level. It is a continual repetition of taking a step too many at the top of the stairs.

The most strongly marked characteristics of the whole experience lay in the change wrought in the affective overtone of perceptual objects in the suggestion of new touch-qualities and impulses, and the existence of abnormal emotional attitudes, but these matters lie too far afield to be considered in the present paper.

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*BIRDS AS WEED DESTROYERS.**

A MILLION weeds can spring up on a single acre. Cultivation will do much to eradicate these noxious plants, but some will always succeed in ripening a multitude of seeds to sprout the following season, so as to make tilling the soil an everlasting war against weeds. Certain garden weeds produce an incredible number of seeds. Thus a single plant of purslane may mature a hundred thousand seeds in the fall, and if unchecked would produce in the spring of the third year ten billion plants.

Probably the most efficient check upon this unbounded increase of seeds is to be found in the seed-eating birds which flock by myriads to agricultural districts to feed upon the bounty of the weed-seed harvest from early autumn until late spring. Since birds attack weeds in the most critical stage of the plant cycle, it follows that their services will be of actual practical value. The benefits are greatest in case of hoed crops, since here found the largest number of annual weeds, which, of course, are killed by frost and must depend for perpetuation solely upon their seeds. Seed-eating species of birds prevent, in a large measure, weeds of this class, such as, for instance, ragweed, chickweed, purslane, crab grass, pigweed, lamb's quarters and several weeds of the genus *Polygonum*, from seeding down the land with a rank vegetation fatal to cultivated crops. The problem of weed destruction is of such magnitude that Mr. F. V. Coville, Botanist of the United States Department of Agriculture, in discussing weed legislation, has said, * * * "Since the total value of our principal field crops for the year 1893 was $1,760,489,273, an increase of only 1 per cent., which might easily have been brought about through the destruction of weeds, would have meant a saving to the farmers of the nation of $17,000,000 during that year alone."

The birds most actively engaged in consuming weed seed are horned larks, blackbirds, cowbirds, meadow larks, doves, quail, finches and sparrows. In a field sparrow's stomach I found 100 seeds of crab grass, in a snowflake's stomach 1,000 seeds of pigweed, and in a mourning dove's crop 7,500 seeds of *Oxalis stricta*. That the destruction of weed seed by birds is extensive enough to be of considerable benefit to the farmer is shown by Professor F. E. L. Beal, who estimated that in the State of Iowa alone a single species, the tree sparrow, consumes annually 875 tons of weed seed.

From the examination of the stomachs of some 4,000 birds it has been determined that the best weed destroyers are the goldfinches, grosbeaks and a dozen species of native sparrows.

In cities the English sparrow, assisted by several native species, does good work by feeding upon the seeds of lawn weeds, such as crab grass, pigeon grass, chickweed and the dandelion. On the lawns of the Department of Agriculture, in Washington, the birds feed upon dandelions from the middle of March until the middle of August. After the yellow petal-like corollas have disappeared, and the flower presents an elongated egg-shaped body, with a downy tuft at the upper end, the sparrow re-

* Birds as Weed Destroyers. Year-book of Department of Agriculture for 1898, pp. 221–232 inclusive.

moves several long scales of the inner involucre by a clean cut close to the receptacle, thus exposing the plumed akenes, and then seizes a mouthful of these between the plumes and 'seeds,' lopping off the plumed pappus and swallowing the 'seeds.' The mutilation of the involucre by the sparrow's beak can be seen until the flower stalk dries and falls. Fully three-fourths of the dandelions that bloomed on the Department grounds during April and May, 1898, were mutilated by birds.

The English sparrow, in spite of the services it renders in consuming weed seed, is a pest because of its despoiling buildings, and because of its extensive pillaging of fruit and grain. The native sparrows, on the contrary, have no such noxious habits, and are much more efficient as weed-seed destroyers.

The several species of goldfinches are equally beneficial. The American goldfinch confines its attacks almost entirely to the *Compositæ;* the thistle, ragweed and dandelion being its favorites. Last October I observed a flock of fifty on a New Hampshire farm. A bird would alight on a bull thistle and the pappus would float away as it feasted. Under a thistle head I found over a hundred empty akenes that had been split open on one side and had their seeds removed. These goldfinches alighted, several at a time, in a single ragweed plant and fed so busily that I could approach within a few feet of them. On another day this flock of birds fed upon the evening primrose. According to Mr. H. C. Oberholser the goldfinch also feeds upon beggar ticks (*Bidens frondosa*) and milkweed (*Asclepias syriaca*).

Dr. E. V. Wilcox has observed American goldfinches in Montana feeding in flocks of fifteen to twenty on the wild sunflower, which is a very bad pest in the West. In the same State he observed Juncos and red poll linnets eating the seeds of the Russian thistle.

The goldfinches and native sparrows are more beneficial to agriculture than a number of other species, such as the English sparrow and blackbirds, which at times injure grain and fruit, but there are, however, in the work of weed-seed destruction some fifty species of birds engaged, and the number of species of weeds which they tend to eradicate amounts to more than three score.

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THE BIOLOGY OF THE GREAT LAKES.

Science for July 1, 1898, contained a notice by Dr. H. M. Smith, of a proposed Biological Survey of Lake Erie to be carried out under the auspices of the United States Commission of Fish and Fisheries.

Unfortunately, none of the work of the season of 1898 could be entered upon until the middle of July, and it was discontinued about the first of September. Since the work outlined in the second paragraph of Dr. Smith's notice is of such a character that it must be carried on continuously, it must wait for the establishment of a permanent biological station on the lakes.

The work that could actually be undertaken was that outlined in the third paragraph of the notice. The shortness of the time (4–6 weeks) did not permit results to be reached in many of the problems under investigation; so that the results of the summer's work so far published are contained in three papers by Dr. Jennings, a brief notice of the occurrence at Put-in-Bay of *Trochosphæra solstitialis*, contained in Science, October 21, 1898, and two papers on 'The Motor Reactions of *Paramœcium*' and the 'Laws of Chemotaxis in *Paramœcium*' in the *American Journal of Physiology*, May 1, 1899. Progress was, nevertheless, made in all the other lines of work. Some of the results are now awaiting publication