SCIENCE

VOL. 88 — FRIDAY, DECEMBER 9, 1938 — No. 2293

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

THE NEED OF INSULAR EXPLORATION AS ILLUSTRATED BY BIRDS[1]

By ROBERT CUSHMAN MURPHY

AMERICAN MUSEUM OF NATURAL HISTORY

I

IF the track of every civilized inquiring traveler could be accurately plotted on a globe, there is little doubt that all but a few small portions would become entirely black, due to the crossing and merging of the countless lines. This would apply to nearly the whole of the ocean as well as to the lesser area of continents and islands. In short, modern man has seen his world and has mapped with extraordinary faithfulness somewhat more than three quarters of it. The "unknown," in the geographic sense, has become exceedingly restricted. On the other hand, the little known still looms amazingly large. The fact that the scope of knowledge is so vast and human interest so diversified means that only a few centers of ripe culture have been studied in any large proportion of the aspects that man's curiosity makes possible. The great bulk of travelers add much to their own store of information and enjoyment; they may also exert a cumulative influence in the field of international relations. Few of them, however, can be expected to add new accretions to the sum of exact knowledge.

When a well-informed layman begins to acquaint himself with the biological material in a great museum, he is likely to conclude that the fauna of the world has been rather thoroughly collected, preserved, classified and filed, or in other words that the strictly pioneering part of the task of getting acquainted with the earth's inhabitants has been finished. For a few groups be-

[1] An address delivered before the Science Section of the American Association of Museums at the Academy of Natural Sciences of Philadelphia, May 20, 1938.

longing to limited regions, such as the game mammals of the African grasslands, the birds of the British Isles or the fresh-water fishes of the United States, this may be substantially true. But with reference to very many other groups of living organisms, throughout expanses of the continents and oceans alike, the surface has not yet been even deeply scratched. Confining my own remarks to such a conspicuous and relatively well-known class of vertebrates as the birds, I am going to attempt to indicate the rich field for fundamental zoological investigation that still lies before museum men at islands scattered throughout the seven seas and their respective gulfs and bights. The opportunity applies scarcely less, indeed, to numberless small islets on the continental shelves, perhaps within sight of mainland shores, than to remote oceanic dots and archipelagoes lying at distances of hundreds of miles from the nearest extensive seacoast.

"The proof of the pudding is in the eating." In 1920 my own institution began a series of ornithological investigations in the Pacific, known collectively as the Whitney South Sea Expedition. For a decade or longer the schooner *France* was maintained as a base of operations. Before the craft was disposed of, and ever since that time, numerous less elaborately organized projects have been carried on continuously. The field of operations has extended from eastern Polynesia westward to New Zealand, New Guinea and its outliers and Micronesia. Let us consider briefly some of the scientific discoveries made in a region which had already been traversed by countless expeditions and visited by scores or hundreds of naturalists representing many nationalities since the birth of the modern age of scientific inquiry shortly after the middle of the eighteenth century. We shall draw our conclusions entirely from results which have thus far been published.[2]

The ornithological reports by six authorities, the majority of which are from the pen of my colleague, Dr. Ernst Mayr, reveal that up to May, 1938, 12 new genera and 196 new species and subspecies of birds have been described from the Whitney South Sea collections. This number is not unlikely to be doubled during the next few years, but no less important than the disclosing of hitherto unknown animals is the interpretative use to which they have been put. Among problems illuminated by the Whitney expedition, the following are some of those discussed in the publications cited:

Biogeographic phenomena of variation, including those exemplifying Bergmann's rule, *i.e.*, increase of size among closely related birds in direct ratio with higher latitudinal range; apparent evolutionary sequences as correlated with the distances between islands, the direction and force of prevailing winds, and other influences that bear upon obvious probabilities of dispersal and survival; the phenomenon of "swamping" or the breeding out of incipient races because of the ease and consequent frequency of repeated incursions from the populations of other island stations; detailed information on seasonal equatorward migration of certain south-temperate insular birds; distribution through primitive human agency; heterogynism, or the condition in which the diagnostic characters of species and races are exemplified chiefly or exclusively among females; other aspects of sexual dimorphism, including evolutionary reversal in its expression; physiology and genetics of plumage pattern in so far as conditions found in nature can be extrapolated from the data of experimental studies; marked disproportion in the normal relative numbers of the sexes; parallel evolutionary trends exemplified among the races of two or more species within a common genus.

II

"Case histories" offer, no doubt, the best basis for intelligible discussion. From a wealth of examples that are wide-spread in the Pacific—and, for that matter, at islands in other oceans—I shall choose certain warblers (Sylviidae) and flycatchers (Muscicapidae), endemic at the Marquesas Islands. Of the fifteen forms within these two families which inhabit all but one of the islands comprising the archipelago, twelve were made known to science by the Whitney expedition.[3]

Both of these groups of birds belong to widely distributed Old World families. The Marquesas have apparently derived their terrestrial biota, including the native human stock, from the southwest; warblers and flycatchers of the same or nearly related species still inhabit the Society and Tuamotu islands to southward. The subsidiary question as to the times, manner and order in which the birds first occupied nine of the ten islands in the rather remote Marquesas archipelago is more open to conjecture. However, the whole chain lies approximately along the axis of the steady southeast trade wind, and there are numerous indications that taxonomic interrelationship is largely in accord with the theoretical chances of island-to-island transfer.[4]

The warblers of the Marquesas are rather closely

[2] The data are recorded in the introduction and assembled papers of a volume entitled "Birds Collected During the Whitney South Sea Expedition, I–XXV" (articles from the *American Museum Novitates*, 1924–33), published by the American Museum of Natural History, November 6, 1933; also in additional numbers of the same journal (Whitney Expedition reports XXVI–XXXVII), 1933–38, as follows: Nos. 665, 666, 709, 714, 820, 828, 912, 915, 933, 939, 947, 977.

[3] These birds and certain related forms have been described and discussed by Murphy and Mathews, *Amer. Mus. Novit.*, No. 337, 1928, pp. 1–18.

[4] In this connection, Mayr has found that at Rennell Island, an isolated member of the Solomon group, the direction of the prevailing winds and the distance from neighboring archipelagoes are clearly correlated with the percentage of the several faunistic elements (*Amer. Mus. Novit.*, No. 488, 1931, p. 11).

akin to the Eurasian and Australian reed-warblers (*Acrocephalus*). They are of the same species, in my opinion, as the warblers of the Society Islands (*Conopoderas caffra*), which lie roughly 800 geographic miles distant. Nine of the ten islands of the Marquesas are inhabited by these birds, and only two of the islands, namely, Hivaoa and Tahuata, which are very close together, share the same geographic race. Each of seven other islands has its own endemic subspecies, differing in size, hue or both from all the warblers of the neighboring islands. In one instance, two islands only a little more than three miles apart (Eiao and Hatutu) are occupied by faintly separate races, illustrating a fact which zoologists have been unduly slow to recognize, *i.e.*, that birds do not always undertake what their wings might make readily possible but that, on the contrary, slight barriers may demarcate for indefinite periods the ranges of closely related forms. Furthermore, it should be observed here that all these Marquesan warblers have exceptionally loose and fluffy plumage, quite unlike the feathering of the active, migratory reed-warblers of Europe. In any event, incipient differentiation is under way between the resident birds of Eiao and Hatutu; as to how much the process may have been inhibited by "swamping" or casual interchange of birds from island to island with consequent back-crossing and leveling, we can not even guess.

Neither have we any means of knowing whether the warblers of Eiao and Hatutu would still be fertile *inter se* if they were brought together, but throughout the archipelago there is a clear correlation, as I have already hinted, between the taxonomic weight of several subspecies and the extent of spatial isolation. For example, the warbler inhabiting Motane Island, which is only ten miles from Hivaoa, is a "weak" subspecies, whereas the warbler of Fatuhiva, an island twenty-five miles from its nearest neighbor and "up wind" from the other islands, is the "strongest" or most highly distinctive race of the whole archipelago.

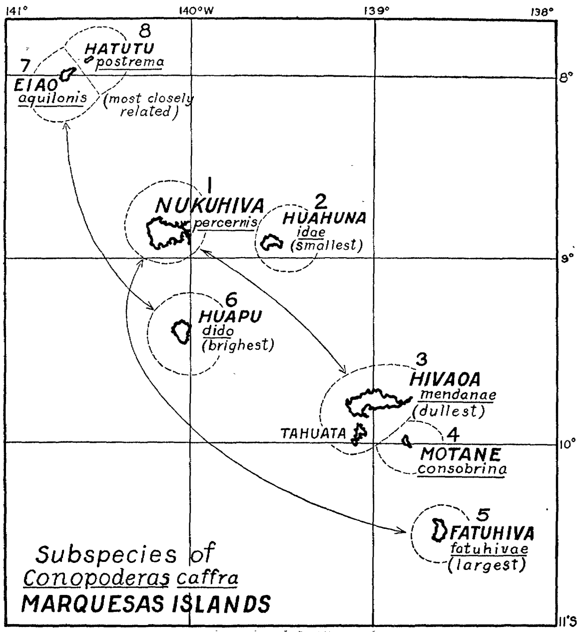

FIG. 1

In Fig. 1 I have allowed the mere subspecific names to stand for the eight warblers, because the birds are of such relatively uniform aspect except as regards the extremes in size that they do not lend themselves well to diagrammatic representation. The three double-headed arrows connecting islands or groups of islands indicate general resemblance or apparent relationship between subspecies, but systematic similarity is not necessarily the same as genetic heritage and no such sequential origin as might be suggested by the arrows can be accepted as established.

The eight Marquesan warblers, when torn from their scattered islands and laid side by side as specimens in a museum tray, comprise a close approximation of what is termed continuous variation. We can all but see intergradation, despite the insular setting. Certainly not one of the races is a notable "saltant," as compared with every other. The slight but constant differences are undoubtedly mutational and, needless to say, they have no conceivable causative relation to the environment. Nevertheless, the several island ranges are of necessity completely discontinuous. The dead birds lend no clue to a genetic interpretation of their characteristics, but surely we have no sound reason for assuming that the blood kinship of these forms is any closer, or their age as taxonomic entities necessarily any less, than that of the far more strikingly different flycatchers which occupy all but one of these same islands. If, as Dobzhansky writes, evolution is a modification of genetic equilibrium, and if mutations are the discontinuous steps in the continuous process of species formation, then the "microgeographic" differences among the warblers are due to different relative gene frequencies which, in such small and discrete populations, would be expected to fluctuate over a wide range of values.[5]

Turning now to the flycatchers (*Pomarea*), the diagrams in Fig. 2 stand for the seven Marquesan forms. Their distribution parallels that of the warblers, except that no flycatcher inhabits the northernmost island (Hatutu). Once again we find that the adjacent land areas of Hivaoa and Tahuata share the same form; that Motane has only a "weak" subspecies, closely resembling that of Hivaoa; that Fatuhiva in this instance also harbors the "strongest" and most distinctive of all these congeneric birds. In short, evidence for the isolation-speciation ratio accumulates.

[5] Theodosius Dobzhansky, "Genetics and the Origin of Species," p. 180, 1937.

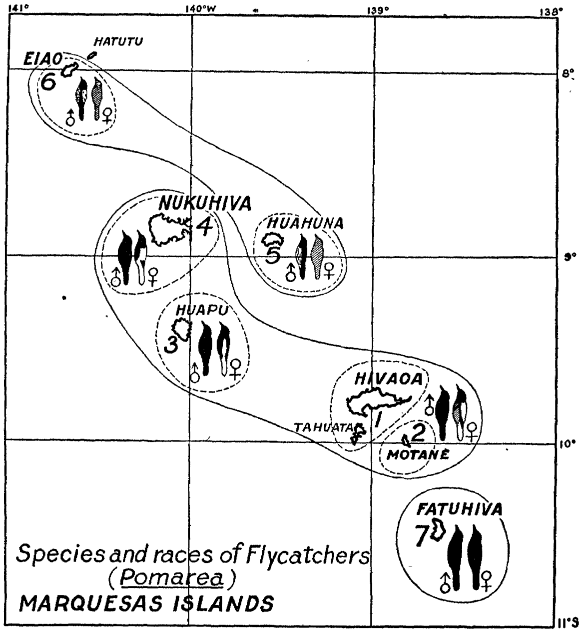

FIG. 2

The flycatchers, because of their marked differences in visible characters, have been described as three species, all endemic at the Marquesas, but they obviously comprise a single Formenkreis. Solid lines in the figure enclose the islands or groups of islands which are the homes of each species, broken lines those of each subspecies, the names of which may be identified from the numbers, as follows: (1) *Pomarea mendozae mendozae;* (2) *Pomarea mendozae motanensis;* (3) *Pomarea mendozae mira;* (4) *Pomarea mendozae nukuhivae;* (5) *Pomarea iphis iphis;* (6) *Pomarea iphis fluxa;* (7) *Pomarea whitneyi.*

In the diagrams of plumage pattern, white represents white, black is black, and ruled lines denote brown. In mature birds of one or the other sex among the seven forms there are therefore instances of an all-brown pattern, of a contrasting black-and-white pattern and of a saturated or all-black pattern. Minor variations include black streaks in the white areas of males belonging to the species *iphis* (5 and 6), and a brown wash on the breast of females in two races of the species *mendozae* (1 and 2). The group as a whole indicates a type of evolution which can hardly be thought of as slow, progressive and continuous. Most emphatically these flycatchers exemplify extreme discontinuity, in sharp contrast with the forms of *Conopoderas.*

Reduced to simplest terms, we find the following combinations of patterns among adult birds from north to south: *P. iphis:* brown or paedogenetic females, pied males; *P. mendozae:* pied females, black males; *P. whitneyi:* black males and females.

The sexes in *whitneyi* are indistinguishable. The species *mendozae,* of which there are four races, is heterogynous in that the subspecific characters appear only in females, the males of all being practically indistinguishable. As between the two species *mendozae* and *iphis,* there has been a partial reversal of secondary sexual characters, the females of the first of these exhibiting a pattern which pertains exclusively to males in the second. Finally, females of the species *iphis* have retained the youthful type of plumage worn by actually immature birds in every one of the seven Marquesan flycatchers, and which, it is not unreasonable to suppose, may typify the primitive or ancestral pattern of the whole assemblage.

Here, then, is something to bite upon, something to serve as a basis for logical interpretation. Within a single closely related group of animals "in the open," we find cock-feathered hens, hen-feathered cocks and immature-feathered hens!

All secondary sexual characters are either sex-linked or sex-limited, that is, the determinant gene lies either in the sex chromosome or in an autosome. In the latter circumstance the gene can express itself only in male or female "soil," as the case may be. Sex-limited characters are a natural result of chemical distinctions between the sexes. The effects of genes should be expected to differ in accordance with the different metabolic rates of male and female.

Thus the variation among these several flycatchers is capable of interpretation in either of two ways, one of which involves sex-linked mutations and the other hormonal control. The latter is more probable, judging by general experimental evidence from birds, but the alternative explanation can not be wholly ruled out as a hypothesis. In females of the species *Pomarea mendozae,* for example, the pied pattern may be either sex-linked in the W chromosome or sex-limited in an autosome. In males of this species the melanistic or saturated pattern may be determined by the Z chromosome and can appear only when two Z's are paired, for among birds, so far as known, it is the male which is homozygous for sex. In the case of *Pomarea whitneyi* we need assume only a familiar type of mutation which makes it possible for the melanistic character to appear when a single Z chromosome is present. We thus arrive at WZ ♀ and ZZ ♂, both black. The condition illustrated by *Pomarea iphis* might be explained by the crossing over of a female character to a male chromosome.

If, on the other hand, pattern determination among the Marquesan flycatchers is similar to that in poultry, male feathering represents the normal species plumage, while the female plumage is the result of inhibitory hormones. The basic condition might then be represented by a pied male and a brown female, as in 5 and 6 (*iphis*). Ovariectomy would cause such a female to become pied after the next molt.

The last statement is equivalent, however, to saying that influence of the female hormone lowered below a certain threshold would also produce pied females, a condition fulfilled in 1 to 4 (*mendozae*). The black males of *mendozae* could be similarly accounted for by a different hormonal threshold which permitted the pigmentation to go beyond piebald to black. The same situation, combined with a complete lack of female hormonal inhibition, would lead to case 7 (*whitneyi*), in which both sexes are black.

Such explanations are, of course, wholly genetic. Genes frequently act through controlling the rates of reaction; the effect of many mutations, as Goldschmidt[6] has pointed out, is to upset timing during development. A mutant gene may cause a certain "dosage" necessary for normal differentiation to be absent, or present only in a quantity below the necessary threshold. Such facts explain why the appearance of "maleness" in one form may denote "femaleness" in another.

If I seem to have gone into somewhat elaborate detail, it is because these two series of land birds, almost identical in their distribution throughout a small archipelago, present such an extraordinary assortment of the possible results within a limited gamut of biological variation. Furthermore, it should be emphasized that the distinctions within the respective genera represent great apparent differences in degree. The warblers (*Conopoderas*) are birds of common facies, their subspecific characters reflecting the sums of slight mutations which have affected chiefly size and color. The flycatchers (*Pomarea*), on the other hand, not only differ more greatly in size and proportions but also, without losing the clear stamp of common heritage, exhibit startlingly diverse plumage patterns, of both primitive and progressive types, which are, moreover, of the sorts that have been analyzed genetically with laboratory animals.

A population broken up into isolated colonies may differentiate mainly as the result of the restriction of its size. Even if the environment is homogeneous for all colonies, their selection and mutation rates the same and the initial composition identical, a sufficient passage of time will bring about a differentiation which need not be adaptive.[7] These Marquesan flycatchers, known thus far only as they exist in a discontinuous natural environment, do not constitute an altogether adequate genetic demonstration, in the strict sense, but surely the circumstantial evidence they present is too strong to be disregarded.

Islands offer, indeed, the closest approach in nature to the conditions of a man-controlled laboratory. They have one inherent advantage, of course, about which the experimenters can only speculate, namely, the presumably amassed influence of prolonged time. I am aware of no geographic reason as to why the ancestors of the warblers and flycatchers under consideration may not have occupied their respective Marquesan islets for, say, a hundred thousand years. Certainly the principle of complete isolation is often fulfilled at island groups throughout secular periods. The land birds that inhabit them are as a rule extremely sedentary so that transportation or "migration pressure" from one station to another occurs only as a result of exceptional agencies and at very long intervals. The oceans abound in instances of more or less adjacent islands occupied respectively by birds which differ from one another only by characters that might reasonably be ascribed to a single genetic factor. Among certain paired examples, indeed, it is almost obligatory to conclude that one of the two is a homozygote, preserved as such because imprisoned as a pure recessive in its insular "laboratory cage." Color mutants of familiar aspect are plentiful in the guise of endemic island races; flightlessness, comparable in skeletal and feather structure to that exhibited by many breeds of domestic fowl, has arisen among island birds of several orders where the absence of enemies lifts the penalty from such a trend; so-called "adaptive" radiation in the structure, and consequently the function (!), of a single organ, such as the bill, may almost parallel in families of island birds the monstrous mutations of bottle-grown fruit-flies. This is exemplified *par excellence* among the strange Hawaiian honey-creepers (Drepanididae) which have run their own complicated evolutionary course so long, and so far removed from the rest of the world, that the clues to their real phyletic affinities have become almost hopelessly obscured. To cite another somewhat comparable family of insular birds, it should be recalled that the famous "finches" of the Galápagos (Geospizidae) were perhaps the strongest particular influence in implanting the germ of the evolutionary idea in the mind of the youthful Darwin, who was impressed by the perfect gradation in the size of the beaks among the species of these curious birds.

III

I accept, in the main, the orthodox tenets regarding the processes of heritable variation which, after the all-important ingredient of *time* has been added, no doubt weave the infinite pattern of speciation in nature. So far as we certainly know, all inherited differences have arisen as mutations, and the example of the Marquesan flycatchers might serve to reconcile the points of view of the taxonomist and the student of genetics. Nevertheless, I want to indicate one or two remarkable cor-

[6] Richard Goldschmidt, "Physiological Genetics," 1938.
[7] Dobzhansky, *op. cit.*, p. 183.

relations frequently illustrated among island birds, in the attempt to account for which, so far as I am aware, neither an adequate genetic hypothesis nor a speculation as to the possible effect of the environment has ever been advanced.

One of these concerns the presence of some particular structural stamp shared by a more than chance proportion of island birds, regardless of their systematic affinities. The other relates to common or nearly universal characteristics that we sometimes encounter in practically all the forms of birds confined to a particular island. At Ninigo, northwest of the Admiralty group, Dr. Mayr has found that every one of a considerable number of endemic subspecies is larger and of darker coloration than the nearest related forms elsewhere. At Rennell, an outlier of the Solomons, the endemic subspecies show a pronounced tendency toward reduction in size; in fact, this island is the sole home of the smallest known races of many species of birds which are widely distributed throughout the Indo-Australian region. These facts can hardly be dismissed as coincidences. It is well known that representatives of various families, orders and even classes inhabiting a given geographical region often undergo convergent changes, for which specific biophysical reasons have been advanced.[8] But neither the adaptive "peaks" and "valleys" of Wright,[9] nor any mechanism independent of the environment appear to explain why mutations toward small size make the components of a varied population fittest to survive at Rennell.

Turning now to the question posed first above, it has long been recognized that island land birds are apt to have longer or more robust bills than their nearest continental representatives. Fortunately, the fourth edition of the "Check-List of North American Birds," together with the exhaustive collections of the American Museum of Natural History, have given me an opportunity to test this tradition statistically for one continent throughout the entire order of Passeres. The results are listed in Tables I and II. Among 27 subspecies of insular larks, jays, wrens, kinglets, shrikes, vireos and finches, covering a zonal range between the Arctic and the Tropics along both coasts of North America, 78 per cent. prove to have larger bills than their mainland representatives. When subspecies have developed into species—if that be, in truth, the actual procedure of evolution—this strange distinction becomes even more marked and we find that *every* North American insular species has a larger bill than its nearest continental kin. For the present, such a problem bids fair to stump geneticists and "environmentalists" alike!

[8] Cf. Dobzhansky, *op. cit.*, p. 165.

[9] Sewall Wright, 1932. *Proc. 6th Internat. Congr.* Genetics, Vol. 1, pp. 356–366.

TABLE I

Twenty-one subspecies of North American passerine birds breeding exclusively on islands, as listed in the A. O. U. Check-List, 1931, which have relatively larger bills than their nearest mainland representative races:

Subspecies	*Breeding Range*
Nannus hiemalis meligerus	Aleutian Is.
" " *kiskensis*	" "
" " *alascensis*	Pribilof Is.
" " *tanagensis*	Aleutian Is.
" " *petrophilus*	" "
" " *semidiensis*	Semidi Is.
" " *helleri*	Kodiak I.
Thryomanes bewicki nesophilus	Santa Cruz and Santa Rosa Is.
Thryomanes bewicki catalinae	Santa Catalina Is.
Thryomanes bewicki leucophrys	San Clemente I.
Salpinctes obsoletus guadeloupensis	Guadalupe I.
Corthylio calendula obscurus	" "
Vireo griseus maynardi	Florida Keys
Carpodacus mexicanus clementis	Is. off California and L. C.
Pinicola enucleator carlottae	Queen Charlotte Is.
Pipilo maculatus clementae	San Clemente and Santa Catalina Is.
Passerculus sandwichensis sandwichensis	Aleutian Is.
Aimophila ruficeps obscura	Is. off California
Passerella iliaca insularis	Kodiak I.
Melospiza melodia graminea	Santa Barbara I.
" " *clementae*	Is. off California

The remaining six island races in the same list, which do not have relatively larger bills than their closest mainland representatives:

Subspecies	*Breeding Range*
Otocoris alpestris insularis	Santa Barbara I.
Cyanocitta stelleri carlottae	Queen Charlotte Is.
Lanius ludovicianus anthonyi	Santa Barbara I.
Vireo griseus bermudianus	Bermuda
Melospiza melodia micronyx	San Miguel I.
" " *coronatorum*	Los Coronados Is.

77.8 per cent. of all the North American insular races are large-billed.

TABLE II

The 9 species of North American passerine birds breeding exclusively on islands, and properly comparable with continental forms, which have relatively larger bills than their nearest mainland representative species:

Species	*Breeding Range*
Progne cryptoleuca	Cuba
Aphelocoma insularis	Santa Cruz I.
Thryomanes brevicauda	Guadalupe I.
Compsothlypis graysoni	Socorro I.
Carpodacus mcgregori	San Benito I.
Carpodacus amplus	Guadalupe I.
Pipilo consobrinus	Guadalupe I.
Passerculus princeps	Sable I.
Junco insularis	Guadalupe I.

No exceptions: 100 per cent. of the island species have larger bills than their closest mainland relatives.

IV

Well, even if you freely admit the fascination and importance of problems in island ornithology, you may still reply, "Why the hurry? The world is overflowing with material for evolutionary research, and our grandchildren can take up these far-away matters after we ourselves have solved a greater proportion of the unknown that still lies within arm's reach."

But that hope is exactly what will not be capable of realization. The oceanic island work, at least, must be done soon or never. Islands comprise the most delicate and evanescent of environments for their native biotic communities as soon as civilized man and his satellites put in an appearance and proceed to upset the ancient balance. The list of organisms that have become extinct within the historic period fairly bulges with the names of astonishing island birds, from the dodo of Mauritius to the mamo of Hawaii. All the peculiar land birds of Tristan da Cunha Island, in the South Atlantic, have become extirpated since the introduction of hogs and rats. The remnant of the fauna of Tahiti is waging a rapidly losing struggle against domestic mammals, alien hawks, mynahs and weavers that have become established there, and against the wild-fire spread of lantana and other weeds that have already dispossessed much of the original vegetation. The same story is being repeated elsewhere; primitive conditions that may have flourished for a million years melt away when men of the dominant races, whether white or yellow, arrive to break the spell.

Experimentalists are understandably impatient of data beyond reach of their breeding tests. But we should remember that the present age of experiment will some day be combined with an age of fuller correlation, when the inconceivably rich mine of factual matter now buried in the text of ten thousand outdated books will be drawn upon, and when zoological collections, no less than zoological literature, will be combed for now ignored truths that can then be properly fitted into the picture of life as a whole. We museum men collect and preserve not only with respect to our individual scientific predilections; rather, we may be said to share some of the characteristics of devoted librarians. We feel a heavy responsibility to lay up, while opportunity offers, a capital sum of the irreplaceable data of science, even though part of this fortune may not begin to bear interest at its proper rate for a long while to come.[10]

SCIENTIFIC EVENTS

RESEARCH GRANTS OF THE VIRGINIA ACADEMY OF SCIENCE

THE Research Committee of the Virginia Academy of Science met on November 5 to make the regular awards for the encouragement of scientific research in Virginia. It had available for distribution $450, which included the $100 from the American Association for the Advancement of Science. It had in hand sixteen applications for grants amounting to $1,200. After long and careful consideration of each request the following awards were finally made:

To Professor James I. Clower, of the Virginia Polytechnic Institute, $50 provided the Virginia Polytechnic Institute would supply an equal amount for the purchase of a Robinson colorimeter for use in his study of lubricating oils in automobiles.

To Dr. J. Frank Hall and Dr. R. L. Simpson, of the Medical College of Virginia, $50 to be used in the purchase of animals and other supplies in their study of the changes in the abutment teeth and their surrounding tissues brought about by the additional stress applied through crown and bridge restorations.

To Dr. C. W. Lampson and Dr. A. I. Whitenfish, of the University of Richmond, $60 provided the University of Richmond would supply a similar amount needed for the purchase of a special condenser needed in their study of the dielectric constant as a factor in the "salting out" of non-electrolytes.

To Dr. M. J. Murray and Dr. F. F. Cleveland, of Lynchburg College, $97.50 to be used for the purchase of apparatus and supplies needed in their study of the Raman effect and molecular structure.

To Dr. A. A. Pegau, of the University of Virginia, $50 to help to defray the expenses in mapping an unmapped portion of the Petersburg granite, chiefly in Dinwiddie County.

To L. B. Snoddy, of the University of Virginia, $90 to help to defray expenses in the study of the luminous discharge in the aurora borealis as a function of time.

To M. A. Stirewalt and F. F. Ferguson, of the University of Virginia, $50 to help to defray their expenses in a study of the occurrence, distribution, taxonomy and physiology of the Turbellaria of the eastern United States.

Dr. J. Shelton Horsley, Sr., reported that the amount of the research fund had now been brought up to $13,000, and consequently the amount available for distribution next year should be correspondingly larger.

E. C. L. MILLER,
Secretary

CONGRESS OF AMERICAN INDUSTRY OF THE NATIONAL ASSOCIATION OF MANUFACTURERS

A THREE-DAY Congress of American Industry opened in New York City on December 7. At this meeting the report was presented of the joint committee of leading industrialists and scientific men that was established last year to study increasing production and employment through wider use of scientific research in industry. A considerable part of the session held on December 8 was devoted to it. The chairman of the committee is M. H. Eisenhart, president of the Bausch and Lomb Optical Company, Rochester, N. Y.

The activities to be undertaken by the committee with relation to industrial research include:

[10] The author wishes to express his appreciation of the privilege of discussing the genetic aspects of this paper with Dr. G. K. Noble and with Professors T. H. Morgan and Richard Goldschmidt.