

American Bitterns were heard more frequently than usual and Great Blue Herons were very numerous. About a hundred were in sight at one time, perched on spiles in the lake. These herons have increased over a wide territory, due, no doubt, to better protection. For the same reason, two American Egrets were seen by Dr. Graefe east of Sandusky and by observers in other places in northern Ohio in July or early in August.

Of ducks, the most notable increase was in Wood Ducks, many of them reared in the marsh. Several times in September, he observed a hundred or more at a time. Men employed to guard the marsh said they had seen as many as 500 Wood Ducks. Gadwalls, although they do not stay in the marsh continuously, were more numerous than for five or six years before.

Mallards, Black Ducks, and red-legged Black Ducks, were about as common as in previous years; teals of both kinds were rather more numerous than usual, Pintails less numerous. More Pied-billed Grebes were seen than usual.

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THE ECONOMIC IMPORTANCE OF BIRDS AS INSECT PREDATORS

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On the surface this may seem a simple subject to discuss. We all know that many birds live on the insects they capture and we also know that insects are always on hand to be eaten, so what is there to talk about? The bugs eat the gardens and the birds dispose of the bugs and save vegetation, consequently the birds are the salvation of the gardeners and the farmers.

I suspect this is the general and popular view of this subject, particularly among ornithologists, many of whom imagine that farming would be a failure if it were not for the birds that control and destroy insect pests. Like most questions, economic ones especially, there are two sides to this one and I want for a few minutes to turn it around so both sides may be seen.

We are aware that animate nature is a tremendously complicated affair, with all its forms of life, animal and vegetable, so intimately combined and correlated that it is simply impossible to deal with or even discuss any one section of this vast complex and ignore any other part. No one realizes this more than an entomologist, who is,

in economic work particularly, continually endeavoring to solve the problems of life histories in order that the relations of insects with one another and with the entire structure of the world around them may be clearly understood. It is a well known fact that there are very few organisms, plant or animal, simple or complicated, that do not have, somewhere in their life cycle, some critical period when they are vulnerable, when they offer the least resistance to outside attack. This fact is really the basis of our work as members of the Federal Bureau of Entomology and it is only because of this fact that insects do not multiply to such an extent as to drive us from the earth.

The enormous possibilities of insect multiplication are not generally appreciated by those who are not entomologists, and it may be worth while to mention this angle of the subject in passing in order to get some conception of the great menace of the insect world. Of course it must be understood that, fortunately, the theoretical and actual figures do not coincide; nevertheless the theoretical figures are given below.

Many of our crops are attacked and destroyed by the larvae of certain moths and beetles. The adult females of many of these moths and beetles deposit something like 300 eggs each.. The first female moth or beetle will place, the first year, say, 300 eggs.. These will hatch and the following year there will be 150 pairs. $150 \times 300 = 45,000$. The second year there will be 22,500 pairs. $22,500 \times 300 = 6,750,000$. All this in three years from a single female. Now supposing, as is often the case, that there are 1,000 females in one field, you can estimate the enormous increase that might result. Figures similar to these may be theoretically true of a great many of our farm and garden pests and some of these pests can make an even better showing.

You may not be acquainted with the classic illustration used by Thomas H. Huxley in demonstrating the tremendous possibility of multiplication of plant lice. These plant lice, or aphids, are about the size of a large pinhead, their bodies are mostly liquid and they can be crushed by a mere touch. Assuming that an aphid weighs but $1/1000$ of a grain and that it requires a very stout man to weigh more than 2,000,000 grains, Huxley shows that from a single aphid the 10th brood alone would contain more weight than 500,000,000 men, or more than the entire population of China. Buckton, an eminent English scientist and student of aphids, criticises these figures as being much too small. He says that if a single aphid, such as one sees on rose bushes, should begin to reproduce and each individual should live but twenty days, at the end of 300 days the living indi-

viduals would number almost 33 quintillions, equal to the weight of 1,638,400,000 men. Another mathematician figures the problem another way and proves that the total number of living aphids that could be produced from a single female in one season would be represented by 210 raised to the 15th power, a number almost impossible to express in figures. If these computations are new to you they may impress you with some idea of what the human race is up against in its fight with the insect world for existence or even for standing room.

I have said that these figures are theoretical and not actual. I suppose the only thing that prevents them from becoming actual is the presence of various destructive agencies with ability to keep down these staggering totals. There are many of these agencies busy every minute, some of them strikingly apparent, others effective but not visible, always engaged in unceasing warfare against the enormous increase of insect life. The great army of insect-eating birds is aggressive in this fight and these birds are entitled to full credit for their efforts in our behalf. Under normal conditions these birds seem able to secure enough insects for their daily needs, for themselves and their offspring. The numbers of these birds remain about the same year after year in the same locality. The constant fatality to bird life probably accounts for the lack of increase in any given neighborhood although countless broods are launched on the air each year.

As I have said, under normal conditions these birds appear to find enough insects for their needs. Now suppose some insect pest eludes its parasites or other enemies and its numbers are, for the time being, increased a thousand fold. The birds that feed on it cannot by any trick of reproduction multiply in time to diminish the pest to an appreciable degree, especially if the outbreak covers a large area, as is often the case. The percentage of any insect that will be destroyed by birds naturally drops far below normal in case of an outbreak. A few sporadic cases are on record, exceptions to the general rule, where birds have moved in, concentrated and effectively reduced the numbers of the marauders. But even in such cases nature depends very largely on parasitic control and is justified in doing so. If cutworms increase birds will manage to find a few of them. But the cutworm has at least a dozen species of parasitic enemies, and if one of these species should happen to be at a low ebb as to numbers there are usually plenty of others that will come to the rescue and subdue the common enemy. If man is to exist on the earth the equilibrium must be maintained by some means.

In this connection it may be in order to explain, before going farther, that a parasite is an insect that lives on or in some other insect and is dependent on that insect for its food supply. Parasites are of an almost infinite variety of size, shape, and habit. They become adapted to their environment and their presence adds greatly to the complexity of the study of insects. They form one of the chief factors in insect control even though often microscopic in size. In New Mexico, years ago, I watched a tiny parasite drilling into the eggs of a moth in the heads of kaffir corn, placing its own egg within the other egg, the moth's egg being about the size of a grain of mustard seed. From one of these I reared three parasites that had found sufficient nourishment within that small egg to bring all three to maturity. Other parasites are even much smaller than these. One species, barely large enough to discern without a lens, is very important in the control of the Hessian fly which is a serious enemy of the wheat crop. Some years ago I dissected one of these very small Hessian fly parasites and counted approximately 3500 eggs in her ovaries.

The point I am making is that, useful as birds are in their way, they can seldom be depended on, unaided, to rid us of our insect enemies. Especially is this true in an emergency when quick relief is demanded. The fact that parasites are able to multiply in prodigious numbers at times, whereas birds are very limited in their ability to increase, marks one difference between these friends of men.

The much advertised corn-borer affords an interesting note on the situation I am trying to describe. The corn-borer comes from Italy or at least is present in that country. And it is said to do very little damage there. Italy is one part of Europe where birds are few in number owing to the fact that even the song birds are used for food at times. When the borer reached the United States, where birds are protected as in no other country on the face of the earth, the borer at once became a menace and remains so to this day. Our birds seem to be useless as far as this problem is concerned. When the parasites now being imported from Italy are distributed and acclimated it is hoped that the corn-borer will become less harmful, but the birds will get little credit unless they get busy.

One fact of importance should be borne in mind in this discussion, namely, that control of insects by birds depends wholly upon the numbers and the appetite of the birds concerned. No matter how many birds are busy, as soon as they are sated with food they are at

the end of their usefulness for the time being. On the other hand, in the case of parasites, appetite has nothing to do with the limitation of their work. With them it is merely a problem of hunting their victims on or in which to place their eggs. The more victims they can find in a given length of time, the more eggs are placed, since, as a usual thing, their supply of eggs is practically unlimited. It seems to me that these facts will explain why parasites have checked so many outbreaks and why birds are so often powerless in the matter of control. Do not understand me to be minimizing the value of birds in their every day labors against injurious insects, but my observations would lead me to believe that they are often overrated. During my twenty-three years of official work I have been in immediate contact with a number of serious insect outbreaks and in no case have birds accomplished any noticeable reduction in the numbers of the pest. One grasshopper invasion below Flagstaff in Arizona was attended by great numbers of blackbirds that captured a small percentage of the hoppers but really interfered but little with their activities.

The Pale Western Cutworm in North Dakota has been attacked in a limited way by the Horned Lark, but the labors of this beautiful bird make only a feeble impression on the numbers of the cutworms in the wheat fields. Other pests such as the Hessian fly, the wheat stem sawfly, and the chinch bug are none of them such as birds can in any way control even to a limited extent. They can be suppressed only by parasites or by cultural methods.

It has always seemed to me that the habit of placing emphasis on the money value of birds is unfortunate for it commercializes them in the same way that many of our blessings have been cheapened. To protect birds because they are an asset to a growing bank account may be good business but it detracts from the esteem in which birds are held or should be held because of their grace and beauty and companionship and song. Our country, even if birdless, would not become a desert, but it would lack the presence of one of the most attractive features of our wild life. And it goes without saying, that, apart from their economic value, they should be protected in every possible manner, both by law and by community support.

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