several improvements in apparatus and methods of experiment have already been made, one on the time of action and the fatigue of monocular accommodation, another on the rapidity of movement of the arm under the conditions present while writing, another on the reaction-time to tones as dependent on pitch, intensity, duration, etc.

The ample accommodations furnished by the fifteen rooms, the three months of energetic preparation during the summer, the high scientific stand taken in regard to research, the wise patronage of Professor Ladd and the enthusiasm of the young investigators lead us to hope that the first year will see us with a recognized standing, second only to Wundt's laboratory at Leipzig. Nevertheless, there are many difficulties to be overcome; the work of instruction really requires as full an equipment as a physical laboratory; moreover, research is the most expensive kind of work, thus putting a great strain on the appropriation. It would be a very great help if some one or more friends would undertake to support or aid some one of the researches, setting any desired amount as the limit beyond which the expenses are to be paid by the laboratory. We have already received considerable aid in our work: Professor Ladd has given the laboratory his valuable collection of charts and models and a microscope; a friend has donated $75 for electric forks required in one of the researches; the B. F. Sturtevant Co. has sent a rotary blower; the Electric Gas Lighting Co. of Boston has sent a dozen Samson batteries; the Aluminium Brass and Bronze Co. of Bridgeport has made us a dozen discs twelve inches in diameter; the Boston Woven Hose and Rubber Co. has furnished some of their cross-stitched rubber belting; E. B. Meyrowitz has sent a set of test-cards, etc. More of such help would be thankfully received; at present we need a ½ horse-power motor, a spark coil, etc. Possibly the day is not far distant when an endowment will be made for a separate building and a full equipment of apparatus.

HYBRIDISM EXEMPLIFIED IN THE GENUS COLAPTES.

BY SAMUEL N. RHOADS, ACADEMY OF NATURAL SCIENCES, PHILADELPHIA.

PERHAPS the most widespread and persistent tendency to hybridism that exists among the higher vertebrates to-day is to be found in this American genus of woodpeckers. The birds responsible for such a state of affairs are well known in their respective habitats as flickers, the eastern species being named the yellow-shafted flicker (*Colaptes auratus*), and its western congener, the red-shafted flicker (*Colaptes cafer*) by naturalists.

It early became known to explorers in the upper Missouri and Yellowstone regions of this country that where the habitats of these red- and yellow-shafted birds adjoin there often occurred individuals partaking the characters of both species. Audubon described in the appendix to his "North American Birds," a flicker from this region, with the yellow shafts and red nape of *auratus* combined with the red mustaches of *cafer*, as a distinct species, naming it *Picus ayresii;* but as more specimens were secured it became evident that these intermediate birds were not constant in character and their numbers were too great to be explained by any other theory than that they were the offspring of distinct species and were hybrids. Professor Baird enunciated this idea in 1858, classing for convenience all these nondescripts under the distinctive name of *Co'aptes hybridus*, and asserting that their existence could be satisfactorily accounted for in no other way. The amount of material on which he based his theory, however, was small enough to warrant other theories, Mr. J. A. Allen attributing the existence of so-called "*hybridus*" to the "action of environment in accordance with certain laws of geographic variation," and later Mr. Ridgway suggested they were "remnants of a generalized form from which two incipient species have been differentiated." Dr. Coues, in 1884, thought the mixed birds might constitute "perhaps a hybrid and perhaps a transitional form," while Hargitt, in the British Museum Catalogue, makes the intermediates a race with the nominal status of a species under the Audubonian name of *ayresii*, admitting them to have been originally the result of a mixed union, showing possibly a "sign of reversion to remote ancestral plumage."

Last year (1891) Mr. J. A. Allen made the relationships of the whole genus the subject of an exhaustive study. The results of his examination are given in full in Vol. IV. of the Bulletin of the New York Museum of Natural History and being inaccessible to the general reader may be briefly summed as follows:—

1. Mixed birds show no stages of geographic variation comparable with those connecting species and sub-species. In the latter the transition is gradual, symmetrical, and correlated with change of environment, but in *Colaptes* the intergradation is irregular, often asymmetrical and without such correlation.

2. Very unlike birds have been found to breed together; diverse offspring being reared in the same nest by parents indifferently exhibiting normal or abnormal characters irrespective of sex. But so far typical *cafer* and *auratus* have not been found paired together.

3. On either side of the boundary of one thousand miles, along which their habitats adjoin, the influence of one species upon the other fades imperceptibly eastward and westward till it disappears.

4. The main area of hybrid distribution covers a belt of country two hundred miles wide and reaching north-westwardly from the Gulf-coast of Texas through Colorado, Wyoming, Montana, northern Idaho and Washington and the southern half of British Columbia to the Pacific, extending from southern Alaska to the mouth of the Columbia River. South and west of this the habitat of true *cafer* reaches from the Columbia to Tehuantepec, while north and east of it pure *auratus* ranges, over an area four times as great, from Florida to Hudson's Bay and from Labrador to Behring Sea.

5. Formerly, collections from certain parts of the far West, notably California and Nevada, were wanting in hybrids, but now they have become so common in some localities that thoroughbred birds are the exception. This favors the assumption that *auratus* is extending its range into the *cafer* region, and the absence of such an invasion of mixed individuals northward indicates that the transmigration is in the historic direction, from north to south.

This, with a few interpolations of my own sums up the evidence which has induced Mr. Allen and the majority of ornithologists to adopt Baird's theory to its fullest extent.

To this I wish to add a few supplementary remarks based on a collection of flickers made this year in British Columbia. As this series was chiefly collected in the breeding period we are relieved of the complications caused by the winter migration of Alaskan *auratus* into the region and can rely on the specimens as representing the domestic relations of the group.

Perhaps nowhere is the proportion of hybrids to pure-bred birds greater than on the Island of Vancouver. The dark, northwestern form of *cafer* found here has so thoroughly assimilated the characters of *auratus* that *cafer* is the exception and *cafer-auratus* the rule. Nevertheless, pure *auratus* is very rare on the island. I have no specimens of it, but Mr. Fannin of the Victoria Museum has one, and Mr. Maynard of the same city states they are sometimes numerous in the fall. I am, however, from the absence of such specimens in collections, inclined to discount this statement, in the belief that they will prove to be of impure origin also. Indeed it is doubtful if there is much association, much less admixture, of thoroughbred individuals of the two species either with each other or with hybrids at the present day, many which appear pure, especially among the females, being of impure extraction.

Comparing the results of an examination of seventy skins, contained in the collections of the Academy of Natural Sciences of Philadelphia from debatable territory in the west and northwest, with the deductions given in Mr. Allen's admirable paper, the following general remarks seem in order:—

1. The prevailing tendency among hybrid flickers is in the direction of a symmetrical assumption of the characters of both species, examples of asymmetric coloration being rarely present and chiefly confined to the females.

2. A much larger percentage of male than female birds show mixed parentage. This indicates either that hybridism in this case results in an overproduction of males or a disparity in the

relative numbers of the sexes among these hybrids, or it is due to the fact that females assume abnormal secondary sexual characters less readily than males. Until it be proven that hybridism does cause a disparity in the numbers of the sexes we may safely accept the latter explanation.

3. The preponderance of hybrids showing typical coloration of *cafer* combined with the red nuchal crescent of *auratus* contrasted with the scarcity of those showing the yellow and black characters of *auratus* shows a predisposition to acquire red in that part quite in accordance with the general law of coloration in the *Picidæ*, and may be considered a reversion to the characters of some common tropical ancestor from which the two species have originally been derived.

4. This tendency to assume red in preference to yellow or black colors fully accords with the southern dispersion of hybrids into *cafer* territory as contrasted with their non-dispersion into *auratus* territory.

5. The absence of records of pure *auratus* and *cafer* birds pairing together, and the abundance and evident fertility of the hybrids in some regions indicates the majority of hybrids are mongrels, i. e., the offspring of hybrid parent or parents as distinguished from those generated by distinct species.

6. It has been determined[1] that mongrels show a stronger tendency to revert to the characters of either parent than do hydrids. In *cafer-auratus* this would result in the final elimination of the hydrid element among these species. But we have seen that the tendency is toward an increase of this element.

A probable explanation of this may be found in the non-appearance of mixed characters in female hybrids by which pure-bred males are readily induced to pair with them and renew the tendency to variability.

Among the most significant queries which spontaneously arise in the mind regarding the case in hand, we may consider the following with possible profit: first, how did it happen? second, when did it happen? third, what will be the result? and fourth, what part has hybridization in the evolution or extinction of species?

Bearing upon the first question the effect of migration is of special import. In general, flickers are very hardy birds, able to resist the severest weather in sheltered localities as far north as the forty-fifth parallel. Over the country south of this the migration is less a southerly movement than a descent from the mountains into the valleys and a retreat to the densely wooded regions of the sea-coast. That the same conditions prevail on the Pacific coast I am assured by Mr. Fannin.

In the vast central territories of the continent north of the Rocky Mountains the southerly migration is more decided and far-reaching. A look at the map will show that the Rockies, after extending nearly due north through the United States from the headwaters of the Rio Grande to the northern boundary, suddenly contract from their easterly amplification in Montana and incline far to the north-west through British Columbia. South of the boundary along the eastern and western slopes of this vast landmark the migrating hosts of interior flickers of each species would respectively pass without much admixture. But in the headwaters of the Missouri region this movement becomes more complicated owing to the westerly configuration of the mountain system and the corresponding westward extension of the habitat of *auratus* north of it toward southern Alaska. Here the migratory movements of *auratus* first assume the character of an actual invasion of the habitat of *cafer*, and as we go further west the southerly migration of *auratus* from Alaska is directed by physiographic and climatic conditions to the shores of the Pacific, along which, from Sitka to California, resides the darker race of *cafer* known as *Colaptes cafer saturatior*.

It is here that conditions exist more favorable to hybridism between *cafer* and *auratus* than anywhere else along the frontier of their common distribution, and it appears extremely probable that the north-west coast of British Columbia was the first witness to their notorious alliance.

Viewed thus, the history of the distribution and evolution of these species over North America becomes of special interest. Starting with a common ancestry in the tropics and diverging northward over the great eastern and western mountain systems of the continent, they became differentiated in accord with the dissimilarity of their environments.

Readily adaptable to extremes of climate, both forms rapidly extended their northerly range into the border lands of the glacial epoch, *auratus* following its receding pathway along the Appalachian system into the Canadian lowlands and across British America in the westerly direction of the Boreal life zone, while *cafer*, spreading over the table lands of Mexico and across the Mexican boundary, reached the west base of the Rocky Mountains, between which and the Pacific it continued to extend until the changed climatic conditions of the North Pacific coast were encountered. From this point, having assumed the darker coloring of *Cleoptes cafer saturatior* it rapidly extended, under more favored circumstances, until it met the southward migration of Alaskan *auratus* with the result already described.

Bearing upon the second question, that of chronology, we have first pretty sure evidence of a recent extension of the habitat of *auratus* into more southern territory, where it had not formerly been recorded. Coupled with this is discovered a growing abundance of hybrids in the same region, indicating an aggressive movement of *auratus* into new territory.

From the rate of this movement and the breadth of common ground over which these hybrids breed it would appear to be of comparatively recent inception, possibly within the last few hundred years.

Owing to the scarcity of intermediate birds in what is considered the rightful habitat of *auratus*, the transmigration has apparently come from the north and east, over neutral territory, until the habitats of *auratus* and *cafer* adjoined along a line considerably east of the base of the Rocky Mountains, following their extension into British America and crossing them about latitude 33° to the Pacific coast. At this phase of their history the two species were probably unadulterated, the mountains continuing in a modified degree to act as a natural barrier to their further extension. These conditions having now made possible the acquaintance of the species, it is for us to examine whether there were any characters shared by them in common which would predispose the birds to more intimate relations and account for their apparently anomalous conduct. As a result we find that in habits, language, size, proportions, physique, and pattern of coloration the two species are indistinguishable, while in color alone they are different. If we take any animal (man included), and endeavor to bring about a union between different species of the same genus we find that in proportion as the parties to such union resemble each other in habits, language, etc., as above given, they will the more readily accept the situation, other considerations being of no great importance.

This much as regards not only the possibility but the probability of a voluntary union between species so circumstanced. I think we must consider the interbreeding of any two species subjected to similar conditions as not only possible but inevitable. It is not in this respect that the hybrid flickers of North America are unique, but in their persistent fertility and wholesale reproduction over a large area. While this instance has no parallel on so grand a scale in the present history of species, so far as known, it is likely that similar conditions have been and are exerting an important influence in the evolution of life as we now see it.

If this be true, we cannot too curiously consider the relationships of our eastern and western flickers, as time goes on, to determine if possible the laws which govern the progress of interbreeding of species in their natural state and whether they show that hybridization has any part in the evolution of new forms or the extinction of the old.

As observed, the present tendency in *Colaptes* resolves itself into an invasion of the hardier northern race upon their counterparts of the south, with the ready absorption of the characters of the former by the latter. This cross-breeding, in accord with laws now recognized, should produce mixed birds superior in some respects to their parents, combining the hardihood of *auratus* with the handsomer coloration of *cafer* and aggressively extend-

[1] Origin of Species, p. 261.

ing their influence in a manner quite independent of the customs and traditions of either parent, just as they seem to be doing.

Whether they will come to represent a distinct yet intermediate Rocky Mountain species, with *cafer* and *auratus* occupying a diminished habitat south-west and north-east of their enlarged domains, or whether, continuing southward, they will affect *cafer* through its entire range until that species, as such, disappears, replaced by a form combining the type characters of *cafer* with the red nuchal crescent of *auratus*, is a mystery the present cannot solve and the future will be loth to reveal.

CONCERNING OUR WASTE GROUND.

BY J. T. ROTHROCK, WEST CHESTER, PA.

FEW persons, except those who have been west of the Mississippi, have any real conception of the vast areas there which might well come under the head of "Waste Ground." To eastern eyes the miles of desert seem, from any productive standpoint, absolutely hopeless. A little examination, however, may reveal the fact that such a judgment is both hasty and erroneous.

It is quite true that these regions are dry and, at present, deserts whose vegetable productions are mainly cacti, sage-brush, and various species of Chenopodiaceæ. It is so true, though, that the elements of plant life are in the soil, that whenever a spring or a flowing stream appears, a more or less dense vegetable growth is seen also. Hence the western aphorism that the value of a man's farm depends not on its size, but on the quantity of water he can put on it during the growing season.

This preliminary statement leads to a consideration of the subject from two points of view. 1. Are the present natural productions of no value, immediate or prospective? 2. Are we utilizing the rainfall of those desert areas to the greatest advantage? It may be said that this second question starts a vast train of secondary considerations, quite beyond the limits of this paper.

As to the first question, it is a fact that thus far mankind has depended very largely on the more fertile ground for support. This is especially true of our own country. It was, of course, in the natural trend of events that a choice between promising and unpromising areas must of necessity lead to the selection of the promising first — the fertile before the barren, that which could be irrigated before that which could not be. Increasing population has left little choice, and the first probiem is, Of what value, if any, are these unattractive forms of desert plant-life? We may eliminate at once, without consideration, the sage-brush and the cacti, because they are of no great promise. The case is otherwise with the Chenopodiaceæ. This order of plants promises much. Its general character, to begin with, indicates latent possibilities. For example, it furnishes the beet, mangel wurzel, garden orach, and several species, also, of the mealy seeds are largely used by our American Indians as food. In South America, quinoa is an established article of food, and comes likewise from this order. Add to the above the fact that *Eurotia lanata*, another representative of the order, is a well-known and highly valued forage plant in some of the drier and more alkaline regions of our West, and the case would seem pretty clear that we have to do with an order which is well worthy of extended observation and experiment.

Here then are three points for consideration: (*a*) What plants of the order can be used as food, and what portions of them? (*b*) What does each promise in the way of improvement under *long-continued*, judicious cultivation? (*c*) Is there any way by which such seeds (of this order) as contain active properties can be treated so as to render them fit for food?

The fact at once suggests itself that here is a field of research, which (however promising) is mainly beyond reach of the individual observer. Time is a prime factor in the most important of the three questions. To test the capacity of any species fully for improvement would require *not less than a quarter of a century*, and, more than likely, a much longer period. It is fairly one of the problems which should be referred to a long-lived government, either for direct consideration by its own corps of experimenters, or, perhaps better still, by the agricultural colleges of each State in which such plants grow abundantly.

Among the Labiatæ (or mint family) the Chia (seeds of *Salvia Columbariæ*) appears. Its use among the aborigines dates back beyond our knowledge. We do know, however, that it was among the so-called "Aztec" races of Mexico an article of food, that it was accepted as tribute by the conquerors from the conquered, and that it still holds a place on the diet-list of the California Indians. Such, then, are some of the indications as to possible sources of food-supply which even the barren-ground portions of our country may be made to yield to an increased and hungry future population. Is it not, also, possible that desert plants, having useful properties, might be introduced, from other countries, into our own drier regions, with advantage to us?

The second part of the barren-ground problem — to obtain the largest utility from our rainfall — is already complicated by its association with existing State lines. Take, for example, the condition of affairs in Kansas, Nebraska, and Utah. Much of the water received by those States and the territory comes from the mountain slopes of Colorado, and how much of this water they shall receive depends also upon Colorado. Yet Colorado was the last of all to be settled. The continued prosperity of three earlier-settled States is contingent upon the wants, the caprice, or the cupidity of one later settled State. Clearly, there is something wrong in a political economy which makes such a condition possible. There is no probability that lapse of years will simplify the problem, and at once the question suggests itself as to whether drainage-lines should not promptly be regarded and acted upon as important factors in determining State boundaries. Here one comes in contact with political organization. All the States concerned (by their commissioners at least) must be in accord before any change of boundary can be made. And one can readily see the almost interminable line of contests, between statesmanship on the one hand and politics on the other, which such change will open up.

There is, however, another aspect from which this question can be viewed. Thus water-storage may, to a certain extent, remove the pressure of an inadequate water-supply. There seem to be certain districts, for example, that of the White Mountains of Arizona, where the rainfall is within a very few inches of enough to ensure crops. That this deficiency could be supplied during the growing season from storage basins seems more than probable. The exact method of constructing such basins so as to ensure the safety of the residents on the lower grounds is more doubtful than the benefits possible if the water were once hoarded.

NOTES AND NEWS.

PROFESSOR GEO. R. VINE of Sheffield, England, has recently distributed a report of a committee of the British Association for the Advancement of Science, appointed to investigate Cretaceous Polyzoa. In this conclusion to a series of investigations extending over a number of years, we have discussions of the species occurring in various sections, together with a catalogue of the Polyzoa found in the Chatham Chalk. In this, references are given to the original place of description of the genera and species, the classification of D'Orbigny being followed to a large extent. There is finally a catalogue of the species of British Cretaceous Polyzoa, numbering 283 species, with references to place of description and the geological or zonal distribution. Students of Polyzoa must be grateful to Professor Vine for the great amount of work he has done at various times upon this difficult group. In a second paper, reprinted from the Proceedings of the Yorkshire Geological and Polytechnic Society, Professor Vine describes and illustrates some new species, and remarks upon many others from Cretaceous horizons.

— "Mother and Child" is a compendium of modern scientific knowledge of the relationship between the parent and her family, which J. B. Lippincott Company will publish at an early day. It is prepared by Drs. E. P. Davis and John M. Keating, and contains information which is of importance to women's well-being, as well as in regard to the varied diseases of children. It is specially adapted to domestic use, but will also be valuable for trained nurses and the medical profession.