gether that if the motor stops, the aeroplane will immediately settle down upon *terra firma.* In his enthusiasm the Brazilian aeronaut forgets also that at least three experimenters in America (Herring in 1898, Whitehead in 1901, and Wright brothers in 1903), Maxim in England (1896), and Ader in France (1897), have already flown for short distances with motor-driven aeroplanes, and yet no really practical machine of the kind has as yet been produced and demonstrated. Langley's experiments showed which was the most efficient shape of plane, and how much a given-sized plane would lift at different speeds; but with all this data to build upon, no one has produced an automatically stable machine, i. e., one with which the occupant has only to run the engine and to steer.

In view of these facts, we do not look for the sudden perfection of the aeroplane flying machine. The public successful flight of Santos Dumont will increase the interest in such machines, and stimulate inventors to further research and experiment in the science of dynamic flight without buoyant gases.

## WHAT DO THE BIRDS EAT?

BY HELEN LUKENS GAUT.

In order to determine the harmful or beneficial relations of birds to agriculture, horticulture, and all plant life, a remarkable work is being carried forward by Prof. F. E. L. Beal, who is in charge of the Division of Economic Ornithology of the Biological Survey, United States Department of Agriculture at Washington, D. C. Prof. Beal has alone examined over thirty thousand bird stomachs, the greatest work of the kind ever accomplished by a single man, while his assistants have examined an equal number, making over sixty thousand in all. A seemingly endless task it is, investigating with a microscope each minute particle in each of these thousands of stomachs, yet all this has been accomplished in a period of seventeen years. When one considers that to do this intelligently and successfully requires a thorough knowledge of the anatomy of bugs and insects, and a familiarity with characteristics of the seeds of both domestic and wild plants, the labor assumes formidable proportions to the uninitiated. To increase their knowledge, workers in this line must spend much time in woods, gardens, and fields, studying hundreds of species of insects, worms, and bugs. The results of these investigations, which are invaluable to science, and of great practical importance to the American farmer, have led to a movement that can intelligently favor the increase of such bird species as are best adapted to preserve the proper balance of nature, and reduce the number of those that prey too greatly on the products of orchard and field. Ornithologists from all parts of the country, and in many instances special field agents who have been engaged for the purpose, forward great numbers of bird stomachs to the department, and thus aid in the practical and scientific research.

It is difficult, almost impossible, to determine what a bird eats by his actions, as he frequently goes through all the motions of eating a hearty meal without taking a thing. The "proof of the pudding" is found in the bird's stomach. If he is loaded with garden seeds, cultivated fruits, or beneficial insects (parasites on other insects), he is relegated to the black list; but if examination reveals a goodly number of bugs, worms, and insects that are injurious to plant life, he is hoisted high upon the pedestal of usefulness, and woe betide the human who does him bodily injury, or tries to besmirch his character.

The contents of a bird's stomach consist of a pulverized, soggy mass, and it is necessary to separate and study each minute particle in order to determine to what species of fruit or insect it belongs. Caterpillars are sometimes recognized by their skins, always by their jaws, and the tiny chitinous plates that surround the breathing holes. The presence of ants and wasps is discovered by the hard thorax, spiders by their mandibles, and sometimes by their eyes, which sparkle in the stomach mass like rubies. Angleworms have hard, indigestible spicules, which project from their sides. Beetles have fierce bony jaws, grasshoppers hard mandibles and tiny leg-armor plates, and so on through the entire insect world. The greatest difficulty is experienced in determining the species of fruit found in stomachs. Usually it is crushed, and if it contains no seed, the only method of examination available for the investigators is to place particles of skin under a microscope and discover the texture. Grain can be recognized by the shape of the starch granules when other methods fail.

"Most astonishing things have been found in the stomachs of birds, everything but diamonds," says Prof. Beal. "A bird stomach which had been kept in alcohol for two years, waiting its turn to be examined, contained poison oak berries, which are the favorite food of many birds. The man who examined this stomach was badly poisoned. Vicious and deadly-poison spiders constitute a favorite bird food. The mere touch of a blister beetle would scorch the flesh of a human, yet in the stomach of one king bird, fourteen of these fiery creatures were discovered. Caterpillars with stinging spines, beetles with acrid secretions that are bitter and burning, bugs with an odor so fierce that a skunk is fragrant in comparison, and fruit bitter and rasping as quinine, and thousands of other obnoxious things, are consumed greedily by the feathered throng."

While sojourning in some localities, certain species may do inestimable damage to crops, after which they migrate to other fields, where they charm with their sweet music, their good nature, and their innocent and harmless demeanor. For instance, the bobolink ravages the rice fields of the South, annually destroying millions of dollars' worth of rice; then, as if remorseful, he wings his way to the North, where he is thoroughly well-behaved, where, with his sweet voice, immaculate decorum, and his propensity for eating bugs and other insects injurious to crops, he earns an enviable reputation. But after the fashion of "Jekyl and Hyde," his methods change with abruptness, and he becomes an incarnate fiend when he returns to the southern rice fields. So great a pest is he to the planters, that in one season 2,500 pounds of gunpowder were used on one plantation in an attempt to reduce his numbers.

After examining hundreds of linnet stomachs, the investigators have passed the verdict that this bird is an abominable pest, with but few redeeming qualities. He ignores insects that are injurious to plant life, and gleans his living by robbing the wealth of orchard and field. He works with systematic energy, defoliating trees, eating fruit, and scratching up seed. He is a cheery, well-groomed little fellow, but he is wicked, deserving all the bad names and gunshot bestowed upon him. Birds are most seriously harmful to crops when a single species is super-abundant in a certain locality, and there is no remedy other than an unsparing use of powder and shot, else orchards will be devastated, the labor and hopes of the farmer be lost, and families left financially destitute.

Crows do immense damage in New England corn fields, and about the only method of protection is to tar the corn before it is planted. The efficiency of this scheme was demonstrated by Prof. Beal, who planted several acres to corn. Toward the end of the planting the supply of tar ran out, and he was compelled to finish without it. The areas planted to tarred corn were ignored by the crows, while the untarred patch furnished a glorious picnic ground for the croaking banqueters. Though crows are ravenous corn eaters, it is stated that this fault is more than counteracted by their usefulness in destroying harmful insects. In one crow's stomach the investigators found the mandibles of ninety grasshoppers, showing that these birds are partial to such food. Robins steal fruit with a vengeance, and many an eastern farmer has been near distraction because of the ravages of these birds. It has been discovered, however, that they prefer wild fruit, and that whenever it is obtainable they scorn fruit that is useful to man. In the stomachs of three hundred robins were found the seeds of forty-two species of wild fruits, and only four or five domestic. Because of this preference, the department suggests that wild fruits be planted in close proximity to orchards, so that birds may be attracted and kept out of mischief. As many of these wild growths are ornamental, the advantages of having them about would be doubled.

Woodpeckers are both harmful and useful. The good they do is in excess of the injury. Flickers thrive on ants. In a single stomach were found five thousand of these little pests. The ants best liked by the flickers are those that befriend plant lice, carrying them from one growth to another, as each becomes defoliated. The red-bellied woodpecker, common in the north of Pennsylvania, causes some disturbance in the orange groves of Florida by pecking holes in the ripe fruit. The yellow-bellied woodpeckers, indigenous to the northern part of the United States and the Alleghany Mountains, have an exasperating trick of girdling trees, and pecking holes in the trunks in order to obtain a sap that exudes from the bruises. They also eat insects that become imprisoned in the glutinous sap.

On expanding leaves and flower buds plant lice accumulate, and most of the warblers perform a work of benevolence for the farmer by going over orchards systematically, and gleaning the offensive and destructive insects. They are indefatigable insect exterminators, and are of great value to the world of agriculture. Meadow larks and cuckoos are helpful, and have no black marks against their names in the ornithological records. The worst insect enemies of the fruit grower are caterpillars, cankerworms, fall webworms, tussock moths, and codling moths. All these creatures the cuckoos dispose of with gusto and dispatch. Few other birds will eat the hairy caterpillars, because the stiff hairs pierce the inner lining of most bird stomachs, and produce discomfort. But the cuckoo experiences no bad result, though sometimes his stomach is completely furred with these hairs. As the food rotates in the stomach, these hairs are brushed round and round like the silk nap of a silk hat. In the stomach of one cuckoo the remains of two hundred and fifty tent caterpillars were found. Bushtits and other small birds are found invaluable for ridding orchards of scales and minute insects that destroy the value of crops. The microscopic eyes of these birds detect the tiniest insect eggs and every species of life, and they perform tasks in insect extermination that would be impossible for man. It is said they can be attracted to orchards by hanging meat on trees.

Hawks and owls are useful to orchardists, for they prey on gophers, ground squirrels, field mice, rabbits, and many other rodents that do great mischief in girdling trees and stealing seeds. True, these birds sometimes feed on small birds and poultry, but their chief food consists of harmful rodents. This was proved by examining two hundred and seventy stomachs. Out of the seventy-three species of these birds to be found in the United States, only six were found to be really harmful. Some States have offered bounties on hawks and owls, while rabbits are allowed to go their mischievous way unmolested. Rabbits are found to be of more harm to farmers than they are of value as food. Owls and hawks are helpful, and it has been suggested that the bounty be placed on the head of the erring rabbit, and removed from those of the enterprising birds.

## SCIENCE NOTES.

Free ammonia in water always indicates organic matter in the process of decomposition. In polluted surface waters it is rarely high, being removed almost as fast as formed by vegetable and animal organisms in the water, and an amount of nitrogen as free ammonia above 0.05 milligramme per liter is unusual, and if it does occur the water cannot be considered as an unpolluted water unless that fact is clearly established by other data.

According to the recent experiments which have been made by Prof. Niccolo Vaccaro, connected with the physical department of the University of Genoa, relating to the spectrum of nitrogen in a magnetic field, he finds that when applying the field so that the lines of force run transversely through the tube containing the rarefied nitrogen, in which the electrodes for the discharge are placed at each end of the tube, the phenomena vary to a considerable degree according to the pressure in the tube, the latter being connected to an air-pump. The present researches, which were made with considerable detail, show in general that when using pressures which are relatively high, the spectrum in the tube of rarefied gas increases both in luminous effect and in the number of lines under the influence of the magnetic field. But for very low pressures the effect is seen to be clearly inverted, and the magnetic field has a weakening effect. He finds that there is a critical point at which no effect is observed from the field, and this is at a pressure of 0.02 inch of mercury in the tube. At this point the magnetic field has no appreciable influence upon the spectrum of the rarefied gas.

A French chemist, L. Ouvrard, has formed a series of new compounds, the boro-stannates of the alkaline earths. He has also succeeded in reproducing the mineral nordenskioldine by artificial means. Researches upon the metallic borates led him to form the boro-stannates by different methods, and among these is the boro-stannate of calcium, which is identical with the above-mentioned mineral. First, he tried by fusion, in chloride of calcium, of a mixture of boric acid or borate of lime and broxide of tin. Here the reaction is not decisive, and no doubt there results a chloro-borate. A better method is to mix in a platinum trough, the precipitated borate of lime, corresponding nearly to $CaO, 2B_2O_3$, with a small quantity of broxide of tin coming from the calcination of meta-stannic acid. The trough is placed in a porcelain tube and brought to a white heat, while passing a slow current of hydrochloric acid vapor. After three-quarters of an hour he finds a melted opaque mass, covered with hexagonal scales, some of which are also deposited upon the trough. These scales, when isolated, are found to be the boro-stannate of calcium $B_2O_3$, $SnO_2$, CaO. This body is colorless and transparent, and not easily melted. It scarcely dissolves in hydrochloric acid, even when concentrated. The crystalline scales are fragile, with a glassy lustre, and resemble the natural mineral. Some of the largest ones are 0.05 inch wide and 0.0004 thick. This compound is identical with the mineral nordenskioldine, which was described by Brügger in 1887. By an analogous process, he was able to form the corresponding compounds of strontium and barium. These, however, are more difficult to produce. Using as above a current of gaseous hydrochloric acid at a red heat he obtains some scales of boro-stannates mixed with numerous crystals of casserite. By reacting upon stannic chloride the results are generally better, and he was able to form the new compounds of barium and strontium in a nearly pure state. These are crystalline bodies having about the same appearance as the calcium compound.