offered by the MCZ. Biology 10A was directed by Dr. Levi with Drs. Boss, Turner and Evans participating. Biology 10B was directed by Dr. Williams—Drs. Paynter, Mead, Lyman and Patterson gave lectures. Two new courses were given: Dr. Evans' Reproductive Behavior of Arthropods (Biology 252); and Dr. Paynter's Biology of Birds (Biology 145). Dr. Carpenter gave Biology of Insects (Biology 127). Dr. Mead, assisted by graduate students Baird and Gadgil, gave Biology of Fishes (Biology 130). Professor Patterson presented Vertebrate Paleontology (Geology 153) and Professor Mayr (with Dr. Gould) offered Principles of Evolutionary Biology (Biology 248) as well as individual lectures in Natural Science 5. Drs. Turner, Levi, and Williams organized freshman seminars and supervised undergraduate research. Dr. Darlington ran the Natural History Seminars.

Graduate courses in reading and research (Biology 320-340) were offered by Drs. Boss, Carpenter, Darlington, Evans, Fell, Gould, Kummel, B. Lawrence, J. Lawrence, Levi, Lyman, Mayr, Mead, Patterson, Paynter, Simpson, Turner, and Williams.

Museum staff members this year supervised the work of 47 graduate students:

Invertebrate Paleontology	8
Herpetology	8
Vertebrate Paleontology	7
Ichthyology	7
Arachnology	5
Ornithology	4
Entomology	3
Malacology	2
Marine Invertebrate Zoology	2
Mammalogy	1

The degree of Doctor of Philosophy was awarded to ten of these students: John Alcock (Dr. Mayr), *Discrimination Learning and Observation Learning by Birds;* Ronald C. Baird (Dr. Mead), *Systematics, Distribution and Zoogeography of the Marine Hatchetfishes (family Sternoptychidae);* Joseph Beatty (Dr. Levi), *The Spider Genus Ariadna in the Americas;* William Eberhard (Dr. Levi), *The Spider Uloborus Diversus (Uloboridae) and its Web;* Madhav Gadgil (Dr. Mead), *Life-History Strategies—A Theoretical Investigation;* Allen Greer (Dr. Williams), *Studies on the Systematics and Ecology of Scincid Lizards;* Michael H. Horn (Dr. Mead), *Systematics and Biology of the Stromateoid Fishes of the Genus Peprilus;* William Jerry Koch (Dr. Kummel—shared with R. Siever), *Lower Triassic Lithofocies of the Cordilleran Miogeosyncline in the Western U.S.;* Robert W. Matthews (Dr. Evans), *A Revision of the Genus Spathius in America North of Mexico (Hymenoptera,*

Braconidae); and William D. Sill (Prof. Patterson), *The Rhyncosaurs of South America.*

EXPEDITIONS AND TRAVELS

Staff and students pursued their quarry in many different parts of the world during the past year. In August Dr. Williams visited the Cordillera Central of the Dominican Republic, making ecological observations on the peculiar montane anole forms and collecting specimens for chromosomal study. Obtained also were several specimens of a new dwarf anole, related on the one hand to dwarf *Anolis occultus* of the mountains of Puerto Rico, and, on the other hand, to the much larger *A. darlingtoni* of the Massif de la Hotte in southwestern Haiti. In December, he flew to the Andes of Venezuela where he obtained ecological observations on *Anolis jacare* near Merida and live specimens for chromosome study.

Thomas Schoener, a graduate student of Dr. Williams, together with his wife Amy, a graduate student with Dr. Fell, spent three months in the Bahamas exploring the ecological interactions of *Anolis* species. The Bahamas afford the special phenomenon of the same three species in different combinations (and on one bank coexisting with a fourth congener). The niches of the several species do shift depending upon the number and primary ecological adaptations of the coexisting species. Amy's time was devoted to obtaining data on reproductive behavior and population dynamics of shallow-water tropical brittle-stars for comparison with corresponding data from the Woods Hole deep-sea transect. Her travels took her over several portions of the route followed by Columbus in 1492, including Fernandez Bay on San Salvador Island, now generally identified as the probable site of the first landing of Columbus. The islands of Micronesia attracted graduate student Ross Kiester where he spent three months rediscovering a

long overlooked species of the skink genus, *Sphenomorphus,* and a new species of *Emoia* as well as accumulating additional data on the distribution of other forms including the microdistributions of the two species of *Emoia* on Aru Atoll that tend to exclude each other on the islets of the atoll. Mexico was the site for graduate student William Hall's summer field work, where he collected primarily the iguanid lizard genus *Sceloporus* for chromosome study.

An old plantation house on the island of Dominica has, Dr. Darlington assures us, a well-deserved reputation as a Shangri-la. He and Mrs. Darlington spent five days there where, he reports, "The pace of life . . . was so slow that I was not able to put in full days of collecting." However, he did collect the two species of carabid beetles he wanted most, one being a scaritine of a genus he had never seen alive before which lives in the surface-soil of rain forest and seems to fill more or less the same ecologic role that *Scarites* fills in Puerto Rico. The other was a flightless *Colpodes* which he found in cover (but not in soil) on the ground in a rain forest somewhat higher up, at about 2500 ft. altitude, which is as high as anyone has ever found Carabidae on this island.

Dr. Evans spent the month of February in the U.S. Virgin Islands as part of a continuing study of the systematics and distribution of West Indian wasps. The observation and collection of fossil and Recent land snail *Cerion uva* drew Dr. Gould to Curacao in July. "*Cerion* is the major genus of West Indian land snails," he comments. "It is so diverse (and taxonomically confusing) in the areas of its abundance, that little can be done beyond cataloguing in amazement, but in the Dutch West Indies a single species inhabits a variety of ecological situations on three islands. This provides an excellent case study for assessing the influences of climate and isolation on variation in this genus. With this information in hand we may better be able to understand its variation elsewhere."

Dr. Kummel and Dr. Curt Teichert of the University of

Kansas travelled to the Permian and Triassic formations of Kashmir. In the Guryul Ravine section, a classical area in Kashmir geology, they were excited to find what they consider a true mixed fauna of Triassic elements (pelecypod genus *Claraia*) and Permian brachiopods of various genera. Reworking as an explanation of this faunal assemblage is regarded as impossible.

Stewart Peck, a graduate student in Entomology, returned in September from an extensive field trip covering various parts of the southeastern and midwestern U.S. making use of berlese funnels to collect numerous soil and litter arthropods. Another graduate student, Thomas Hlavac, spent several weeks in Puerto Rico searching for endemic scaritine carabid beetles.

Field work in Africa occupied graduate students Vincent Maglio and Anna Behrensmeyer during October and November. The objectives of the work—to refine and complete preliminary mapping begun in 1967 and to follow up the previous collecting of fossils—were successfully carried out. A number of interesting specimens, particularly elephants, were obtained. During the summer graduate students Craig Wood and Miss Behrensmeyer continued work begun last year in Paleocene deposits at Shotgun Butte, Wyoming. A large collection of small mammalian and other vertebrate remains were obtained. A very peculiar feature of this deposit is the high proportion of teeth of small sharks in the faunal assemblage.

A visit to Peru in November offered Dr. Paynter the opportunity to observe a varied sample of the avifauna from that of the highest "puno" region of the Andes, at 15,000 feet, down to the tropical zone of the Amazon slope and the arid coastal zone on the Pacific. The guano islands off the coast were also visited. While this was not a collecting trip, Dr. Paynter did obtain a representative sample of seabird skeletons which were found in abundance along the coast.

The Wichita redbeds of North Texas have been for nearly

a century the main source of specimens of vertebrates from the early Permian, but the boundaries between the six formations included in the group have never been mapped and the faunal succession could not be accurately established. In default of such work by the geologists, Dr. Romer decided that he would do it himself, and with Mrs. Romer as field assistant, he has devoted some time to this project for the past six years. With the aid of numerous far-ranging sandstone layers and a check from abundant subsurface logs, the task has been completed and the six formation boundaries have been mapped from the marine beds farther south to the Red River on the north or to the overlying Cretaceous on the east. As a result all specimens collected here can now be accurately located in the stratigraphic succession.

Mr. Schevill spent three months searching for cetaceans in southern South American waters. During the first two months, November and December, he cruised from Valparaiso to Cape Horn, mostly in the Chileno fjords, jointly with Professor K. S. Norris of the University of California, using the National Science Foundation ship *Hero* on her first commission. Underwater sounds and photographs were taken and specimens deposited in the Smithsonian Marine Mammal Study Center. In December and January Mr. Schevill, accompanied by his wife, Barbara Lawrence, worked in coastal and estuarine waters in and near Rio de la Plata, and succeeded in finding *Pontoporia blainvillei.*

Another staff member who ranged far afield was Dr. Simpson who travelled extensively in Australia visiting fossil mammal localities and observing living animals. He also drove across much of both major islands of New Zealand, where visits to fossil and recent penguin sites were included.

Many members of the staff also traveled to museums, conferences, and other universities in connection with their research. Dr. Boss attended the Third European Malacological Congress in Vienna and while in Europe worked at the natural history museums in Amsterdam, Leiden, London,

and Vienna. Dr. Turner visited Washington, D.C., to participate in a panel meeting of the American Society of Mechanical Engineers on biodeterioration. She worked frequently at the Nahant Laboratory of Northeastern University and conducted field studies at La Parguera, Puerto Rico.

Dr. Kummel visited the British Museum of Natural History, the Geological Institute of Amsterdam University (where he arranged the loan of an important suite of Triassic ammonoids from Timor), the Geological Institute of Copenhagen University, and the Austrian Geological Survey, in Vienna. Dr. Gould delivered a lecture at the University of Rochester on the evolution of Bermudian land snails in December and at the United States National Museum in June, the topic being growth and form in systematics. In April Dr. Levi presented a lecture at the University of Tennessee.

Professor Patterson visited museums in England, Kenya, and South Africa in connection with work on the Museum's African collections, and gave lectures at Princeton University and at the University of Illinois.

RESEARCH

To the layman, biological research may often appear to be of a complex and impractical nature unrelated to the problems of everyday life. One of the reasons for this impression may be a lack of interpretative language in scientific reporting; another factor may be the nonprofessional's lack of understanding of the implications and applications of certain research projects. What may appear to be an impractical and esoteric study of the life history of a starfish in a remote ocean may become of crucial importance for the saving of coral reefs throughout the Pacific. A scientist's careful study of fossil elephants takes on added meaning when it leads to a more precise dating of the hominid scraps found in conjunction with these bones. And even a study of an unlikely

skink could provide a key to the explanation of puzzling phenomena of the transmitter of human variation, the chromosome.

This year's report of research contains many instances of especially pertinent investigation. One example is Dr. Levi's study of a common house spider. He has long been interested in the effect of spider bites, particularly of black widows (*Latrodectus*) and *Loxosceles.* He has now found evidence, in work done with Dr. Andrew Spielman from the Harvard School of Public Health, that bites of a common house spider, *Chiracanthium mildei,* might cause necrotic lesions. This species was introduced in the 1940s from the Mediterranean region where it is rare and has no contact with man. In the twenty years since its introduction it has become the most common North American house spider, distributed from coast to coast. It has been shown to be poisonous, causing necrotic lesions in experiments with guinea pigs, but its implication in the causation of necrotic lesions in man is as yet indirect. In the genus *Phidippus* of jumping spiders, Lawrence Pinter, a graduate student, found one species in southern California, and several of them were collected after biting humans.

In studying the degree of range contractions of large North American mammals during settlement of the land by nineteenth century immigrants, Dr. Fell has been able to point to man as responsible for a similar pattern of extinction during the late Pleistocene. A new insight on fossil insects was provided by Dr. Carpenter's study, which reveals that primitive nymphs very likely made use of their wings, a feature lacking in the modern insect. Conservationists and commercial interests alike will take note of Dr. Turner's study of marine wood-boring mollusks such as the shipworm, and her study of marine fouling mollusks. Finally, Dr. Matthews is engaged in studying the little known genus of wasps, *Spathius,* that attacks bark beetles harmful to valuable conifers.

Research does not always entail field expeditions and microscopic examinations of subject matter. Reassessments of data, such as Dr. Mayr's and Dr. Short's analysis of species taxa for birds, are necessary to ascertain the continuing validity of basic systems of classification. Many of the staff have been engaged in publishing ventures; much of Dr. Paynter's time this past year was given over to the editing and reading of proof for volume 14 of Peters' *Check-list of Birds of the World.* Staff members have also participated in committees studying far-ranging problems, such as Dr. Mayr's chairmanship of the National Academy's Committee on Ecological Research for the Interoceanic Canal, which is studying the potential effects on marine floras and faunas of a sea-level canal across the Isthmus of Panama.

Evolution

Rather than concentrating on the reconstruction of phylogenies as in former periods, evolutionists now turn increasingly toward the study of the relation between the environment and evolutionary adaptations. Dr. Williams in his studies of lizards found that if the genus *Anolis* is represented in a given region by only a single species, that species will be similar in size, morphology, and ecology to species in other districts that are likewise the single representatives of the genus in their area of occurrence. This is true for *Anolis jacare* of the Andes of Merida in Venezuela, which is quite similar to solitary species on the islands of the Lesser Antilles, which can be shown to be only distantly related (by the study of the chromosome pattern). Thomas Schoener had previously found that these solitary Lesser Antillian species had converged strikingly in size, even though derived from two quite distinct phyletic stocks and occurring on islands of quite different size. The nature of the selection pressures responsible for this convergence are only dimly apparent.

Dr. Levi found that orb-weaving spiders of the *Araneus diadematus* group that live in meadows have an oval abdomen, while the species that live in forests or on rocks have humps. This correlation holds true for the American as well as for the European species. It is not yet clear what the adaptive value of the humps might be.

Dr. Gould continued his work on land snails of the genera *Cerion* and *Tudora* in the Dutch West Indies. The growth pattern of local populations is clearly influenced by the nature of the substrate (limestone versus non-limestone), vegetation, tradewind exposure, and distance from the coast. Pleistocene fossils are quite different from modern shells, and elucidation of the current environmental correlates should permit an assessment of Pleistocene climates in the Dutch West Indies.

Adaptive radiation can be found at every level. Graduate student Thomas Hlavac, working with Professor Darlington, showed this to be true for the three species of the endemic carabid beetle sub-genus *Antilliscaris* (*Scarites*) from Puerto Rico. Two of the species are rather small, but the third is by far the largest carabid in the West Indies, and has also acquired a number of structural peculiarities. The ancestor of this group apparently invaded the rain forest floors of Puerto Rico a long time ago (perhaps shifting from a water-edge habitat) and has radiated on the island in the rain forest habitat.

Dr. Gould completed a lengthy review article on "Paleontology and the Science of Form" in which he argues that it is necessary to add a mechanical-functional approach toward organic form to the usual quantitative methods in order to provide a full explanation of observed changes in fossil structures. He also completed a study on correlation patterns in the molar teeth of insectivores and rodents. The multivariate techniques of factor analysis and morphological integration were used to detect various levels of integration that produce characteristic patterns of correlation. Patterns

for the two groups are quite similar. General factors influence teeth as secondary results of general increase in body size. Special factors are reflected in the higher variability of the third (last) molar and in its negative interaction with the anterior molars. Since it forms last in embryogenesis, we can attribute the negative response of this molar to the fact that it must occupy whatever space remains after the anterior molars form.

William Hall continued his study of chromosomal patterns in Iguanid lizards, further documenting the considerable karyotype variation in this family. As a result of his Mexican trip, Mr. Hall was able to obtain karyotype data on all but one of the sceloporine genera, and on about 75 per cent of *Sceloporus* species. In the karyotypically very variable genus *Sceloporus* the most exciting finding was the discovery of a surprisingly complex pattern of intraspecific chromosomal variation in the widespread species *Sceloporus grammicus*. Besides populations with a primitive karyotype, he found populations homozygous for fissions of either the smallest or the two smallest macrochromosome pairs. A study of the contact area between one homozygous fission population and an ancestral population in the Valley of Mexico revealed a zone with fission heterozygotes which, however, proved not to be hybrids between the two adjacent homozygous fission populations, but heterozygotes for a third fission type—fissioning of the largest macrochromosome pair, not the smallest. Further field work is planned in an attempt to explain this puzzling situation.

New light on several aspects of the evolution of man is cast by the working up of the rich fossil collections which Professor Patterson made in recent years in East Africa. Thanks to the recent establishment of a large sedimentary sequence at Omo in southwestern Ethiopia, which overlaps Olduvai at the top and extends down at the bottom to deposits dated around four million years, it is now possible to correlate the faunas of the two most important localities in

northwestern Kenya explored by the Museum. The material of elephants and fossil pigs obtained by the expeditions is particularly rich. Studies of these two groups by a graduate student, Vincent Maglio, and by others reveal that the Kanapoi site is approximately equivalent in age to the base of the Omo sequence and that it is late Pliocene rather than early Pleistocene. The lower beds at Lothagam Hill (also northwestern Kenya) are earlier and carry the sequence still further back into the Pliocene.

Mr. Maglio visited most of the museums with relevant material of fossil elephants which gave him the opportunity of examining nearly all known specimens that bear on the origin and early evolution of this family. He has been able to reconstruct the course and determine the rate of evolution in several lineages of the family with the very important result that it is now possible to utilize extinct elephants for the purposes of stratigraphic correlation in a much more satisfactory manner than has hitherto been possible. The importance of this for correlating deposits containing hominid remains needs no stressing. It now appears that the hominid scraps obtained by the expeditions at Kanapoi and Lothagam Hill are of late Pliocene age and hence represent the earliest known members of our family apart from the late Miocene *Ramapithecus.*

Extinction. One of the most prominent and yet least understood phenomena of evolution is extinction. Perhaps 99.99 per cent of all phyletic lines of the past have disappeared. In addition to steadily continuing extinction, the paleontologists have discovered several periods of mass extinction in the history of life. Among these, that between the Permian and Triassic systems is one of the most significant episodes. Dr. Kummel has studied it for many years and has attempted to record in detail the steps by which the Permian faunas became extinct and the subsequent diversification of faunas in the Triassic developed. To secure these data, Dr. Kummel, in collaboration with Dr. Curt

Teichert of the University of Kansas, attempted to visit all the areas in the world where the boundary between these two geological eras is exposed. Critical field studies were made in the Salt Range of West Pakistan, the Kap Stosch area of east Greenland, Kashmir, and the Djulfa region of northwest Iran. Political conditions prevented visits to the only other two critical areas known, which are situated in Kwangsi province of South China and a region of northern Nepal. Although it is still an unsolved puzzle what factors were responsible for the collapse of the Permian fauna, these studies are now making it possible to reconstruct in great detail the various stages of the subsequent replacement.

It is apparent that a small, homogeneous and thoroughly cosmopolitan fauna survived the catastrophic extinction of the late Permian. The number of taxa gradually increased in the ensuing period, and with it occurred a gradual differentiation of faunas in various distinct faunal provinces. As a result there is a striking contrast between the homogeneity of the earliest Scythian (Lower Triassic) faunas with the latest Scythian pattern of ammonoid distribution which presents a faunal radiation from the Tethys to the circumarctic region.

Dr. Gould was able to determine why certain species of large endemic Bermudian snails (*Poecilozonites*) became extinct during the Pleistocene. The clue was provided by a study of microgastropods (very small snails). Analyzing the distribution of fifteen species (three of them new to Bermuda) he found that they are good indicators of habitat and climate. Dr. Gould discovered that the extinct large species *Poecilozonites cupula* and *P. nelsoni* are found only in association with those species of small snails which are indicative of cool and moist climates. It is not surprising that the large snails became extinct during an interglacial period when the sea level stood twenty meters higher than

at present and a warm and dry environment was associated with intense dune building.

Dr. Fell reconstructed the chronology of range contraction of large North American mammals through four centuries of expanding European colonization. He found that the pattern of extinction during this historical period was of essentially the same character and magnitude as the late Pleistocene extinctions of large mammals and birds and concluded therefore that P. S. Martin has a very good case when attributing the large-scale Pleistocene extinctions to the activity of primitive man, rather than to climatic factors. This is in contrast to the situation with the invertebrates of North America, in which the maximum degree of extinctions seems to coincide with the rapid deterioration of the climate at the end of the Pliocene. That man rather than climate is largely responsible for the extinction of large warm-blooded vertebrates is confirmed by a study of New Zealand fauna. Dr. Fell points out that a terrestrial fauna of giant birds on this island had successfully survived four or five glacial periods with intervening sub-tropical stages. The glaciation resulted in some of the most severe climatic jolts suffered by any fauna, for the insular fauna had no escape route to warmer territories, as did continental faunas, and the species were obliged to remain within a narrow range of latitudes. The effect of the climatic deterioration on the invertebrates was felt as soon as the Pleistocene began when the sub-tropical forms disappeared. The avifauna did not begin to suffer extinction until after the arrival of man, about two thousand years ago, and by the end of the eighteenth century all the large land birds had disappeared. The sequence of events clearly points to man as the agent responsible for the extinction, for it is inconceivable that the minor climatic changes known to have occurred within the last two thousand years should have had a greater effect than the drastic alternation of glacial and interglacial periods during the entire Pleistocene.

Faunal History

The refinement of taxonomic analysis makes it increasingly possible to reconstruct faunal histories. Dr. Darlington finds that the New Guinea fauna of carabid beetles is perhaps three-fifths Oriental and two-fifths Australian in present relationships, but that as far as ultimate derivation is concerned, it is even more strongly Oriental than indicated by present relationships. Apparently there has been a continual movement of carabids toward Australia, much more than in the reverse direction. In some groups, extinction seems to have begun at the Asian end of the line and proceeded toward Australia, leaving isolated relicts in Australia.

Mr. R. I. Johnson undertook a thorough geographic analysis of the fresh-water bivalves (Unionidae) of the peninsula of Florida and adjacent Apalachicolan region. During the early Pleistocene virtually the entire Floridian peninsula was covered by sea, except for a few islands in the vicinity of Polk County. One of the two endemic species of Florida may have persisted here since the Pliocene. Most of the other unionids have repopulated Florida from the west. These are either endemic to the Apalachicolan region or came from still further west. Two species come from the Atlantic slope region.

Dr. Fell continued his study of the structure and dynamics of faunas and their dispersion under the environmental influences of the rotating earth. Particular factors studied during the past year include temperature effects, the diversity of the environment, the density of faunas, extinction rates, and dispersion rates.

In studying the echinoderm faunas of various southern islands, associates of Dr. Fell have found additional evidence for the apparent resettlement of tropical and subtropical elements on isolated islands where they must have almost certainly become extinct during the cold stages of

the Pleistocene. Dr. Sylvia Earle's collections from Juan Fernandez yielded a new species of the sub-tropical sea urchin *Centrostephanus,* its closest relative being apparently the species which occurs in New Zealand and Australia. This matter, now under closer study by Julian Fell, seems to provide evidence for one of the longest open ocean drift transfers of any echinoid, for it is obvious that no land bridge route could have been open during the late Pleistocene in this part of the South Pacific. Further confirmation of this theory was provided during the year when word was received from colleagues in New Zealand that a natural raft had been sighted passing through Cook Strait. It was pursued by boat and found to comprise a structure about fifty feet long, of twisted giant brown seaweed of two genera, carrying a cargo of sponges, other species of seaweed, a cloud of fishes swimming underneath and, of particular interest, bottom-dwelling invertebrates, indicating that the structure had developed on the sea floor before breaking loose. The speed was reported to be about two knots.

Systematics

Faulty classifications have been the reasons for much error in phylogeny, zoogeography, ecology, and indeed in all sciences which try to describe and explain the diversity of living nature. The basic unit of classification is the species and it is of special importance that this standard component of a classification be particularly well-defined and delimited. The question is sometimes raised whether species are really such an important unit, indeed whether there is such a unit as species, or whether the local population is the only meaningful unit on which to base classifications. To answer this question as it pertains to birds, Dr. Mayr, in collaboration with Dr. Lester Short of the American Museum of Natural History in New York, investigated the species structure of North American birds. They found that 92.4 per cent of the

606 species of North American birds were as well-defined and easily delimited as is usually claimed. Only 46 have geographic races that are sufficiently distinct to cause specialists to disagree as to whether they should be considered species or sub-species. Many North American birds belong to widespread superspecies, and if they are included in the analysis, only about 80 per cent of the North American species are unambiguously delimited. Phenotypically very similar pairs of species (sibling species) are much rarer among birds than among almost any other group of organisms. Only twenty-five species of North American birds are sufficiently similar to a previously described species to have caused them to be temporarily overlooked. Yet, all but three of these species were described more than 100 years ago. The three exceptions are two Empidonax flycatchers and an Arctic gull. Polymorphism has only rarely been a source of confusion in bird taxonomy. In North America it has caused disagreement only with respect to the Great White Heron (a morph of the Great Blue Heron) and the Snow Goose (a morph of the Blue Goose). In short, this analysis confirms that species taxa are indeed remarkably well delimited in birds, and only rarely give rise to argument.

Precision in species delimitation has been far less advanced for mollusks, as was shown by Dr. Boss in a detailed analysis. This has resulted in considerable divergence of opinion concerning the number of living species of mollusks —recent estimates have ranged from 40,000 to 150,000, with a figure of 107,000 most recently given. Dr. Boss began to assess the reliability of these figures by conducting an analysis of the most recent and thorough revisions of families and genera. This analysis revealed that in well-studied, monographed groups, each real species has been named at least five different times. This ratio is vastly increased in some highly variable land and freshwater forms where individual species have been named two hundred times

over. Supplementing this information by a faunistic analysis confirmed drastically lower figures. Thus, the marine fauna of shelled mollusks of the eastern Atlantic Province including the coasts of Europe and much of western Africa numbers some 1,500 species, while that of the entire eastern Pacific-western Atlantic Province contains around 7,000 species. With fewer than 10,000 marine species in two of the most extensive ocean provinces, the estimates of species number exceeding 100,000 become untenable. Marine species considerably outnumber the species of land snails. In the most complete treatise, Pilsbry's *Manual of Conchology*, 11,000 species are treated, but many of these are rare, being based on isolated colonies which, as modern studies have revealed, are at most subspecies. Thus, various lines of evidence indicate that the total number of mollusk species is far smaller than usually claimed, presumably being rather close to 50,000.

Significant advances in animal classification were made by many members of the staff and their students. Graduate student Allen Greer continued his studies of the systematics of lygosomine skinks. Utilizing skull characters, he demonstrated that several species traditionally placed in the genus *Dasia* actually belong to three distinct taxa, each worthy of generic rank. As usual, as soon as the species are regrouped on the basis of the morphological characters, other characters fall into place. *Dasia,* as redefined, is now restricted to southern Asia, west of Wallace's Line, and is almost unique among skinks in that the young are brightly cross-banded with silver or orange alternating with black. This banding, whose function is unknown, is entirely lost in the adults, except in one species. Slowness of movement is another peculiarity of this genus. Three of the four species of the other two genera are Bornean endemics while one of them, *Lamprolepis smaragdina,* is widespread in the Indo-Australian region and strikingly polymorphic in coloration in many places.

Dr. Levi continued his revision of the American orb-weaving spiders. He spent one month at the British Museum illustrating 180 types of American species and the types of about twenty genera. Considering how increasingly often orb-weavers are used for behavior studies, it is particularly important to place their taxonomy on a firm foundation. Mygalomorph spiders are commonly considered a tropical group, but the antrodiaetid trapdoor spiders are a temperate zone family endemic to North America and northeastern Asia. This family was monographed by graduate student Frederick Coyle as part of his thesis research. One of the spiders is found as far north as southern Alaska.

Dr. Clench completed a monograph of the genus *Spirodon* in the freshwater mollusk family Pleuroceridae. This is one of the two genera of this family which have managed to reach the rivers draining directly into the Atlantic between the Connecticut River in New England and the St. Johns River in Florida. Most other species are found in the numerous tributaries of the Mississippi River system and the rivers entering the Gulf of Mexico.

Dr. Boss has continued his studies of clams of the family Vesicomyidae. These are members of the interesting archibenthal fauna which lives on the ocean floor between the edge of the continental shelf and the abyssal plain. These deep-water animals have adapted to a unique niche in the marine ecosystem. Several unusual species which might be called deep-sea quahogs frequent depths beyond 500 meters. Vesicomyid clams are unusual in their shell structure. Dr. Boss is collaborating with Dr. Jean Jacques Oberling of Bern, Switzerland, in the study of the microscopic structure of the shells of the genus *Calyptogena.* Previously, tentative classifications of these organisms placed the genus in close conjunction with primitive heterodont bivalves such as the Carditidae. Our recent studies have shown that the shell microstructure and gross comparative anatomy of *Calyptogena* contraindicate previous familial allocations. The

thick, chalky valves of this clam show, in their ultrastructure, crystallographic features which resemble those of the shallow-water Veneridae. Red coloration of the gills in some vesicomyids suggests the presence of hemoglobin and may thus represent a further example of convergent adaption in mollusks that live in an oxygen-poor habitat. Cooperation with Japanese, Russian, and other deep-sea biologists has provided enough data to document the widespread occurrence of *Calyptogena* in the Recent fauna and to recognize the Tertiary lineages of the modern species.

The anoline lizard species *onca* has always been separated in a monotypic genus (*Tropidodactylus*) because it has narrow keeled scales under the toes instead of expanded adhesive pads on the phalanges ii and iii as do typical anoles. Now Dr. E. E. Williams has found a new species from the Lake Maracaibo region of Venezuela which is intermediate between *Tropidodactylus* and typical *Anolis*. It has adhesive lamellae under phalanx ii, but keeled scales under phalanx iii. The karyotype of this species, investigated by George Gorman, is quite typical of one of the two major lineages within *Anolis*.

Paleontological research was advanced on many fronts during the past year. Dr. Romer continued his study of the fossil reptile material from the Chañares Triassic beds of Argentina. This included work on the crania of two cynodonts belonging to the family Chiniquodontidae, most advanced of adequately known carnivorous members of this group. One of these new forms, which may be close to the actual line leading to mammals, is of especial interest in that it, alone of all cynodonts, shows, in addition to the primary jaw articulation of quadrate with articular, a definite articulation between the squamosal bone of the skull and the dentary bone of the lower jaw. This characteristic foreshadows the diagnostic mammalian condition in which the primitive quadrate-articular joint (still persisting here)

was abandoned in favor of the articulation of squamosal and dentary.

The African aardvarks, Tubulidentata, constitute one of the more peculiar and isolated of mammalian orders, which has usually been regarded as including only one evolutionary lineage. Remains of a new genus collected at Lothagam Hill, the most generalized member of the group so far found, has led Professor Patterson to review the order. He concludes that there were four lineages, the most peculiar of which is represented by *Plesiorycteropus* from the late Pleistocene of Madagascar.

Dr. Simpson continued his studies of fossil penguins, utilizing a visit to Australia and New Zealand to examine material in several museums. Fossil penguins are known mostly from the Miocene epoch of Australia, New Zealand, Patagonia, and Seymour Island (off southern South America, but not, as usually misstated, in the Antarctic). Oddly enough, none of these forms are clearly ancestral to living penguins. They indicate a remarkable adaptive radiation, most of the members of which eventually became extinct and were replaced by a later radiation. Of the Miocene forms, the least known are those from Australia and Dr. Simpson was particularly grateful for being able to study a number of previously undescribed specimens in the National Museum of Victoria. He also assembled data for a complete revision of the relatively abundant and well-preserved New Zealand specimens.

Marsupials went through two largely, or in all probability, entirely independent evolutionary radiations in South America and Australia. Dr. Simpson has completed studies of the South American forms as far as he had planned. Information on the Australian forms is increasing to a remarkable extent, with a good sequence of fossils now extending from late Oligocene onward, and with rich new data on biochemical, karyological, and behavioral characters of living forms. Thanks to the generous cooperation of Australian colleagues

in the proliferating universities and other institutions, Dr. Simpson was enabled to get a good idea of this mass of new data, mostly still unpublished, for incorporation into a general review of marsupial evolution. This affords much insight into the principles and course of mammalian, including human, evolution in general.

Graduate students in Invertebrate Paleontology are working on several monographs in various stages of completion. James Sprinkle continued his examination of the higher taxa of attached echinoderms. He now believes that the old grouping "Pelmatozoa" should be split into two separate evolutionary lineages at the sub-phylum level. Mr. Sprinkle continues his exciting discoveries in the world of early echinoderms and has even added a new class to the burgeoning list of higher taxa.

This has been a year of important discoveries in the field of fossil insects. Professor Carpenter has concentrated on insects from the Upper Carboniferous, most of which were in nodules from the Mazon Creek area in Illinois. The strip mining operations in Grundy County have resulted in extensive dumps consisting of soft matrix with many ironstone concretions, most of which contain fossils, although insects are very rare. Recent years have seen a very active group of amateur fossil collectors in the Chicago area gather a surprisingly large number of specimens of insects (about 200) preserved in the nodules. Through the kindness of Dr. Eugene Richardson of the Field Museum, several of these collections have been made available to Professor Carpenter for study. Mr. and Mrs. Walter Dabasinskas, Mr. and Mrs. Ted Piecko, Mr. Jerry Herdina, Mr. and Mrs. Lincoln Douglass and David Douglass have been especially cooperative in sending him for study a series of most remarkable fossils which have contributed greatly to our understanding of insect evolution. Of special significance are the nymphs of Megasecoptera (genus *Mischoptera*), these being the first immature forms which can definitely be associated with

any Megasecoptera. The nymphs are unique in having the wing pads project laterally from the thorax, not positioned longitudinally along the thorax, as in all other nymphs. This difference strongly suggests that in the primitive winged insects, the developing wings may have had some dynamic functions in the nymphal stages. Among the other insects preserved in the nodules is the first definite nymph of a paleodictyopteron; its wing pads are positioned similar to the megasecopterous nymphs already mentioned.

Professor Carpenter has also continued his investigations of Permian insects from Kansas, concentrating on very minute forms (wing expanse only about five mm) related to those that have previously been found in the Permian of the Soviet Union and that have been considered the oldest members of the order Embioptera (web-spinners). He is now convinced that these Permian insects are not related to the Embioptera but are definitely members of the extinct order Protorthoptera.

During the year an exciting discovery of Jurassic insects in Antarctica (Carapace Nunatak) was made by Professors Borns and Hall of the University of Maine, in a program of Antarctic research sponsored by the National Science Foundation. The specimens have been turned over to Professor Carpenter for study; one of them turned out to be a true dragonfly belonging to a suborder (Anisozygoptera) that is now extinct except for two isolated species. The Antarctic dragonfly belongs to the extinct family Liassophlebiidae, which has been previously known from Jurassic deposits in England and the Soviet Union.

Dr. Jarmila Kukalová, of the Faculty of Geology, Charles University, Prague, has carried out extensive research in Professor Carpenter's laboratory during the year, under a grant to him from the National Science Foundation and an Alexander Agassiz Lectureship appointment at the MCZ for the spring term. She completed an important study on the morphology and systematics of the species of Palaeodicyop-

tera from the Upper Carboniferous shales in France. Through the use of special techniques she has discovered many morphological details not previously observed in these insects, and demonstrated an entirely unsuspected diversity of form. Even though the Palaeodictyoptera turn out to have had well developed sucking mouthparts they are not related to any of the Recent insect orders with similar structures, being actually palaeopterous insects related to mayflies. Dr. Kukalová has also completed and published an account of Permian mayfly nymphs, based on specimens from Oklahoma and Moravia. Her studies show that most of the mayfly nymphs of that period had wings developing in an oblique-lateral position, as in the Megasecoptera and Palaeodictyoptera, a fact that has added support to the conclusion that the wings of the primitive flying insects developed in that manner. She has also shown that the tracheal gills of Permian mayfly nymphs are as well developed as in Recent types and also that they had more of them; on the other hand, the Permian nymphs had walking legs instead of swimming legs.

Dr. Evans is describing three fossil wasps from the Cretaceous period which came to him from diverse sources. Previously the only known wasp from prior to the Tertiary had been a problematic wing from the mid-Cretaceous of Russia. The three new specimens are all very clearly wasps. One, of somewhat doubtful position, from the early Cretaceous, is probably a sphecid (digger wasp). Two from Canadian amber, of the lower part of the Upper Cretaceous, are very similar to modern wasps of specialized groups. It is now clear that the wasps radiated greatly in the Cretaceous, thus setting the stage for the evolution of several groups derived from wasps: the ants (already known from the mid-Cretaceous) and the bees (assumed to have evolved concurrently with the flowering plants in the Cretaceous but unrepresented in the fossil record before the Oligocene).

Ecology

The relation of organisms to their environment has been studied by various members of the staff and graduate students. Dr. Turner has continued her studies on the life history and ecology of the marine wood-boring mollusks found in Puerto Rico and Florida. Special attention was given to the development of new techniques for the rearing of larvae and for observing their behavior during settlement and metamorphosis. She found that a free-living ciliate could be a serious predator of the veliger larvae. One of these protozoans had four teredo larvae in its "gut." It is quite probable that such predators and parasites have a controlling effect on the frequency of shipworms. For instance, the turbellarian *Taenioplana teredini* is a predator of metamorphosed shipworms in wood. Dr. Turner also discovered that the presence of large numbers of ciliates in the mantle cavity of adult teredinids has a deleterious effect on the developing young of larviparous species. Since these predators are certainly detrimental to laboratory cultures, they may have a similar effect in nature, which may explain the great fluctuations noted in some of the natural populations.

Employing techniques and equipment similar to that used for the study of marine boring organisms, Dr. Turner has now begun research on marine fouling mollusks, primarily at the Marine Science Institute at Nahant, Massachusetts. The study will be divided into three general phases, all of which will be investigated simultaneously: 1) preparation of a handbook of fouling mollusks of the world, including synonymies, distributional records, ecological notes and illustrations; 2) life history studies and larval ecology of as many species as possible; 3) study of factors affecting development and settlement, the importance of the primary microbial film, and the exposure of larvae to various treated surfaces. Some of this work will be done in cooperation with

Sphecomyrma freyi Wilson & Brown. Photograph of holotype, preserved in Cretaceous amber from Cliffwood Beach, New Jersey. The two known specimens of this ant have been given to the Museum by Mrs. Frey.

Peter with stuffed animals

Peter relaxing in salad bowl

Dr. Ralph Mitchell, Assistant Professor of Applied Microbiology at Harvard University.

Dr. Boss has carried out studies of *Odostomia,* a genus of marine gastropods of the Pyramidellidae, a family which is largely ectoparasitic. The literature has contained conflicting opinions regarding whether or not pyramidellids are host-specific. The discovery of great numbers of *Odostomia bisuturalis* Say in the tidal flats behind Duxbury Beach, Massachusetts, provided an opportunity to observe the behavior of the snails under natural conditions. In laboratory experiments Dr. Boss showed that *O. bisuturalis* might select a range of hosts rather than be restricted or limited to the American oyster, *Crassostrea virginica* (Gmelin). However, evidence for non-specificity under natural conditions were lacking until Robert Bullock, a graduate student in the department, and Dr. Boss collected *O. bisuturalis* on six different species of mollusks at Duxbury Beach in early June. The small snails were found in association with the periwinkle (*Littorina littorea*), the mud snails (*Nassarius obsoletus* and *trivittatus*), a slipper limpet (*Crepidula convexa*), the oyster drill (*Urosalpinx cinerea*), and the edible mussel (*Mytilus edulis*). In addition, the ectoparasites were taken on sand collars or egg cases of the snail *Polynices* (*Lunatia*) *heros.* Thus, in one field observation the non-specific nature of the behavior of *O. bisuturalis* was established, and several new host records were recorded. However, what is true for *O. bisuturalis* may not be the case for other pyramidellids and continued, more extensive, studies of the behavior of these animals promise further discoveries.

Dr. Matthews completed a revision of the genus *Spathius* (Hymenoptera, Braconidae). These small wasps are parasites of bark beetles and are frequently encountered in ecological surveys of forested areas and in studies of the biological control of forest pests. In the past it has been virtually impossible to identify them accurately. Dr. Mat-

thews has worked out keys for their identification and recorded the host range of each species. It appears that certain species attack diverse bark beetles and other wood-infesting insects. Evidently the wasps are not strongly host-specific but most species are influenced by the host tree which the beetles attack.

Dispersal is one of the most important characteristics in all animal populations for it insures the continued existence and evolution of organisms despite local catastrophes and extinction. Dr. Fell studied dispersal in a marine species by analyzing a large series of tag recoveries of marked marine crayfish liberated in the New Zealand region. Most recovered specimens were found within two miles of the liberation site, while the remaining ones were scattered up to a distance of 150 miles. A review of the monthly returns disclosed that the maximum distance reached varied linearly with time, the maximum distance increasing by nine miles a month. The area to be colonized increases with the square of the distance, and allowing also for the random nature of the variation, yields a Gaussian distribution. The recognition of this fact is important for the interpretation of faunal dispersion in past geological periods.

Graduate student Robert Jenkins completed his field work on fruit-eating birds in Costa Rica. He found that there is a striking coadaptation between plants depending on birds for the dispersal of their seeds and birds which derive most of their nourishment from fruiting plants. There has been a long history of selection pressures which have resulted in an optimal size of fruits, the protection of the seeds while they pass through the birds' intestinal tract, spreading the fruiting seasons so that some fruit are always available for bird dispersal, and having the fruits colored in such a way as to be maximally attractive to birds. On close study it is very obvious how delicately every aspect of this adaptive complex is continuously adjusted by natural selection.

Behavior

Naturalists often discover rabbit nests and try to hand-raise the young. This is almost invariably unsuccessful. However, Dr. and Mrs. Levi were twice successful raising New England cottontails (*Sylvilatus transitionalis*). A female lived in their household for five years and five months. Dr. Levi reports:

"During the last years, she was very aggressive toward me, would attack me readily, and before attacking, make clicking sounds. Lorna (Mrs. Levi) could pick her up at any time, turn her over, and scratch her belly. Benjamin, the surviving male, although brought up in the presence of the older female, is much friendlier toward me, lets himself be picked up or stroked by me—but not by others. (Once in a while he is uncooperative and likes a chase before being handled.) When together, the two rabbits fought each other for resting places: my chair (when I got up) or desk, top of the file, or window sill. While Peter, the female, made antagonistic sounds when I tried to occupy my chair or when she was attacking Benjamin, Benjamin only rarely makes these sounds, only when thrown from his perch or when he falls as a result of misjudging a jump, but also sometimes in sleep. Other sounds made are a 'surprised' chirp when picked up while asleep, and a rare, very loud squeak, perhaps when in pain, but also made twice when in a cage and wanting to get out. The two rabbits never fought for food, or while feeding. Licking each other with the ears folded back, and a strong bite (often into my ankle) seemed to be lovemaking. The female never did permit Benjamin to mate. The rabbits were housebroken, but somewhat destructive, especially Peter to house plants, to anything plastic or wooden, to light cords, learning readily that only one side of a light cord can be bitten through with safety. They got along well with other pets: dogs, and an imprinted white duck. The food preferences of adults seem

to be clover, alfalfa, and frozen lima beans, but they consume a varied diet with bark needed during winter. Once in a while favorite food items were carried with them to their resting place."

John Alcock, a graduate student, studied to what extent birds can learn by watching other birds. His experiments indicate that they can learn where food seems to be, but they do not learn how to reach concealed food. Observational learning apparently can draw attention to available food, but the actions of the observed birds are not necessarily imitated in all detail.

Dr. Williams and A. S. Rand, when analyzing the role of the dewlap in species recognition in *Anolis,* concluded that there was a superabundance of information provided by the size, color, and pattern of the dewlap. This redundancy, seemingly unnecessary under favorable conditions, is evidently useful under conditions of poor visibility. Allen Greer studied the evolution of nesting behavior in Crocodilians. Some species lay their eggs in the ground; others build a mound of vegetation in which the eggs are laid. The two nest types correlate well with what is known of crocodilian relationships and evolution, with mound nesting more advanced than hole nesting. What the adaptive significance of the two nest types is remains unknown, particularly since almost nothing is known of the nests except their gross appearance (except in the mound nesting American alligator). The genus *Crocodylus* includes both types of nest builders, and the differentiation may be a useful clue to relationships in a genus that has been rather refractory to analysis.

William Eberhard finished his graduate studies in uloborid orb weavers. The orb-making ability has apparently evolved at least twice in spiders, in the Araneidae and the Uloboridae. Although the procedure for making the web is the same in both families, the sticky silk in uloborids is woolly, while in araneids it is viscid. The woolly silk stays

sticky longer than the viscid silk, even though the araneids have been a much more successful family in number of species and individuals.

Physiology

In connection with his work on hibernation, Dr. Lyman's laboratory obtained golden hamsters from Turkey some time ago. These animals, which are physiologically (and in their karyotype) quite different from the well-known Syrian hamsters, are excellent hibernators and should become the ideal laboratory animal for hibernation studies as soon as some of their reproductive peculiarities are solved. They are superior to ground squirrels (the "white rat" of hibernation research) because they can be bred in the laboratory and because their tendency to hibernate is not seasonal. Comparison of specimens in the British Museum show that the species *Mesocricetus auratus* varies very little morphologically from the Caucasus to Romania. The meaning of the physiologically and karyological variation is not yet understood.

Dr. Lyman continued his studies on the ability of the hibernating mammal to control its internal environment. In spite of a body temperature which may be close to the freezing point of water, the animal in hibernation maintains its basic physiologic functions in a remarkably steady state. Before the advent of modern electronic apparatus, it was not possible to measure physiologic changes in the hibernating animal because any mechanical manipulation caused the animal to arouse from hibernation. Now, with chronically implanted vascular cannulae, electrodes, and thermocouples, it is possible simultaneously to measure body temperature, heart rate, blood pressure, muscular movement, brain waves, and the level of the blood gases without the animal being aware of any change. Drugs of known pharmacological effect may be introduced via vascular cannulae

without disturbing the animal, and their effects can be monitored.

Dr. Lyman comments:

"Using these techniques, we hope to shed some light on the controls which are active in the animal during hibernation. A current aspect of this research is the control of respiration. Previous data indicate that the acid-base balance and concentration of the blood gases in the hibernator are very similar to those found in the active animal. Respiration during hibernation may be even, occurring as one or two breaths a minute compared to 60 to 120 per minute in the active animal. At times, however, the hibernator undergoes prolonged periods of apnea, and cases have been recorded where the animal held its breath for as long as fifty minutes. We are studying the changes in the blood gases during such a period by continuously pumping blood through suitable measuring devices and then returning it to the animal. It may be that the hibernator makes vascular adjustments similar to those already demonstrated in diving mammals."

LECTURES AND SEMINARS

Dr. Roy A. Crowson of the Zoology Department of the University of Glasgow, and Dr. Jarmila Kukalová of the Department of Geology, Charles University, Prague, delivered the Alexander Agassiz Lectures during the past year.

Dr. Crowson is considered the leading authority on the classification of Coleoptera, and Dr. Kukalová is a distinguished specialist in fossil insects. *Some Phylogenetic Problems in the Coleoptera; Some Evolutionary Interrelations Between Beetles and Plants*; and *Classification and Biology*, were the subjects of Dr. Crowson's lectures; and *Preservation and Nature of Oldest Insect Assemblages, with Possible Paleoecological Deductions;* and *New Evolutionary Views on the Palaeodictyoptera, an Extinct Order of Insects* were the topics selected by Dr. Kukalová.

Natural History Seminars were again sponsored by the Museum, and a complete list of the lectures is appended to this report.

PUBLICATIONS

Staff members and graduate students were responsible for some 144 new periodical publications, totaling approximately 1,920 pages (exclusive of articles still in press). About 115 of these were reports of completed research or other writings of a strictly scientific nature; twelve were reviews of books; the remainder were of a more general or popular nature. A number of new books were published (totaling 1,857 pages) as well as several new editions and translations. Counting only new publications, the total of pages published was 3,777.

Among the new books were:

Levi, H. W.
Kaestner's *Invertebrate Zoology*, vol. 2, Arthropod Relatives, Chelicerata, Myriapods. Wiley, Interscience, New York, 472 pp., 1968. (Translated from the German and revised by H. W. and L. R. Levi.)

Mayr, E.
Principles of Systematic Zoology. McGraw-Hill, New York, 428 pp., 1969.

Romer, A. S.
Notes and Comments on Vertebrate Paleontology. Univ. Chicago Press, Chicago, 304 pp., 1968.

New books for a broader audience were:

Evans, H. E.
Life on a Little-Known Planet. E. P. Dutton, New York, 318 pp., 1968.

Levi, H. W.
Spiders and Their Kin. Golden Press, New York, 160 pp., 1968. (With L. R. Levi.)

Simpson, G. G.

Biology and Man. Harcourt, Brace & World, New York, 175 pp., 1969.

Revisions and foreign editions were:

Mayr, E.

Artbegriff und Evolution. Paul Parey, 617 pp., 1968.

[*Animal Species and Evolution.* Russian edition] Moscow, 597 pp., 1968.

Simpson, G. G.

The Meaning of Evolution. Rev. ed., Yale Univ. Press, New Haven, Conn., 368 pp., 1968. (Hardback issue.)

Life. An Introduction to Biology. Shorter edition. Harcourt, Brace & World, New York, 546 pp., 1969. (With W. S. Beck.)

Het Wereldbeeld Van Een Evolutionist. Utrecht and Antwerp, Aula-Boeken, 415 pp., 1968. [Translation of *This View of Life.*]

Dr. Paynter served as editor of Volume 14 of *Check-list of Birds of the World* (Peters'), Mus. Comp. Zool., xii + 433 pp., 1968.

Six numbers of the MCZ *Bulletin* were published, totaling 781 pages, and twenty-seven numbers of *Breviora* (451 pages). There was one issue of *Johnsonia* and the Museum sponsored six papers in *Psyche.* The total number of manuscript pages in our editor's office in June 1969 still awaiting publication was 1,834.

COLLECTIONS

The late Mr. and Mrs. David Schmidt of Sarona, Wisconsin, were for many years friends of the Mollusk Department and were avid collectors who specialized in the shells of western Florida and the Florida Keys. After the Schmidts' death, their son, Robert, of Arlington, Virginia, gave his parents' collection to Harvard. The shells, which number over 10,000 lots, are currently being sorted. The great value of this collection is that its excellent series show the ranges of variation of many species. Dr. Turner provided extensive

collections of mollusks to which the introduced green alga, *Codium,* was attached. This plant has caused serious disruption of scallop beds in the Cape Cod Canal. Other contributors were Dr. David Stansbury of the Ohio State Museum, who sent a series of freshwater mussels from the Ohio and Tennessee River systems, and Professor Andrew Carey of Oregon State University, who forwarded a sizable collection of deep-sea bivalves off the coast of the Pacific Northwest.

One of the most significant donations of the year to the insect collection was the gift of the holotype and paratype specimens of the oldest ant, *Sphecomyrma freyi* Wilson and Brown, preserved in Cretaceous amber from New Jersey. These two fossils, which stand in a nearly intermediate position between the ants and the wasps, were donated by Mrs. Edmund Frey of Mountainside, New Jersey. Professors George E. Ball of the University of Alberta and Thomas C. Barr of the University of Kentucky have presented holotypes of exciting new species of Carabidae.

Through the efforts of Dr. Lawrence, assisted by graduate students and technicians, a large portion of the Coleoptera collection has been rearranged, relabeled, and generally made much more readily available to specialists. A major part of this reorganization involved the moving of many thousands of specimens of leaf beetles of the Bowditch collection from old wooden boxes to unit trays and new drawers.

The MCZ collection of Hemiptera (Heteroptera) has been transferred to the American Museum of Natural History in New York where it will be under the care of a specialist, Dr. Pedro Wygodzinsky. This collection contains relatively few types but does contain a large amount of unsorted, unworked material from various parts of the world. The American Museum has deposited a synoptic world collection of Heteroptera, of some 600 species of all major groups, at the MCZ. Thus an identified collection will

be available to students and staff, while a large amount of unworked material has been placed at an institution having an active program on this group of insects. Considerable space has thereby been released at the MCZ for the expansion of other parts of the insect collections.

The Invertebrate Paleontology Department continues its program of dusting, reboxing, and updating specimens with the aid of full-time assistance from Antioch College students. Bryozoans and brachiopods are now complete and stratigraphic material has been sorted to eliminate useless items. Type specimens have been segregated in a central area for easy access, and a card file begun which will eventually lead to the publication of a type catalogue. The "brachiopod" room, once the dingiest corner of the department, is being renovated for use by graduate students and visiting scientists.

The employment of a very efficient young man for several months has permitted bottling of most of the spider collection. Dr. Levi reports that the last ancient collections have been sorted, but the staff has only barely been able to keep up with incoming collections. The bird collection was increased by approximately 700 skins during the past year, and 343 skeletons were prepared and catalogued.

Very large additions to the Herpetology collections were made again this year. As before the largest contributions were made by Fred Parker with very valuable material from the Cape York Peninsula of Queensland and from New Guinea. Other valuable specimens were obtained by T. Preston Webster in Guadacanal and other parts of the British Solomons. Hundreds of specimens of pelomedusid turtles were received from Roger Wood, and Stewart Peck contributed a large collection of cave salamanders.

LIBRARY

The most important single activity in the Library this year was the sending of overdue notices in April, May, and

June and in general requesting the return of all library materials. Ordinarily this would not seem like too exciting an event, but from the records in the circulation file it appeared that nothing of this nature had been done for quite some time. The response was overwhelming. Hundreds of books were brought back, including "missing" ones. It was extremely time-consuming for the Library to check this material in and to shelve it, but certainly well worth the effort to dislodge material which was not actually being used by the borrowers. New loan periods for graduate students were also instituted, with loan time changed from one year to one month for books and from two weeks to three months for journals.

EXHIBITS AND MUSEUM SHOP

Mr. Harold F. Holland, the new exhibit preparator, arrived in January and commenced maintenance and restoration of the older halls. Mr. Holland also has begun restoring some of the older examples of museum taxidermy, devising an ingenious "skin grafting" technique from rubber molds which has reclaimed a damaged rhinoceros. The major new project is the invertebrate fossil hall, where work is underway on a very large case to depict the progression of life through the ages. Actual specimens will be used to illustrate all major groups at several stratigraphic levels. Smaller cases will show the application of key concepts of evolutionary theory to the fossil record, as well as illustrate the history and adaptations of major groups of invertebrates.

Under the able management of Mrs. Thomas Kivney who took over just prior to fiscal year 1968-69, the Museum Shop showed an increase in gross income of approximately 23 per cent. All profits are applied to the costs of our exhibition program.

ACKNOWLEDGMENTS

We are grateful to the interested friends and associates of the Museum, who have, as always, augmented our collections, given generously of their time, and contributed to our resources. We are particularly indebted to the following:

For valuable additions to our collections:

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Y. Coineau
C. E. Dawson
Dr. Sylvia A. Earle
Richard D. Estes
Dr. Henry Field
Mrs. Edmund Frey
Miss Eleanor Garfield
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Thomas Hlavac
Richard I. Johnson
A. Ross Kiester
J. D. Lynch
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Charles W. Mack
R. Mascord
F. Medem
Mrs. A. Moreton
Illar Muul
Fred Parker
Alan Patterson
Bryan Patterson
Stewart Peck
Miss Sue Pressman
Mrs. M. Sabath
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Friends of the MCZ (See Appendix I)

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No. 2. Geographic Variation in *Anolis distichus* Cope (Lacertilia, Iguanidae) in the Bahama Islands and Hispaniola. By Albert Schwartz. Pp. 254-310, 27 September 1968.

No. 3. Ammonoids of the Late Scythian (Lower Triassic). By Bernhard Kummel. Pp. 311-701, 28 April 1969.

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No. 1. The Myrmecophilous Ptinidae (Coleoptera), with a Key to Australian Species. By John F. Lawrence and Hans Reichardt. Pp. 1-28, 30 April 1969.

No. 2. Host Relationships in North American Fungus-Feeding Moths (Oecophoridae, Oinophilidae, Tineidae). By John F. Lawrence and Jerry A. Powell. Pp. 29-51, 30 April 1969.

No. 3. The Zoogeography of Lesser Antillean *Anolis* Lizards —An Analysis Based Upon Chromosomes and Lactic Dehydrogenases. By George C. Gorman and Leonard Atkins. Pp. 53-80, 30 April 1969.

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No. 296. The Genus *Dysderina* (Araneae, Oonopidae) in Central America and the West Indies. By Arthur M. Chickering. 37 pp., 11 October 1968.

No. 297. Population Structure of the *Asthenes flammulata* Superspecies (Aves: Furnariidae). By Francois Vuilleumier. 21 pp., 11 October 1968.

No. 298. Monograph of the Cuban Genus *Viana* (Mollusca: Archaeogastropoda: Helicinidae). By William J. Clench and Morris K. Jacobson. 25 pp., 11 October 1968.

No. 299. What is *Lumbricus Eiseni* Levinsen, 1884 (Lumbricidae, Oligochaeta)? By Gordon E. Gates. 9 pp., 11 October 1968.

No. 300. Contributions to a Revision of the Lumbricidae. III. *Eisenia hortensis* (Michaelsen) (1890). By Gordon E. Gates. 12 pp., 11 October 1968.

No. 301. New Echimyid Rodents from the Oligocene of Patagonia, and a Synopsis of the Family. By Bryan Patterson and Rosendo Pascual. 14 pp., 11 October 1968.

No. 302. *Geomyersia glabra,* a New Genus and Species of Scincid Lizard from Bougainville, Solomon Islands, with Comments on the Relationship of Some Lygosomine Genera. By Allen E. Greer and Fred Parker. 17 pp., 11 October 1968.

No. 303. Review of the Genera of the Tribe Loberini (Coleoptera: Languriidae). By T. Sen Gupta. 27 pp., 31 December 1968.

No. 304. Redescriptions of *Anachis avara* (Say) and *Anachis translirata* (Ravenel) with Notes on Some Related Species (Prosobranchia, Columbellidae). By Amelie H. Scheltema. 19 pp., 31 December 1968.

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No. 310. A Shovel-tusked Gomphothere from the Miocene of Kenya. By Vincent J. Maglio. 10 pp., 31 March 1969.

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No. 312. Ecological Observations on *Anolis occultus* Williams and Rivero (Sauria, Iguanidae). By T. Preston Webster. 5 pp., 31 March 1969.

No. 313. Louis Agassiz's Numbers for Steamer Blake Stations of 1877-78, 1878-79. By Myvanwy M. Dick. 11 pp., 31 March 1969.

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No. 316. Cytotaxonomic Studies on Some Unusual Iguanid Lizards assigned to the Genera *Chamaeleolis, Polychrus, Polychroides,* and *Phenacosaurus,* with Behavioral Notes. By George C. Gorman, R. B. Huey and E. E. Williams. 17 pp., 30 April 1969.

No. 317. Relationships of Two Cretaceous Lizards (Sauria, Teiidae). By Richard D. Estes. 8 pp., 30 April 1969.

No. 318. *Leucolepidopa sunda* gen. nov., sp. nov. (Decapoda: Albuneidae), a new Indo-Pacific Sand Crab. By Ian E. Efford. 9 pp., 30 April 1969.

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No. 47. The subfamily Tellininae in the Western Atlantic. The genus *Strigilla*. By Kenneth J. Boss. Pp. 345-366.

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No. 4. A New *Omophron* and a New *Siagona* from the Philippines (Coleoptera: Carabidae). By P. J. Darlington, Jr. Pp. 314-330, December, 1967.

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No. 2. A New Cave Catopid Beetle from Mexico, with a Discussion of its Evolution. By Stewart B. Peck. Pp. 91-98, June, 1968.

No. 3. A New Leleupidiine Carabid Beetle from India. By P. J. Darlington, Jr. Pp. 208-210, September, 1968.

No. 4. The genus *Triaeris* Simon (Araneae, Oonopidae) in Central America and the West Indies. By A. M. Chickering. Pp. 351-360, December, 1968.

No. 4. Demetrida (Coleoptera: Carabidae) in the Moluccas. By P. J. Darlington, Jr. Pp. 360-363, December, 1968.

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Appendix II

NATURAL HISTORY SEMINARS

1968-1969

September 25: Dr. H. Homann (Göttingen, Germany), *Eyes of Spiders: Anatomy, Embryology, Phylogeny, and Importance in Systematics.*

October 2: Prof. Bryan Patterson (Museum of Comparative Zoology), *New Finds Bearing on Human Evolution.*

October 9: Dr. N. M. Wace (University of Adelaide, Australia), *Tristan da Cunha Islands and their Wild Life.*

October 16: Prof. Kenneth D. Roeder (Tufts University), *Interaction of Moths and Bats.*

October 23: Prof. Edward O. Wilson (Harvard University), *Theory and Experiment in Island Biogeography.*

October 30: Dr. Edgar F. Riek (Division of Entomology, Commonwealth Scientific and Industrial Research Organization, Canberra, Australia), *A Possible Origin of the Insects.*

November 6: Prof. Clifford O. Berg (Cornell University), *Adaptive Radiation in Snail-killing Diptera.*

November 13: Mr. Nelson Papavero (São Paulo, Brazil), *Vegetations and Habitats of Brazil, and the "Permanent Amazon Expedition."*

November 20: Dr. Ruth Turner (Museum of Comparative Zoology), *Biology and Distribution of Deep-sea versus Littoral Wood Borers.*

November 27: Mr. Eli G. Minkoff (Museum of Comparative Zoology), *The Facial Musculature of Galago and the Hypothesis of Nerve-muscle Specificity.*

December 4: Dr. Lion F. Gardiner (Woods Hole Oceanographic Institution), *Post-marsupial Development of the Deep-sea Crustacean Family Neotanaidae.*

December 11: Dr. I. C. P. Nisbet, *Ecology of a Northern Bird Migrant Wintering in the Tropics.*

December 18: Dr. James B. Kring (Connecticut Agricultural Experiment Station), *The Behavior of Winged Aphids.*

February 5: Dr. Robert P. Higgins (Office of Oceanography

and Limnology, Smithsonian Institution), *The Kinorhyncha: Bibliocryptozoans from the Interstitial Sea.*

February 12: Amy Schoener (Harvard University), *Ecological Studies on Some Stars (Echinodermata) from Inner Space.*

February 19: Dr. N. B. Todd (BioResearch Institute, Cambridge), and Dr. R. D. Staton (Brown University), *Mammalian Chromosome Evolution.*

February 26: Dr. F. M. Carpenter (Harvard University), and Dr. J. Kukalová (Charles University, Prague, and Harvard University), *Paleozoic Insect Nymphs and their Evolutionary Significance.*

March 5: Mr. Ross Kiester (Harvard University), *Species Diversity of North American Amphibians and Reptiles.*

March 12: Prof. H. B. Fell (Harvard University), *Quantitative Biogeography: Some Methods and Results.*

March 19: Dr. Helen T. Ghiradella (Tufts University), *Air and Ocean: Chemoreceptor Morphology of Marine and Land Crabs.*

March 26: Prof. Dennis Chitty (Univ. of British Columbia and Smith College), *The Regulatory Action of Weather in Population Phenomena.*

April 9: Dr. Ellis MacLeod (University of Illinois), *The Biology of Diapause in the Chrysopidae (Green Lace-wings).*

April 16: Dr. R. A. Crowson (The University, Glasgow, and Alexander Agassiz Lecturer, M. C. Z.), *Some Phylogenetic Problems in Coleoptera.*

April 23: Mr. Roger Wood (Harvard University), *Zoogeography and Evolution of the Fossil Pleurodiran Turtles of Africa.*

April 30: Mr. John Alcock (Harvard University), *Learning, Bird Feeding Behavior, and Mimicry.*

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