general location of the continental divide, one of the most interesting points of which lies to the north of the dome center between the heads of two competing streams on the wide floor of a subsequent valley that they have excavated along a belt of weak shales. To the south the underlying and stripped Shinarump and Permian strata rise toward the dome center; to the north the Wingate and higher strata stand up in three-story cliffs; the first brick-red member always excites the wonder of transcontinental travelers by rail or highway as they pass near its successive salients.

Each of the two bulletins above referred to[2] contains, first, a section on systematic geology in which the successive members of the geological column are concisely described; and second, accounts of the structure of selected areas. The bulletin on New Mexico, from the overlong title of which the first part should have been omitted, is a compendious handbook, exceptionally well illustrated and indexed. It must become, like the map, an indispensable companion for all geologists who enter the state.

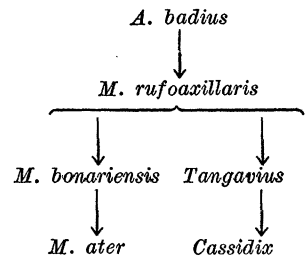
UNIVERSITY OF ARIZONA W. M. DAVIS

SCIENTIFIC BOOKS

The Cowbirds, A Study in the Biology of Social Parasitism. By HERBERT FRIEDMANN. Charles C. Thomas, 1929. 421 pp., 29 pls., 13 text-figs.

ALTHOUGH this book contains the results of only a portion of Dr. Friedmann's researches on parasitic birds, it probably represents the most important contribution to ornithology within recent years. It is, moreover, of no little interest to the parasitologist and entomologist. The parasitic behavior which consists in ovipositing in the nests of alien species and leaving them to rear the resulting young has been observed in members of no less than five natural families of birds: the cuckoos (Cuculidae), cowbirds (Icteridae), weaver-birds (Ploceidae), honey-guides (Indicatoridae) and ducks (Anatidae). The present work, which is confined to a detailed field-study of the cowbirds, with an account of their geographical distribution, taxonomy and ontogeny and an extensive citation of the pertinent literature, is an admirable demonstration of the kind of ethological investigation that has to be accomplished before the physiologist or experimentalist can even approach the fundamental problems of parasitism.

The cowbirds are a rather compact group of American Icterids comprising three genera: Agelaioides, with two species and three subspecies; Molothrus, with three species and ten subspecies, and Tangavius, with two species and three subspecies. One species of Agelaioides and one of Tangavius are known only from a few museum specimens. The greater part of the volume consists of an account of *A. badius, M. rufoaxillaris,* and *M. bonariensis* which Dr. Friedmann was able to observe in Argentina, of *M. ater,* which he studied very thoroughly in the United States, and of *T. aeneus,* which he observed in southern Texas. There is one other Icterid parasite, the neotropical rice grackle, *Cassidix oryzivora,* to which a short appendix is devoted. The study of geographical distribution, habits (especially courtship and song) and the ontogenic development of coloration all indicate that the phylogenetic relationships of the parasitic Icterids conform to the following scheme:



The baywinged cowbird, *A. badius,* which occurs in Argentina, Uruguay, Paraguay, Bolivia and southern Brazil, is the most primitive form of the series and is non-parasitic, except to the extent that it appropriates, either peacefully or by force, the nests of other birds, particularly those of wood-hewers, spinetails and oven-birds (Anumbius, Synallaxis and Furnarius). It may still exhibit the nest-building instinct, especially early in the breeding season, and usually adds to or rearranges the materials of the nests of which it takes possession. Its breeding instincts are still intact. Dr. Friedmann regards it as the direct ancestor of the screaming cowbird, *M. rufoaxillaris,* the parasitic habits of which were first studied by W. H. Hudson. This bird has the same range as *badius* and lays its eggs almost exclusively in the appropriated nests of its putative ancestor. The shiny cowbird, *M. bonariensis,* with its eight geographical races, or subspecies, ranges over nearly the whole of the South American continent and has become a general parasite on a large number of birds. Its eggs have been found in the nests of ninety-eight different species, eighty-four of them being parasitized by the typical subspecies *bonariensis* alone. Hudson and Friedmann observed occasional abortive attempts at nidification in the shiny cowbird. It pecks holes in the eggs of its host. Its own eggs show great

[2] N. H. Darton, "A Résumé of Arizona Geology," Bull. 110, College of Mines, University of Arizona, 1925; and by the same author, "Red Beds and Associated Formations in New Mexico, with an Outline of the Geology of the State," Bull. 794, U. S. Geol. Surv., 1928.

variation in color, form and size. According to Hudson, it lays from sixty to one hundred eggs in a season, but Friedmann finds that the number is only six to ten. Several females may lay in the same nest. In one nest of a rufous oven-bird Leo Miller found thirty-seven eggs. "As many as thirteen different cowbirds have been found to lay into the same nest in one of these extreme cases late in the season." This intensification of parasitism is due to the great abundance of *M. bonariensis* as compared with the North American *M. ater* ("certainly twice as abundant"). *M. bonariensis* also destroys or even devours a great many eggs of its own species when it finds them in a nest.

> In this way, in regions where the cowbirds are exceedingly common and checks upon their increase at the expense of the rest of the bird population are lacking, the species acts as a check upon itself. If it did not the rapid increase of the cowbirds in any locality would soon cause a scarcity of hosts, which would in turn cause a diminution in the number of young cowbirds raised, which in turn would give the fosterers a chance to increase again, and so on in an endless series of waves of depression and inflation of the population both of the parasite and its victims. This egg-pecking habit tends to maintain a normal, instead of a shifting, status of bird population.

Dr. Friedmann believes that the egg-pecking had its origin in the habit of throwing out the eggs of the host.

The most nearly complete study—a veritable monograph in itself—in the volume is on our North American cowbird, *M. ater*. Though evidently of neotropical origin, this species and its three subspecies are now confined to southern British America, the United States and temperate Mexico. Many interesting facts are recorded in regard to its distribution, migration, courtship, eggs and egg-laying, the development of the young, their instincts and plumage, the moults, food and association with cattle in the adults, the relations to other birds, longevity, etc. The sections on the hosts and relations to cattle will be read with particular interest. All the host records have been conscientiously collated with the result that the cowbird is now known to lay its eggs in the nests of 195 different birds belonging to 158 species, 103 genera, twenty-five families and eight orders. Of course, the successful rearing of the young depends on the character of the chosen host. It must be an altricial species with eggs of about the same size as those of the cowbird and possess similar habits of feeding its young. Sometimes the cowbirds lay in the nests of birds with habits too aberrant to act as foster-parents, such as hawks, doves and swallows. Nests in holes are usually avoided. The only families of Passerine birds not known to be parasitized are the shrikes (Laniidae), dippers (Cinclidae) and wagtails (Motacillidae). The dippers breed at too high an altitude and only one species of wagtail breeds within the cowbird's range. The Corvidae (crows and jays) have too large eggs. Of the 195 different host birds listed by Dr. Friedmann, ninety-one have been definitely recorded as rearing the young parasites. Some birds, *e.g.*, the robin, catbird and yellow-breasted chat, absolutely refuse to tolerate the eggs. The robin and catbird toss them out of the nest and various vireos, warblers and the redstart build over them. Many birds desert their nests if the cowbird lays in them first, and the yellow-breasted chat does this even if it has eggs of its own and notwithstanding the similarity of the eggs of the two species. The majority of the species, however, seem not to notice the presence of the cowbird eggs and proceed to rear the hatching young. As a rule the cowbird lays only a single egg in a nest and while the owner is away. Moreover, it rarely lays in a nest containing partly incubated eggs or hatched young. Often the host eggs fail to develop or disappear (probably thrown out by the young cowbird).

> When some of the rightful eggs hatch the young are usually starved or suffocated by the young cowbirds, although nests are occasionally found in which one or more of the young survive together with the interloper. . . . The young cowbird usually tries to trample on the other young in the nest and to this extent the death of the rightful young may correctly be attributed to the volition of the parasite. The question of starvation is, however, somewhat different. Birds do not feed their young in any definite sequence but always feed the one that seems hungriest first. Hunger is expressed by the food-reaction, *i.e.*, the elevating of the head and opening of the mouth with the associated food calls. The bird with the longest neck and biggest mouth gets the food, and the cowbird usually answers these requirements. Naturally endowed with an ample length of neck and size of mouth, the cowbird usually possesses two additional advantages over its nest-mates. First, it is larger to begin with, thereby enabling it to raise its head higher, and second, it usually hatches a day or so before any of the others and thus gets a start on them.

The cowbird owes its name to its frequently observed association with cattle, the bison formerly, and domestic kine, horses and sheep at the present time. The various interpretations of this association which is most apparent from midsummer to the time of the autumn migration of the birds are discussed and the conclusion is reached that, contrary to the opinion usually held, the cattle themselves do not provide the birds with an adequate supply of food in the form of ticks, flies, bot-fly larvae, etc., but as they move about the pasture stir up the grasshoppers,

leaf-hoppers, etc., and thus facilitate their capture by the birds. Grasshoppers and leaf-hoppers appear to be the cowbird's favorite food, the former constituting 11 per cent., the latter 45.1 per cent. (in August) of the stomach contents that have been investigated.

All these insects are naturally hidden in the grass and would be difficult for the cowbird to obtain were there not some agent to cause them to jump up and reveal themselves. The grazing action of the buffaloes (or the cattle) provides exactly such an agency. The animals do not cause or bring about a supply of food for the birds but help them to find the stores of food existing all around them.

This is very probably the correct explanation, and reminds the reviewer of his experiences while walking through thickets in New Zealand in 1914. After entering the vegetation he was often accompanied by a small fly-catcher (Rhipidura), which was so tame as almost to alight on his sleeve or insect net. At first he was inclined to regard this as an exhibition of extraordinary friendliness, but soon noticed that the bird was merely acting as his *fidus Achates* in order to feed on the midges and small moths which he stirred up in his progress through the shrubbery. Subsequently the same species of fly-catcher was seen accompanying grazing cows in the same manner and with the same object.

The account of the red-eyed cowbird, *Tangavius aeneus,* which inhabits Central America and tropical Mexico and enters the southern border of the United States, is rather brief. This bird was studied by Dr. Friedmann in the Lower Rio Grande Valley.

The red-eyed cowbird victimizes relatively few species of birds. The various species of orioles seem to be the chief hosts of this parasite. When we consider that of all the species in the genus Molothrus, the screaming cowbird, *M. rufoaxillaris,* is the nearest relative of the red-eye, this restriction of the parasitism of the latter to relatively few species becomes particularly interesting. The screaming cowbird is parasitic almost solely on the bay-winged cowbirds, its closest relative, while the red-eye, not having any non-parasitic cowbirds to victimize, has taken to using the nests of an allied genus, Icterus, to a very large extent. It is also gradually widening its sphere of activity to include more and more genera and species and at present is known to victimize eleven genera and seventeen species and subspecies, but about 75 per cent. of all the eggs are laid in nests of Orioles. I have data on seventy-six victimized nests all in all and of these no less than fifty-one belong to four species of Icterus.

The rice-grackle, *Cassidix oryzivora,* which looks like a larger edition of Tangavius, ranges (with three subspecies) from Southern Mexico to Paraguay, Southern Brazil and Missiones in Argentina. Its parasitic habits were first observed by Goeldi (1897) in Brazil, where it lays its eggs in the nest of *Ostinops decumanus* and *Cassicus perseus.* Chapman has recently observed it on Barro Colorado Island, Panama, victimizing *Zarhynchus wagleri.* Other hosts in South America are *Gymnostinops montezuma* and *Ostinops cristatus.* Apparently the young Cassidix does not always starve out the host young.

To the general reader the closing chapter of the book on the origin and evolution of the parasitic habit in the cowbirds will prove to be the most interesting. After reviewing the various authors from Aristotle to F. H. Herrick, G. M. Allen and E. Chance, Dr. Friedmann is inclined to accept Allen's view that parasitism has arisen independently in each of the various groups (cuckoos, cowbirds, weaver-birds, honey-guides and ducks). He calls attention to the fact that

All the cowbird's closest relatives are nest-builders; in fact, its family, the Icteridae, is known as a family in which the nest-building instincts reach their pinnacle of development. . . . Within the genera Agelaioides and Molothrus we find several stages in the evolution of parasitism exhibited by different species. The bay-winged cowbird, *A. badius,* uses other birds' nests and lays its eggs in them but incubates and rears its own young. Sometimes it makes its own nest. The shiny cowbird, *M. bonariensis,* is parasitic but has the parasitic habit very poorly developed, wasting large numbers of its eggs. Rarely it attempts to build a nest but in this it is never successful. This indicates that originally it built a nest but no longer knows how. The North American cowbird, *M. ater,* is entirely parasitic but is not wasteful of its eggs. The screaming cowbird, *M. rufoaxillaris,* carries the evolution of the parasitic habit in a different direction to some extent in that it tends more towards specificity in hosts.

Since all the cowbirds establish breeding territories but show a diminishing tendency to defend them *pari passu* with the development of the parasitic habit, it is inferred that the breaking down of this instinct, especially in the male, is the immediate cause of parasitism. Another factor in producing this singular behavior is a disharmony in the cyclical instincts of nidification and oviposition in the female, as suggested by Herrick. In most birds nidification, of course, precedes oviposition, but if the latter is hastened by physiological stimuli (sight of other birds' nests or eggs, etc.) the latter may become vestigial as in the Argentinian, or suppressed as in the North American species.

A question that can not be answered but that nevertheless keeps cropping up is whether parasitism originated very gradually in a large number of individuals comprising a group or a species or whether it began

after the fashion of a mutation in a very few individuals. There is much to be said for both sides but neither leads us to any definite conclusion. The processes and methods of evolution are clear until we attempt to study any single case.

To the entomologist Dr. Friedmann's studies are unusually suggestive because they disclose so many analogies with the parasitism of social insects (wasps, bees and ants). There are similar indications of an origin of parasitism in struggle and parasitism, of preference for single or multiple hosts, of a lapse of nidificatory behavior owing to precocious readiness for oviposition, and, in one case at least, of a derivation of parasitic from host species. This is clearly shown in the parasitism of *M. rufoaxillaris* on its ancestral species, *A. badius,* a condition strikingly paralleled among parasitic wasps, bumblebees and ants. In other respects, however, the cowbirds, cuckoos, etc., are more like certain non-social insect parasites, such as the Mutillids, Sapygids, Chrysidids, etc., because in these cases we are concerned merely with brood-parasitism as in the cowbirds and not also with an adoption of the mother parasite in the nests of the host as in the case of *Vespa austriaca* and *arctica* among wasps, the various species of Psithyrus among bumblebees and such parasitic ants as *Formica sanguinea, Polyergus, Anergates,* etc.

The volume is well printed though it contains some unfortunate typographical errors; the bibliography is ample and there is an excellent index.

W. M. WHEELER

BUSSEY INSTITUTION

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A VIBRATO TONOMETER

THE recent recognition of the significance of the vibrato in artistic singing has created the need for an apparatus suitable for demonstrating the various forms which the vibrato may take and for carrying on psychological and esthetic experimentation on the perception of the vibrato. The vibrato tonometer has been developed for the purpose and is recommended to experimenters because of its simplicity, convenience and relatively inexpensive construction. With it a vibrato may be produced with the number of oscillations per second, extent of the frequency fluctuation, extent of the intensity fluctuation and frequency-intensity phase relation under separate control.

The apparatus consists of a pipe, similar to an organ pipe, enclosed in a partially sound-proof box. The frequency is varied by an oscillating movement of the plunger, and the intensity by a sliding door in the side of the box. The plunger and the door move back and forth at the same frequency. Both are controlled by scotch-links, which impart a sinusoidal form to their movements. The device is operated by a hand crank, and when turned in rhythm with a metronome, or other timing device, the rate of the vibrato produced can be very accurately controlled. The ratio of the pulleys is such that each revolution of the hand crank produces three vibrato cycles. Thus, by setting the metronome at a known number of beats per minute, a vibrato of any desired number of cycles per second can be produced.

Two scotch-links are used, one controlling the frequency and one the intensity fluctuation. They are mounted on opposite ends of the same shaft, which is turned by a belt from the hand crank. The use of adjustments on the pins of the scotch-links makes it possible to vary independently the amount of the frequency and intensity fluctuations, respectively, from zero to the maximum used in an artistic vibrato.

By changing the position of the scotch-links on the shaft with respect to each other, any phase relationship desired between the frequency and intensity fluctuations can be produced.

The device thus provides for the production of a vibrato with independent control of the extent of the frequency fluctuation, extent of the intensity fluctuation, rate and frequency-intensity phase relationship.

JOSEPH H. TIFFIN

UNIVERSITY OF IOWA

LABORATORY USES OF ULTRA-VIOLET TRANSMITTING GLASSES

IT may be of interest to those who are not familiar with the special glasses, particularly those biologists and chemists who are studying the effects of ultra-violet on bacteria or on chemical decompositions and syntheses, to learn that satisfactory containers can often be blown of glass. The new glasses vary in short wave-length transmission limit from about 2500 A to 3000 A, so that within this range it is possible to study the effect of wave-length by employing test-tubes, flasks, etc., of different materials. Each container acts as a filter, making external filters unnecessary. Of course, for wave-lengths shorter than 2500 A quartz or else open containers would probably be employed.

I have recently had occasion to study the emission of the 2537 A mercury line under such a variety of conditions that a large number of very special shapes and sizes of discharge tubes was required. To have used quartz with the necessary graded seals or graded