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FIELD OBSERVATION IN ECONOMIC ORNITHOLOGY

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Since the beginning of serious studies in economic ornithology in this country stomach examination has served as the backbone of the advance of that science. As early as 1858, Prof. J. W. P. Jenks examined the stomachs of Robins in Massachusetts and, on the basis of that work, he may be considered the American pioneer in that method of research.[1] Twenty years later Prof. Samuel Aughey's paper on "Notes on the Nature of the Food of the Birds of Nebraska" appeared.[2] He also employed stomach analysis as a means of obtaining data on which to base opinions. This published work was the result of researches extending "over a period of thirteen years on ninety different species, and an examination of more than 630 stomachs."[3] Soon thereafter appeared the memorable work of Prof. S. A. Forbes on the food of certain birds in Illinois.[4] This and other papers by the same author, who used stomach analysis as the foundation of much of his study, have established his name in the annals of economic ornithology as the founder of its modern phase. Other workers followed. There were Prof. F. H. King, in Wisconsin, Dr. B. H. Warren, in Pennsylvania, E. V. Wilcox, in Ohio, Prof. C. M. Weed, in New Hampshire, and through subsequent years, the various workers in the United States Department of Agriculture.. The leaders in this group included Dr. W. B. Barrows, Dr. A. K. Fisher, Dr. S. D. Judd, Prof, F. E. L. Beal, and W. L. McAtee. All of these workers availed themselves of stomach analysis as a basis for deductions.

In Europe events in the field of economic ornithology followed a somewhat parallel course. The work of Prevost, Schleh, Rörig, Herman, Newstead, Gilmour, and Collinge attests to the almost universal adherence among these workers, to the belief that the examination of

[1]Trans. Mass. Hort. Soc. 1859.
[2]U. S. Entomological Commission, First Annual Report. (1878).
[3]Palmer, T. S., A Review of Economic Ornithology in the United States. Yearbook, U. S. Department of Agriculture, 1899; 259-292.
[4]Bull. Ill. State Lab. of Natural History (1880).

stomachs furnishes the most reliable data on which to base deductions concerning the general utility of birds.

With the passing of the years since stomach examination became the *sine qua non* of research in the field of economic ornithology, public confidence in its reliability has increased. It has acquired, in both the scientific and lay mind, a status of finality shared by no other method of approach. To call attention at this time, therefore, to what may be termed limitations in this well-established procedure, especially as applied to destructive species of birds, may appear presumptuous and even a bit late on the part of one who has spent nearly half of his life delving into the secrets of bird food through this very means. It is my intention, however, to do this very thing and in defense I may simply state that my object is not to detract from what has been done, well done in fact, nor to discredit in the least stomach examination as a fundamental procedure in the solution of problems in economic ornithology. Instead I wish to point out merely certain limitations of method and of application of data obtained by this means especially when species capable of inflicting severe damage are involved and to emphasize the importance in those cases of availing ourselves of pertinent data obtainable largely through field observation and experimentation.

It is fitting to explain at this point that the Biological Survey has for years taken cognizance of the points I am raising and has made decisions with these circumstances well in mind. The writer lays no claim to originality of argument or to discovery of method in the subject matter on which this paper is based. The limitations of which I speak are as old as economic ornithology and vexed even the pioneers in the field. I have ventured, however, to offer some modern aspects of these difficulties and have tried to show why at times the dictates of sound economic logic as well as the appeal of fair treatment for our birds compel us in special cases to leave the laboratory and go to the field for our answers.

The points raised are essentially only two; each has ramifications and varied aspects; and, as previously stated, they have their most pertinent application in the study of species capable of inflicting direct and severe damage. They may be outlined in the following language. Each will be discussed in turn and illustrated by a recital of incidents that have arisen largely in the writer's own experience.

1. *One concerns the difficulty in placing correct interpretations on some of the economically more important items that are revealed by stomach examination.*

2. *The other centers about our helplessness in attempting to convert abstract percentages of bird food items into terms of agricultural, horticultural, and other forms of modern, human economics.*

1. The Interpretation of Food Items

Knowledge of field conditions and the circumstances surrounding the collecting of stomach material is the key to the proper interpretation of food items. Were it possible for the examiner of bird stomachs personally to collect every specimen which he later examines, many of the uncertainties of our work would never arise. Yet even the keenest of observers cannot hope to know what has transpired previous to his observance of a bird, the stomach of which is later examined and found to contain remnants of food eaten several hours previous to its collection. Much is left to the examiner's own judgment in the light of general conditions, and, when material is examined by some one other than the collector, reliance must be placed on such notes and appraisal as the collector may have made, which, experience has shown, are usually woefully inadequate. The Biological Survey has aimed to reduce this element of doubt by giving its laboratory investigators all possible opportunity for field work.

As an illustration of the point at issue, let us cite the case of a crow's stomach—not an isolated or peculiar stomach—but simply one of many that may be encountered in the examination of a large series. The examination, in this case, was made by the writer some years ago. The bird, apparently an adult, was collected at Meriden, Connecticut, on June 2, 1915. The collector had submitted no notes of help in interpreting the items found and the examiner was placed on his own resources in their interpretation. The examination record first lists numerous insects of several different families, totalling 31% of the food. It then continues, "shell of hen's egg, 4%; feathers of a small bird, 1%; bones and flesh of a fish, 60%; trace of a batrachian; hulls of corn, 1%; vegetable debris, 3%."

Three of the six items mentioned, the hen's egg, feathers of a small bird, and corn are of more than ordinary importance from an economic viewpoint. The remains of the fish and the batrachian are of less interest, and the "vegetable debris" need not concern us. Every one of the six items, save the last, may have more than one perfectly plausible interpretation placed upon it.

The hen's egg may have been pilfered from some unguarded nest; it may have been an addled egg; or the fragments of shell may have been found as such by the Crow and eaten for the mineral matter contained—a habit of many female birds during the breeding season. By

applying the first interpretation this particular crow would be subject to censure; with either of the other interpretations the food item becomes of no economic importance.

The item, "feathers of a small bird" brings up a similar problem. Is the presence of these feathers indicative of an act of vandalism against some smaller species, or does it reflect simply the carrion-feeding habit of the crow which has found the body of a bird killed by flying into wires, by an onrushing automobile, or by some other cause?

A similar dual interpretation also may be advanced to explain the items of fish and a batrachian. The crow is somewhat of a fisherman and frog-catcher; he is just as energetic a scavenger of the lake shore and marsh.

Corn, in the particular stomach cited, formed only one per cent of the food, and since the crow was collected in early June, the probability is that the grain was waste gleaned from some previous year's corn field or from kernels left uncovered at the last planting. Yet there is the possibility that it may have come from a feed lot where the grain was being fed to stock, or even to poultry. At other seasons of the year the difficulty of interpreting correctly the corn found in crow stomachs is greater. Once the grain has been digested to the point where nothing but the seed coat remains, a condition found in many stomachs, there is no way known to the writer to differentiate sprouting corn in the spring of the year from waste of the previous autumn's crop. Later in the year we find in many stomachs that corn torn from the standing grain in the milk or dough stages is indistinguishable from that picked up after the harvest or that being fed to farm animals. With such uncertainties presenting themselves in the course of even the most painstaking examinations the investigator soon realizes that correct interpretation easily may be a *matter of greater significance than the identification of the item itself.*

From the crow we may pass to another of the Corvidae, the magpie, which presents a complicated problem in economic ornithology. It is more insectivorous than the crow but has many traits in common with that bird. It preys on other birds and their eggs, it raids hens' nests, feeds on carrion, attacks maimed or sickly livestock, and obtains a portion of its sustenance from farm produce. Illustrative of the difficulties arising in attempts to appraise the bird through stomach examination, inadequately supplemented with pertinent field observations, may be cited the following record of analysis.

The specimen, a nestling, was collected by the writer in May, 1912, in Utah, and is typical of a considerable series secured at the same time. With the exception of five per cent of vegetable debris, the food was entirely animal in character. Forty-seven per cent of it was obtained from the insect world and included certain coprophagous forms which lent circumstantial evidence of the character of mammal remains found. The items of greatest importance in the present discussion were "fragments of the shell of a hen's egg, 5%;" and "remains of a young *Microtus* sp., 43%". The question arising concerning the hen's egg is whether it conveyed evidence of a robbed nest or whether it meant merely the consumption of discarded shell fragments or a decayed egg. The fact that it had been fed to a nestling magpie lends credence to the former interpretation. But notwithstanding the fact that the writer personally collected and examined the specimen he cannot state beyond a reasonable doubt that the act of feeding on this material should be charged against the bird. A similar situation arises in connection with the remains of the *Microtus* eaten. Was the presence of this rodent in the stomach indicative of the predatory or scavenger habits of the magpie? The presence in the same stomach of a *Silpha ramosa* and twenty-four histerids gave strength to the latter contention, yet I have no evidence to show that the coprophagous beetles may not have been obtained from other carrion.

Evidence of the detestable habit of the magpie of attacking and feeding on young, sickly, or freshly branded livestock is unobtainable through stomach analysis. There is no satisfactory means of differentiating in stomach material between a mass of flesh and hair torn from the body of a helpless animal and that rent from a fresh carcass. When confronted with such a problem of appraisal the investigator, if unaided by pertinent field evidence, must resort to personal judgment which, candidly stated, often may be nothing more than a guess. The writer has himself examined many winter stomachs of magpies containing flesh and hair, which, for lack of evidence to the contrary, was construed as carrion. A pardonable bias in favor of a most interesting, though at times despicable species, no doubt played a part in this charitable interpretation. How much of this material was in fact torn from the backs of helpless animals one could not determine by stomach examination. It may readily be seen, therefore, that whenever the investigator is in a similar frame of mind this trait of the magpie will consistently be minimized when an appraisal of it is made through the laboratory. Later in this paper evidence will be cited in connection with another species, the red-winged blackbird,

in which the reverse is true—a tendency to obtain an exaggerated idea of damage when stomach analysis is employed as the means of approach.

Another bird possessing great individual and collective capacity for either good or harm and in an economic study of which the Biological Survey has made full use of the field method of approach is the Starling. The problem of interpretation arising in an appraisal of its insect food may, because of its extreme complexity, be omitted from the present discussion. There are no great difficulties in judging its diet of wild fruit, but in its feeding on cultivated fruit, the bird presents problems that vex the food analyst. I refer particularly to its consumption of late fruits—apples and pears. These items are detectable in the stomach in the shape of bits of fruit skins or masses of pulp. The Starling may obtain this either from marketable fruit in paying orchards, from isolated and abandoned trees, or from fallen fruit of no value, or from garbage. In each case the evidence revealed by stomach analysis would be essentially the same and were the bird not observed feeding on the controversial item at the time of its collection or shortly previous thereto, the examiner would find himself at a loss to appraise the situation. In this connection I recall having examined a series of Starlings collected near Adelphia, N. J. A large proportion of them contained the skin and pulp of apples which field observations indicated were obtained from a few abandoned trees, the fruit of which was of no commerial value, or at least was not being harvested. Another group of Starlings in the stomachs of which apple remains were found, was collected at Freehold, N. J. Here field observation indicated that the fruit might or might not have had marketable value. A third lot was obtained near Brookdale, N. J., under conditions that made it appear real damage was being inflicted by the birds. Stomach examination gave the same ambiguous answer in all three instances; field observation supplied the necessary information for a proper interpretation of the evidence. It might be added furthermore that field observation also brought to light the fact that damage to late fruit by Starlings is consistently greater in old, poorly kept orchards than in young, thrifty ones, supplying the bulk of the higher grade, marketable fruit.

The ubiquitous English Sparrow presents numerous problems in economic ornithology that are difficult of solution by the laboratory method alone: One of these arises from its insect-eating habits. If judgment were based solely on stomach analysis we would be led to believe that, during the balmy days of May and June, this bird (at

least the urban portion of its race) is a potent factor in the control of May beetles (*Phyllophaga*). In small towns of the Middle West, May beetles form a conspicuous portion of the diet of the young. Individual stomachs containing the remains of several of the bulky insects are not unusual, yet the seemingly commendable activity is severely discounted when a little field observation discloses the fact that the parent birds are obtaining many of the insects from beneath city arc lights where on mornings dead beetles may be found littering the pavement. In this manner the energetic destroyer of insects may suddenly assume the prosaic rôle of a scavenger of doubtful utility.

In judging the English Sparrow's vegetarian diet difficulties comparable to those mentioned under the discussion of other species arise. Are the oats found in the stomach of an adult female collected in the town of Independence, Iowa, in June, to be judged as waste gleaned from the street or were these kernels rustled from some suburban poultry yard? The wheat found in the crop of a sparrow shot on a roadside in Ohio, in July, may have been pilfered from the standing or shocked crop, picked up from waste in the stubble or along the road, or stolen from chicken feed. The pulp and skin of fruit may have come from a number of sourcees, each indicative of a different economic factor; yet all this material may have essentially the same appearance in the stomach contents.

This discussion might be carried on to include many other species, the economic influence of which is important and direct, and about which modern decisions are being demanded. Comparable cases showing the inadequacy of stomach analysis as the sole or dominant means of approach could be cited for such birds as the red-winged blackbird and ducks when feeding in rice areas; some of the hawks that at times develop habits akin to those of the carrion feeders, and, conversely, the vultures themselves that, in certain sections of the South, have been known to prey on living animals, such as newly born calves. Without substantiating field evidence, the fish in the stomach of an Alaskan bald eagle may be interpreted either as stream-polluting carrion or what might have been the contents of just one more can of salmon. The fingerling trout in the stomach of a kingfisher may be either an illustration of nature's normal control or it may represent an inroad on some hatchery, a favorite rendezvous for these birds during migration in August. Even the shells of rail eggs in the stomach of a Fish Crow collected on the Virginia coast may signify robbery or just plain frugality, according to whether the bird had destroyed a nest or was

engaged in making an honest, though lowly living by feeding on rail eggs destroyed by some unusually high tide.

From the foregoing one comes to the conclusion that the solution of some of our more important problems in economic ornithology depends largely on exact and pertinent field observation, without which much of our stomach examination data would have little significance. More than ever in these days of local adjustments in problems of wild life there is need for a correct interpretation of facts. To be able to identify items with specific exactness, items of utmost importance in the economic relations of the bird, and yet be unable to state whether those items should be placed in credit, debit, or neutral categories with respect to the economy of man plainly indicates that other methods of approach must at times be invoked. By all means there must be no slackening in laboratory research, but wherever it is evident that this method is incapable of accomplishing the object sought, there should be no hesitancy in adopting also some other plan that will give corroborative or other evidence of the status of the species. This the Biological Survey has endeavored to do throughout its work and only recently has placed even greater emphasis on field aspects of the economic study of birds and mammals by the establishment of a sublaboratory of its Division of Food Habits Research at Denver, Colo., where closer field contact may be had with western problems.

Let it not be inferred, however, that stomach examination, despite certain inherent weaknesses or limitations, does not play a most important, yes, indispensable rôle in our science. Aside from the legitimate demands of pure research in food habits to which stomach examination has and will continue to contribute bountifully, certain of the practical problems of economic ornithology lend themselves to direct solution solely or largely through this method of approach. I have in mind, particularly, those in which the identification of food items constitute the major objective. By that I mean that whenever we are seeking the *identity* of food items, irrespective of the economic significance of the bird's having fed on them, or whenever we aim to determine merely the presence or absence of particular items of diet, analysis of stomach contents is the only direct and reliable method of approach. And what a convincing method of demonstration it may be! Well do I recall experiences in 1919 when, after the enactment of the Migratory Bird Treaty Act making illegal the destruction of night herons, an inventive genius of the State Legislature of Louisiana, with fond longings for his favorite fried *grosbec*, contended that these birds

were highly destructive to the frogging industry of the State and hence legitimate objects of control. Investigation was made and in its course I had my first and most interesting contact with the ornithology and human inhabitants of modern Acadia. Night herons were collected, old and young, in the very county and with the aid of the very persons most affected by the alleged destructive habits of the birds. To a marked degree the specimens collected were "hand picked" to emphasize if possible their frog-eating propensities. Stomachs were examined later and in more than 100 studied, no trace of a frog was found, crawfish comprising practically the entire food. Needless to say the evidence acquired through stomach examination was amply sufficient to perpetuate the protection of the night herons.

In like manner stomach examination has yielded most convincing testimony in instances where field observations have been superficial or where circumstances have conspired to confuse the issue. I recall cases in which crop or timber damage has been charged against birds where, as a matter of fact, actual injury was inflicted by insects more or less concealed, which served as a lure and in that manner incriminated the more conspicuous birds. Stomach examination usually puts matters aright in such cases by revealing the identity of food items and thus places the blame for damage where it belongs. In this capacity, the laboratory channel of approach never will be excelled.

Stomach analyses of extensive and representative material is the only means, furthermore, of creating a background for proper appraisal of the general economic status of birds, something that is needed as a check upon every local or specific study.

2. Food Percentages and Economic Status

Workers in economic ornithology freely admit that food percentages, however computed, still must be interpreted by the investigator before decision on the status of a species may be determined. Abstract decimal or fractional values can not be subjected to mathematical formulae and results computed therefrom as can be done in problems of engineering or chemistry. One estimated percentage indicating a beneficial activity cannot be construed as offsetting an equivalent designation of opposite economic significance. After all the painstaking examination and computation of food percentages of a species have been completed, what we have is simply a somewhat more tangible and understandable picture of food preferences. The conversion of this into terms of human economics is a matter resting largely on the personal judgment of the investigator. The wider his field experience and the sounder his logic, the more accurate will be his

appraisal. A sympathetic understanding of agricultural problems will add much to the value of his decision. Yet, at best, in the attempt to convert abstract food percentages into terms of human economics, the ornithologist still is confronted with a problem of no mean proportion or complexity.

With all the afore-mentioned data before him, how satisfactorily can the investigator answer questions such as the following propounded, we will say, by some practical farmer: "With crows, as you tell us, subsisting on corn to the extent of thirty-eight per cent of their diet, what percentage of crop loss may I expect from this species on my farm in southern Illinois?" or, on the other side of the question, "Is the practical good done by the crows feeding on white grubs, which were found in one out of every twenty-four stomachs, sufficient to warrant my allowing them to go unmolested and 'pull' five per cent of my sprouting corn?" Again, from the rice growers of the Gulf Coast, he may hear, "Now that food analysis has shown that somewhat more than half of the food of the red-winged blackbird of the Gulf Coast is rice, is it sound economy for us to attempt wholesale blackbird destruction in the rice area?"

The inadequacy of stomach analysis alone to produce data with which to answer queries similar to the last and the necessity for field appraisal in meeting such problems was forcibly brought to light a few years ago in work in the coastal rice area of Louisiana. Two seasons' field study of the rice-blackbird problem supplemented by the examination of more than a thousand stomachs brought forth enlightening data. The stomachs showed that rice in one form or another—as seed, as ripening grain, as part of the harvest, or as scattered waste in the stubble—served as a year round article of diet, the staff of life of the redwing of southwestern Louisiana. During the milk and dough stages of the crop and during the harvest, rice supplied nearly the entire sustenance of these birds. The insects eaten by them, though in fair proportion during the breeding season, were not those of importance to the grower of rice. The problem as viewed through the laboratory microscope and as judged from the tenor of written complaints could be answered in only one way—by an unqualified condemnation of the redwing in that region.

What, however, were the findings of field study? Briefly they were these. As a feeder on rice in any of its stages, the redwing of the Gulf Coast is outstanding; the findings of the laboratory were reflections of what the individual blackbird was doing in the field; the damage complained of was real and severe—real and severe, how-

ever, *only along a narrow strip of rice country bordering on the coastal marshes.* At the short distance of two miles from the border the damage was less frequent, at four miles it was seldom experienced, and in the center of the rice area it was never mentioned. Yet the individual redwing in the center of the rice area ate just as much rice as the bird on the borderline and under the microscope its stomach contents told a story identical with that of the borderline bird. The difference in conditions came about through the fact that the daily flight of the enormous flocks from the roosts in the coastal marsh to the feeding ground in the rice area stopped on or near the first line of fields, leaving only small squads, stragglers, or local roosting birds to frequent the center of the rice area where their feeding in the extensive fields went wholly unnoticed. It can be seen that here is a case, in direct contrast with that of the magpie previously mentioned, where a judgment, guided largely by the results of stomach analysis, would tend to exaggerate to an undue degree, the damage done.

From the rice fields of Louisiana let us pass to the barley fields of the Imperial Valley, California, for another illustration of the necessity of field appraisal. The writer's contact with this problem occurred in the winter of 1921-22, a season during which the damage was by no means as severe as in previous winters, yet in some instances serious enough to force the replanting of fields, with the attendant losses of seed, labor, irrigation water, and time. From the very nature of the case the damage was local but severe. If for some reason, as a low head of water, or lack of suffiicient farm help, the process of irrigation after seeding was prolonged, dire results were likely to follow. "Puddle" ducks of several species were quick to locate the banquet and after a night or two of reconnoitering, enormous flocks made short work of the submerged barley.

How much of the economic and conservation aspects of this problem did the examination of stomachs supply? On the basis of about 150 stomachs of four species of ducks it revealed that pintails ate a greater percentage of barley (43%) than the other ducks, a fact quite generally recognized by local sportsmen and farmers. It also verified the generally accepted belief that widgeons ate more sprouting alfalfa than any of the other species. It also showed that the little Green-winged Teal ate less barley (22.0%) than the widgeon (24.5%).

What, however, did field studies show? In the first place, they told something of the extent of the devastation wrought. They shed light on the acreage of damaged fields and the fact that, in addition to the immediate injury, the ducks often so puddled and de-aerated

the fine silt of the grain fields that an unfavorable soil condition was created that lasted for several seasons. They revealed that the thirty per cent of young alfalfa eaten by the widgeon meant at times a severe economic loss in uprooted plants. They disclosed the fact that the widgeon, a more abundant and more voracious feeder, far out-stripped the diminutive teal as a destroyer of barley seed, although stomach examination showed only slight disparity between the proportions of barley found in each. And back of all that, they told the vital story that, so severe had the damage been in some winters that illegal shooting to protect crops was frequently resorted to; that honest efforts to protect grain were being discredited by abuses on the part of hunters who offered "their services in the cause of crop protection", that game law administration became a real problem, and that the whole fabric of the game protective movement in this locality was jeopardized largely because of a lack of understanding of what ducks can sometimes do. All in all, in the study of this local but vital problem of economic ornithology, field studies played a decidedly important rôle.

Not to confine the discussion to grain-eating species consider, for a moment, the irksome question of the ruffed grouse and its disbudding operations in apple orchards in New England, and the part that stomach analysis may play in clarifying the problem. Despite the fact that this can not be considered among the more serious of the problems in economic ornithology, it has been of enough consequence to result in state legislative provisions for the payment of damages locally.

For a basis of discussion let us take the contents of twenty-four crops of ruffed grouse collected in orchards in New Hampshire in 1923, at a time when there was much agitation against this species. Apple buds were present in nineteen of the crops and constituted 43.5% of the food. They were present at an average of 173 for each of the 19 crops in which they were found. One contained as many as 819. The remaining food consisted of buds, catkins, and browse of several species of wild trees and shrubs. That was the evidence contributed to the problem by stomach analysis; it tended to incriminate the ruffed grouse, but it in no way conveyed the graphic picture obtained by field observation. There was no doubt as to the correctness of the identification of the food items but one could not tell therefrom whether the indulgence of the grouse in this article of diet resulted in great damage, moderate damage, or possibly even in good through a process of desirable pruning. Such evidence was contributed, however, by horticulturists and zoologists of the New Hampshire State College of Agriculture. A detailed inspection of a representative

series of trees in an area whence reports of damage had come revealed a bud loss of forty-four per cent attributable to the work of grouse. Since some of this pruning would not result in an actual reduction in the crop the estimated crop loss, provided all other factors were equal, was placed at thirty-five per cent in the orchards inspected. There also came to light the attendant evidence that almost invariably damage of consequence occurred only in orchards situated near brush.

How well this illustrates the point that there is no tangible means whereby data on food preferences as revealed in stomach contents can be translated directly into terms of horticultural economy. Though we may say that under average conditions a ruffed grouse prefers an aggregate of buds of wild species to those of cultivated fruit, to measure and express the economic significance of its having fed on apple buds to the extent of thirty or forty per cent of its diet, is biologically and statistically impossible.

Few who know the meadowlark in the North have a realization of its capabilities for harm in sprouting corn fields of the South Atlantic States. Two factors, a predilection for the soft, sprouting kernel aggravated possibly by an early season scarcity of insects, and a flocking habit that tends to emphasize the effect of this trait, combine to make the meadowlark a distinct agricultural pest in the March planted corn in some sections of the Southeast.

Let me quote briefly from notes taken during a field study of the problem in 1919, when censuses were taken of the damage inflicted on early planted corn fields. "One of these, north of Manning, South Carolina, had been frequented by a flock of twenty-five larks for several days. Part of the field had been replanted but on a portion of the original stand I counted 298 healthy plants and 275 that had been either removed entirely or so badly damaged that they had little chance of surviving. A portion of a neighboring field revealed 168 missing plants, 231 damaged, and 172 untouched. While these counts were made in the most severely damaged sections there was injury throughout such fields that necessitated either replanting with the hoe or replowing and replanting with a planter. Whenever the proportion of damaged plants approached one-third of the total stand it was considered more economical to replow, which had the added advantage of an even stand."

"The replanting of portions or all of fields of early corn is an almost universal misfortune for the planter in parts of South Carolina. At times the replanted seed meets the same fate as the first sowing

and it requires a third planting to insure a stand with the loss of about three weeks of the best corn growing weather."

How much of this pertinent economic information is obtainable from stomach analysis and, in fairness it may be added, how much other information not discernible from field observation is to be had from the laboratory source? Unfortunately there is not available a representative series of stomachs of meadowlarks collected exclusively in corn fields of the Southeastern States. We do know, however, that the examination of 890 stomachs of meadowlarks collected under varied conditions in the Southeast revealed the fact that grain (corn, wheat, and oats) constituted a little less than nine per cent of the annual food.* Most of this was eaten during the winter months, indicating that it was waste. *No sprouting grain was found.* No doubt had more stomachs been collected in newly planted fields abstract evidence of this trait would have been revealed, but at best one could expect merely an indication of the habit, not an adequate idea of its economic significance and seriousness. Such an estimate necessarily must rest on careful, methodical, and often arduous, but none the less scientific work through field estimates and appraisals. In the case in point, field studies conducted by the Biological Survey revealed conditions that warranted the issuance of permits, locally, for the suppression of meadowlarks.

But what of that part of the story not readily acquired through field observation, that dealing with the insectivorous habits of these meadowlarks of the Southeast? Field observations usually yield little more than the fact that insects are being eaten. Stomach examination on the other hand has divulged the identity of these insect items, often with specific and subspecific precision. It has afforded data on the numbers eaten in the course of the bird's last "meal". It has estimated the proportion of the diet formed by each component and it has given us data from which a visual idea of the birds' insectivorous habits can be drawn, a picture of the food preferences of the species and the *part each group of items plays in furnishing sustenance for the bird.*

But may it not logically be asked, even as has been done in the case of those food items, the consumption of which represents a direct loss to man, how complete an understanding of the *economic effect of these insectivorous habits* have we other than that obtained through a more or less theoretical process of deduction in which the judgment of

*U. S. Dept. of Agri., Farmers' Bulletin 755. Common Birds of Southeastern United States in Relation to Agriculture, by F. E. L. Beal.

the investigator plays an all important, yet uncertain part? Does not stomach examination alone, though far-reaching in its accomplishments, fall short of the goal in the economic appraisal of insect food, as in the appraisal of losses to farmers' crops?

Let us try to simplify the picture by omitting, for the present, the highly involved interrelations existing between the varied insect forms commonly entering into the diet of a bird, or, if preferred, let us assume that we have a complete understanding of all these interrelations and that there is nothing left for the stomach examiner to "interpret" among the food items he discloses—truly an all-embracing assumption. Let us grant that he has identified all items, computed the proportions of each and understands the abstract economic significance of the destruction of each insect item by the bird. Yet consider for the moment what chasms still are to be spanned. With all these data before him can the stomach examiner answer the direct and plausible inquiry, "Is it sound agricultural practice to allow meadowlarks full freedom of the corn field during sprouting time with the expectation that their destruction of wireworms is service well rendered at the price of one or two replantings of the field because of their corn pulling activities?"

To cite another case, who can state what degree of suppression of the alfalfa weevil is exerted by the English Sparrow in Utah by reason of the fact that about twenty-eight per cent of the food of the young and thirteen per cent of that of the adults during three months of the year is obtained from this source? The answer to this will remain undetermined until some estimate is had of the weevil-destroying capacity of the race as a whole in relation to the total weevil population. To say that twenty-eight per cent of the food of young English Sparrows is composed of alfalfa weevils is significant in the laboratory appraisal of the *food preferences* of that species, and might, in the judgment of some, place the balance in the bird's favor. Protection might even be urged as reward for commendable service. Yet, without an understanding of the effect of this destruction on the total weevil population, no one is able to say whether this service is considerable or insignificant. One might as well aim to answer the query, "How rapidly are our national timber resources being depleted?" by stating that one per cent of the average man's yearly expenditure (or power to consume) is spent for lumber.

Other illustrations may be cited, but the foregoing, coming to mind by reason of the writer's personal contact with most of the problems mentioned, will suffice to emphasize the inadequacy of stomach analysis alone in solving many of the modern problems in economic

ornithology. It is a truism, however, that stomach examination, carefully conducted, gives the best possible index to the food items of a bird, and in the light of many such examinations, an idea of the food preferences of a species. By it the general *tendencies* for good or harm can be shown; variations due to seasonal changes and those connected with environmental factors can be indicated in the abstract. It is even possible, by computing from the capacity of individual stomachs, and the daily dietary needs of birds, to obtain some rather hypothetical idea of their consuming powers, be it in relation to insect food or kernels of grain. Yet, withal, the results attained largely are those viewed from the standpoint of the bird itself. They fail to meet the issue when we are seeking *the effect of feeding habits*, which, in the final analysis, is the actual goal in many modern problems of economic ornithology.

The Sequel

Repeated contacts with problems similar to those dealt with in the foregoing recital lead one to the simple and evident conclusion that determination of the economic status of a bird, its relation to the interests of man, calls for something more than a knowledge merely of food habits or food preferences. Economic status and food habits are, by reason of their fundamental aspects and definitions, antithetic. In seeking the economic status of a species one aims to determine and to express in understandable form the effect of its feeding and other habits on agriculture, horticulture, forestry, and other human interests. On the other hand, a record of the food habits of a species, as obtained through stomach analysis, is an expression of the part that grain, fruit, truck crops, poultry, and various other products of the farm, as well as the weed, insect, and rodent pests of the land play in furnishing the sustenance of the bird. The one discloses the influence exerted by the species on man and his welfare; the other shows the manner and extent to which the product of nature's and man's activities affect the species. The one indicates what should or may be done to improve the interrelationship to the advantage of man; the other reveals in what manner conditions may be altered with respect to the well-being of the bird.

With all this evident distinction between the two, how frequently do we encounter a confusion of ideas on the subject! Primarily the objective in our problems is one of economics; yet the product of much research into the economy of birds is purely biological. This product, the result of painstaking stomach examination, often is looked upon as the end sought or, if not actually the goal itself, so close an ap-

proach to it that the intervening gap is but a step in a simple process of deduction. Therein lies a fallacy that has served as the theme of much of this paper.

Two points have been stressed in this discussion, (1) the importance of correct interpretation of the items found in stomach contents, and (2) the need of a method or procedure helpful in bridging the gap between abstract food percentages and the economic objective, the effect of the birds' feeding habits. As I see it there is only one course open to the attainment of these objectives, possibly not completely, but in a substantial manner, and that is through intensive and extensive application of field observations and experimentation.

It may be stated at this point that this very principle has been recognized in ornithological work in the Biological Survey for some years and is destined to play an even more important rôle in future studies. The needs and opportunities ahead are great. Although, in many problems the field has scarcely been touched, a beginning has been made which, as time goes on, should lead to marked advancement in the science.

One need not speak in detailed terms to set forth the general course open to a fuller, a fairer, and, withal, a scientific appraisal of the economics of bird life. Intensive field observations, which, in the attainment of their own peculiar objectives, may be conducted just as accurately and yield a product just as scientific as the painstaking work of the laboratory, come foremost. There are estimates to be made on a substantial and representative scale of the extent of injury done by species feeding on buds, fruit, grain, and truck crops. Likewise we should have more data on the actual insect and rodent destruction effected by birds, revealed by close inspection of infested areas. In the verification of such data the use of representative quadrats, some bird-frequented and others devoid of birds, should lead to convincing facts. There is much yet to be learned of the direct and aggregate effect for good or harm of several common species that appear at some seasons of the year in great flocks; and then, of prime importance is the ever present need of a close study of environments in which material is collected for subsequent stomach examination in order that the factor of uncertainty in interpretation may be kept at a minimum.

As time goes on the economic ornithologist will find himself confronted with an ever broadening field of work. His problems will become more complex and any attempted aggressive action is bound to be closely scrutinized by an increasingly more watchful public,

Already there is a real and appealing need for extensive study in methods of preventing or reducing bird damage through means less drastic than wholesale destruction. There is missionary and experimental work to be done, largely of the farm demonstration type, to meet certain situations in which the most practical and economical solution seems to be, not in attempts at bird control, but in the avoidance of damage by a well planned change in the crops being raised. It will take time and patience and a sympathetic understanding of the viewpoint of those affected to reach a satisfactory solution in matters such as these. To deny a fair hearing or to minimize a just complaint may cause irreparable harm to the very cause we hold most sacred. An open-mindedness, and a willingness to study and decide each problem on its merits should characterize every attempt at appraisal or adjustment. Much of this can be done only in the field, and it is there, as I see it, whence our most important missions in economic ornithology now beckon.

U. S. Biological Survey,
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NINETY MINUTES WITH ROBERT RIDGWAY

BY DAYTON STONER

Contacts with the masters lend inspiration and enthusiasm to the efforts of those who would learn. Such a contact serves as the basis for the present brief narrative.

In the course of an automobile trip from Denver, Colorado, to Gainesville, Florida, taken in October, 1927, by Mrs. Stoner and the writer, we recalled, as we neared Olney, Illinois, that this was the home town of Robert Ridgway, who, at the time of his death in 1929, without doubt was entitled to the distinction of being the Dean of living American ornithologists. Accordingly, it was decided to halt at this shrine for a passing visit.

Upon inquiry in the town we learned that the home of Mr. Ridgway was about a half mile from the business district and easily accessible. Driving south over the railroad tracks the visitors approached on their left a slight elevation, "Larchmound". This tract was well fenced in and presented a trimly cut lawn whereon the great profusion and variety of trees and shrubbery at once attracted attention. And, well back from the highway, beneath two tall and symmetrical larch trees nestling among this dense growth and more or less hidden by vines and shrubs, reposed an old and unpretentious, though well pre--