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BLACKBIRD FLOCK BEHAVIOR IN CORN, A THEORETICAL MODEL

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I realized this past winter that redwings form the base for an international problem, and so I went down to see Jim Caslick in Florida. Unfortunately, I picked the wrong season. I misjudged the weather for when I went down in May to get experimental birds it was pretty hot. Next year I'll be a bit more careful and go down during the winter time.

I want to discuss something a bit different but still in line with crop damage by red-winged blackbirds. I want to relate the damage assessment that we're making in agricultural corn to bird behavior. We've taken a small deviation to one way or another in an attempt to come up with a few ideas of how and why large masses of birds feed in corn. For one, we don't really believe that they need the corn to exist. This is the first premise; it may or may not be right. The reason we believe this to be correct is that it has been pointed out to me that there are some very old records of large bird populations in the Lake Erie area. Some of the first journals of the French fur trappers coming into Ontario, and I suspect through parts of the U.S., point out large masses of redwings, which were misidentified as starlings. In the Windsor region, Jacque Lery, in his journals through Ontario speaks of the large masses of birds. He doubted whether any community development would ever be started in the Windsor region because of the pest problem that these birds posed to the small grain crops. This was in 1749. Two hundred years later we are still talking about the same things. Therefore I want to briefly review what really the problem is.

Individual birds really cause no problem. I think that we would probably accept this, But, most of the research work to date has been done on individual birds, i.e., the territorial breeding bird. There is a very good reason for this emphasis because the breeding period is the easiest time of year to study them and we can define their movements and habits best at this time of year. But little work has been dedicated to what I would call post-breeding behavior or post-breeding population work, and there is an equally good reason for this fact. It is very difficult to make these latter studies and it is very difficult to understand the results in such a study. The reason is very simple. It is because of complexity of numbers. The movements of one bird can be understood and perhaps the movements of 10 birds, and perhaps a 100. But when one increases these numbers in a logarithmic fashion to a thousand, 10 thousand, 100 thousand, a million, or 10 million, one can quickly lose track of what is happening. These latter numbers of course, are the numbers that we're dealing with. This is a post-breeding phenomena.

Typically when redwings (and other birds) lose their so-called breeding territoriality they flock together. This fact is well known. But the important thing that we have to recognize is that birds do not lose their territoriality. They carry some sort of a territory with them the whole year. They carry a spatial territory around themselves--a certain distance that is inviolate and they do not allow another bird to come within this distance. So, with this premise, maybe we can analyze what is going on in the post-breeding behavior. What then is really happening when these widely dispersed masses of breeding birds get together and congregate in an intensive manner in a certain region?

We know for example that in certain sparrows, various populations tend to remain together. For example within each of three regions, A, M, and W, I will postulate three distinct breeding populations (see Figure 1). These areas can be further divided into subunits and these are where the territories are spread. There will be regions B, C and D within A, regions N, O and P within M and X, Y and Z within area W, etc. When the breeding season is over these birds start flocking together. First the flock will be composed of the local breeding birds, then they will coalesce with neighboring small flocks of breeding birds until these flocks reach an optimum size. There is a maximum and probably a minimum, and there are some interesting reports on what this optimum might be. Emlen stated, in 1953, that the optimum is probably a flock whose size is large enough to have enough eyes to find food, but not too many mouths to eat it all up. This is a very crude definition but then he goes on to be a little bit more specific. He said there are certain forces, forcing the birds away from one another, which he calls centrifugal, and there are certain forces that we don't know about that tend to pull the birds together which would be called the centripetal forces. The checks and balances of these two socially interacting forces then provide a flock and depending upon perhaps the population, the subpopulation, the subspecies or the species even of birds, these factors will determine the size of the flock. We know that the interactions must be very complex in blackbirds because we see large flocks.

Sometime in late summer or autumn we know redwings start migrating south and it is when they start this migration that problems arise. They migrate I am sure, in traditional patterns and on the basis

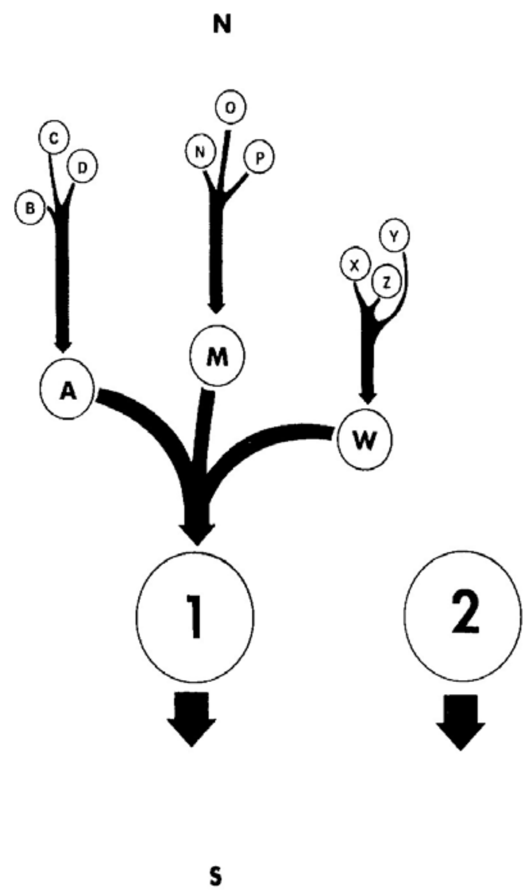

Figure 1. Hypothetical case in which small units of birds gather, from widely distributed areas on breeding grounds, into massive concentrations for southward migration in the fall.

of the 1749 report, they have been doing this for centuries. The idea that redwings come south along the Great Lakes system is not unique. As a matter of fact, so do over 200 other species of birds. There seems to be a major North American funnel across Lake Erie.

This then establishes that there are traditional flight patterns. There is probably nothing that man has done to alter significantly these major flight patterns, The birds select these pathways because natural forces have dictated that this pattern be set up. By the time redwings reach Ontario, there is an undetermined number (1 to 10 million?) of birds. They arrive there at a very in-opportune time. They come when there is important agricultural crop available and thus cause a problem to one of man's resources.

We know that these redwings select certain roost sites along Lake St. Clair. Now the question comes, how stable are these roosts? I have postulated that it is of no advantage to have these roosts set up at random. Likewise it is of no advantage for an animal to go about its activities in a random manner. Once it learns a pattern, if the pattern is successful and success is measured in survival, it is a disadvantage to alter this pattern. In otherwords, once an animal (bird) has learned that there is a safe place to go, it is going to go there. Also, once it learns where food supplies are, the animal is going to go there and it certainly is not going to wander about looking for food over Lake St. Clair, for example, if it knows or has learned by past experiences, that the food is to the east. Once this pattern is started, how constant is it?

Therefore, it is my contention that these patterns are very constant. We know there is variability, but how much variability is exhibited? I think that it is our inability to examine these large masses of birds and define what is happening that poses the largest problem. Radar has helped a great deal, mostly because it compresses a large area of the earth's surface onto a very small area. Many patterns of bird movement have been defined this way. To date the main thing that has come out of these studies is the interesting thought, at least to me, that these large masses of birds are wandering in discrete flocks that are highly integrated in their behavior. I also think that they integrate themselves by flocks and that these behavioral mechanisms are as constant and can be as well-defined as individual spring breeding behavior.

There is no doubt about the fact that redwings cause a great deal of damage and, we know that this damage is not evenly distributed about the countryside. Many individual farm owners are not even aware of bird problems while others become rather emotional about the subject. I will briefly explain some of our results from the first year's work in corn damage assays and if there are any questions I'll be happy to try to answer them. We have been studying both sweet corn and field corn. Because we had intensive sampling in sweet corn, we were not able to get to many different fields. We sampled field corn using the transect method followed by the Denver Fish and Wildlife Research

Lab. and if you're not familiar with the method we can go through it later.

Suffice it to say that we thought that we could, at that time, accurately assess damage. The sweet corn assay was somewhat easier. All we did in our sampling was to take the percentage of ears damaged. If it was damaged it was counted as 100% lost as far as the industry was concerned, that is, once an ear of corn had been attacked then it was of no value to the sweet corn industry. At this point, let me show results obtained out of the analyzing of our corn damage, not in view of agricultural loss but in view of bird feeding activity.

Slides:

This photo of damaged corn is a very common scene and we have difficulty measuring damage to this partly damaged ear of corn. The distribution of ear lengths is fairly normal and each has a certain amount of corn on it and with a certain amount of damage. If this damage has been uniformly distributed around the ear tip, we can measure it. If it hasn't been, we start getting into problems in sampling. I'll get to this a little bit later. Next slide, please.

This is our material from 2 years ago. These are the transects that were sampled, A, B and C. Along transect A, there was an incidence of 45.5% damage, or an estimate of 45.5% of all of the ears of corn that were damaged which resulted in an average of 12.5 bushels lost per acre (Figure 2). Along B, 29% of the corn was hit with a loss of 6.8 bu./acre and along transect C 12% of the corn was damaged with 2.7 bushels lost per acre. This is quite a large region so the first thing that comes out from these data is that damage is not uniform in the region and the reason is that there was not distribution of birds. They were not giving the same attention to area C as they are to area A. This is the picture for the entire region, let's see what a closer look presents. Next slide.

Here is the variability of the sweet corn pattern that I became intrigued with (Table 1). Near the marsh, apparently this farmer had no damage at all to his sweet corn field. Another field with no damage is shown in the 2 to 4 mile range from the marsh roost. Here is one in the same area, 2 to 4 mile range, and he had 8% of his sweet corn lost. And finally here is one with a maximum of 15.36% at somewhere about 6 or 8 miles away from the marshes. Now, if there was no bird protection, we would expect exactly the reverse picture of damage. The birds will go to the closest food supply. But we don't think that this is all true. We think that if the ability throughout the region of the farmers to apply stress with carbide exploders, shotguns and so on, is equally distributed then there is an equal stress to the whole population. This may or may not be true, but there still is something in here that can be analyzed for the bird's behavior; not man's activities but bird behavior. Next slide.

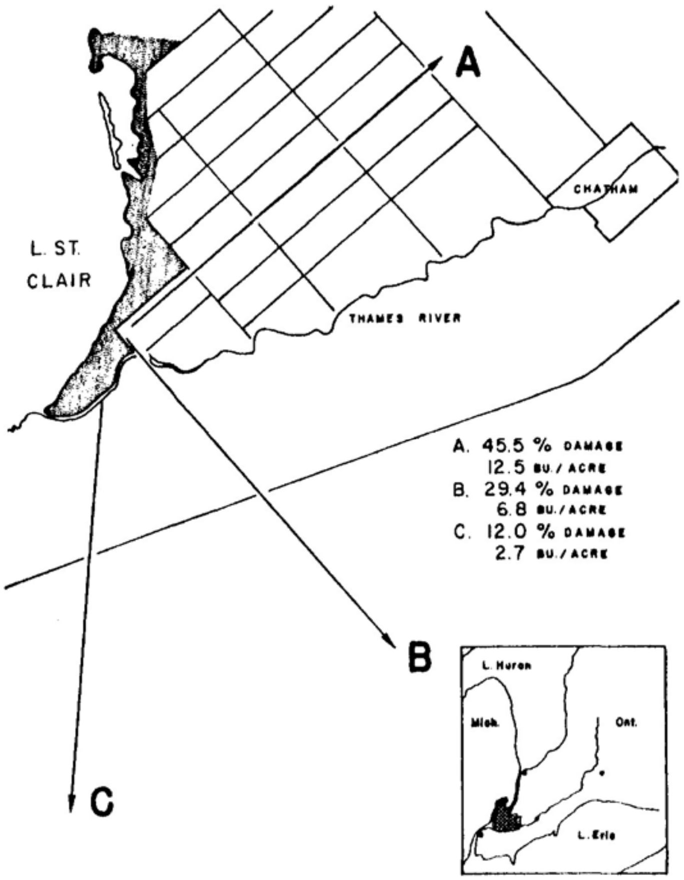

Figure 2. Field study area in Ontario.

I took 2 of those fields that were intensively sampled and divided them arbitrarily into 9 equal-sized lots to see if there was any difference in damage levels within the fields (Figure 3). Now I'm using a field as a small model scale of the whole region. First I established that there was unequal damage in the region then I asked, is there unequal damage in each field? And the answer was, on a statistical test, yes there was unequal frequency of damage in that field. This means that the birds were feeding in the field in very localized places.

This slide shows the plot of these two fields. One is about 17 acres and the other is about 23 acres. Damage, or feeding pattern, was significantly variable in the fields and for Field 1, the damage was

TABLE 1

Assay of Bird-Caused Damage Levels to Sweet Corn, Kent County, 1964

Field No.	Distance from	Acres	No. Ears Examined	No. Ears Damaged	% Damage
1	0-2	25	6795	0	0
2	0-2	15	2849	3	0.10
3*	2-4	24	812	66	8.12
4	2-4	16	6748	0	0
5	2-4	19	7824	110	1.41
6	4-6	50	2793	65	2.32
7	4-6	17	8843	98	1.11
8	6-8	23	12433	1910	15.36

* Partially sampled.

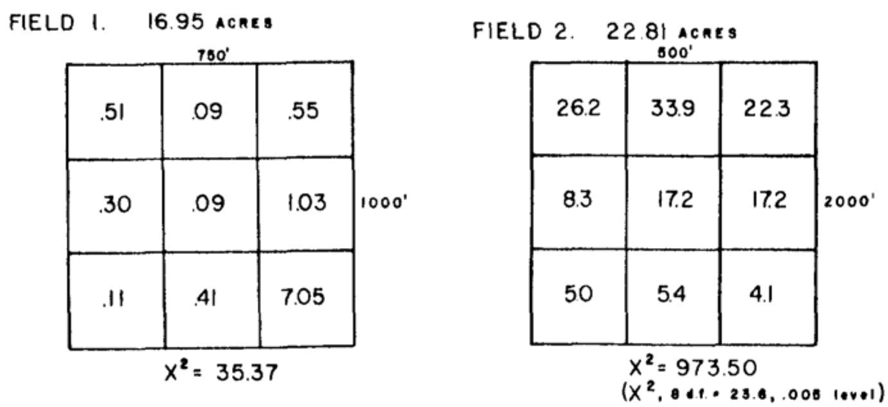

Figure 3. Two sweet corn fields sampled to determine frequency of damage within each field.

concentrated in one corner with 7.05% of the ears fed upon. This means then that the birds fed most in that portion of the field. In Field 2, in which the average damage amounted to 15%, the range was 4.1% to the highest value in one particular section where 34% of the ears were damaged. So again I can say that the birds chose for some reason a particular part of the field in which to feed. Did they choose it because man shoved them back there? In this instance, that wasn't the case at all.

We know that the fellow was being very ineffective in any control program he was carrying on. My point is, no matter what the reason is, whether it's man's stress, whether it's a roost, the birds, through visual or auditory stimuli, have decided to feed in one particular region. Now the question is, how much time does it take a bird to cause this much damage and how many birds does it take to cause this much damage? We are now working on this point.

This is the story on the field corn. These are the results of the transects that I took. I worked up the data and found a very peculiar relationship (Figure 4). I found a curvilinear relationship, that is, a log by log relationship between the percent of ears damaged within a field and the total number of grain missing from that particular field. Let's just examine and see what this is saying. When one percent of corn damaged was in the field, there was a very low amount of corn removed. At the highest level that we measured (96% of the ears were damaged within a field) we had a rather large amount of corn removed from the field. The interesting points are the ones in which 10 to 50% of the ears were visited or damaged in the field. For these the same curvilinear relationship held. Certainly, there is a finite number of ears in a field--100%. Therefore, if they are all visited, by the time the incidence reaches 100%, birds in any incoming flock will have to go to an opened ear of corn. But when 10%, 20% or 50% of the ears are damaged, birds entering a field face a decision--to go to an opened ear or to open a new one? I assume there's more work in opening up a new ear; but how much work, we have to find out. Still, the bird is faced with a decision. Let

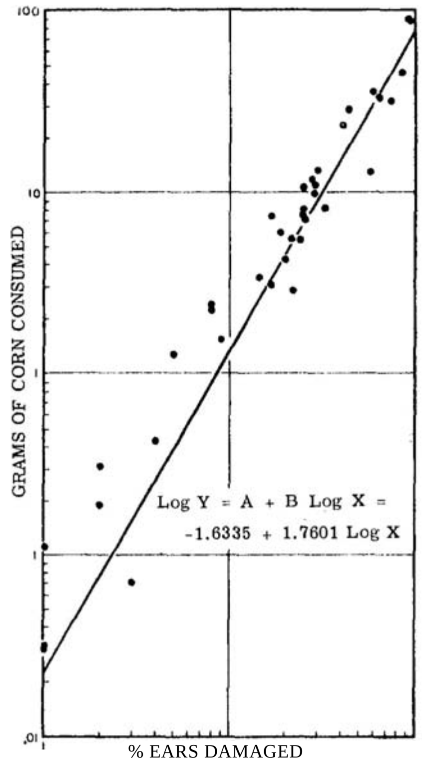

Figure 4. Plot of field corn damage in 1964. The data are taken from the transects A, B and C of Figure 2. They show the log-log relationship between incidence of damage and amount of corn removed from each ear.

us assume that it is lazy and "doesn't want to" open up a new ear but "would rather find" an opened ear. How does it know where this opened ear is? I've already shown that there was not a homogeneous scatter of birds in a whole region and also there is not homogeneity within a field. If this reasoning is correct, each bird was returning to the same exact spot that he fed previously. It had opened up an ear--and it "knew" where this ear of corn was and preferred to feeding on that ear of corn. To be sure this is a very generalized scheme. If he fed randomly, this relationship I have just described would never have existed. The scatter of points on the graph would be random and there would have been no nice straight-line relationship between numbers of ears visited and total damage. That would be the alternative. Next slide please.

This slide shows the same data reworked a different way along with data from an interesting report Dave Schneider found for me. R. W. Hayne reported redwing damage from Michigan in 1946. I reworked his data in addition to the Ontario material (A) and the figure shows the results. This line (b) is the report from 1939 and '40 of red-winged blackbird damage in Michigan and it follows the same relationship of the curve I have already discussed. I have not tested the two curves, but I would be surprised, from the samples that he had and the samples that I had, if there is any statistical difference. Therefore, I suggest that there is some circumstantial evidence that long-lived feeding patterns have developed in redwing flocks, and they are probably constant for this species. This suggestion may not be too surprising, but I think the surprising thing is our inability to think in these terms. So obviously we have to reorganize our thoughts.

Now we must define these patterns more factually. For one thing we are reorganizing our methods of data collection. The estimates that we have had from the field are inadequate. To get around these inadequacies we are harvesting the corn and making our analyses in the laboratory. From this we will be analyzing the damage and weight basis rather than a field basis. If we can establish, in this area and other areas, that these relationships I have discussed hold true, there maybe a convenient way for assessing crop damage but I am more interested, of course, in getting more information of patterns of bird flock feeding behavior.

DISCUSSION

H. MILITIZER: I've been impressed with these meetings and the things which have been said. One of the things which impresses me greatly has been the tremendous effort, the sincerity and devotion that these research men have given to the problem. I think that in evaluating the entire problem, they stand comparable to an epidemic in New York City that might be controlled by six physicians; it can't be done. One of our biggest problems is, I think, to somehow find helpful personnel to develop a program of some sort to help bring control to the bird problem --other than just the pest control operator.

In Canada, I know that the officials aid their pest control operators to a far greater degree than in the United States. I've been in the pest control business forty years. I've done some bird work for most of that time, and some of it on farms. In thinking about where we may find people, I recall something that I did as a kid. There were a number of us in Toledo in Sherman School who had rifles, and we used to go out every Saturday and shoot sparrows. We shot sparrows first for fun, and then, like kids--we didn't like to waste the birds--we wondered whether the meat was good to eat. We pulled out just the breast and found them quite edible. We would have cookouts every Saturday after shooting.

Sportsmen like to shoot; it's a great sport. Sportsmen's clubs of America could be encouraged to go into corn fields, and if they were permitted into cornfields at the right time, I think that they could do more to bring about control in a matter of five to ten years than we can hope to do in a hundred.

I was also impressed by the statement of Dr. Balser, that it was a habit to leave every 12th row bare. If the farmer could be encouraged to do that here, he would provide a walking area with sufficient distance for shooting. I do believe that this would help solve a critical personnel problem.

C. FAULKNER: A few years ago that philosophy was tried in New Jersey. We were opposed to it mainly because it's against the migratory bird regulations; the blackbird is protected by treaty by the government. But if the birds are doing or about to do damage, we allowed any farmer to welcome the sportsman to come onto his land. This was advertised for three solid weeks in papers and through sportsmen's groups. The sportsmen arrived and gunned for about two hours the first day. And it fell flat. They liked the first day kill, like any opening day. The program was authorized to go for the entire month. Generally, the philosophy was right, but the program fell flat. The sportsmen lost interest quickly and did not follow up.

DR. BALSER: Being first on the program this morning, I wanted to wait until I heard what everyone else said before I said too much. As a research man, we're always concerned with releasing information. I, personally, am not involved in bird control research, I'm in an administrative position and all the credit for the work that's been done goes to our boys in the field. But I heard quite a bit of pessimism about some of the difficulties of these bird problems. But I think that we've been quite fortunate in Denver, in that every one that we've been able to concentrate effort on, we've come up with solutions.

Now at Sand Lake, South Dakota, I'd like to show you a little something that has happened there in the past two years. I think that this is an item of encouragement, and we are going to publish this data shortly. It's an indication that all isn't hopeless and something can be done. Sand Lake Refuge is on a marsh on the James River, roughly 20 miles long with a number of dams. The area surrounding it grows corn. The James River comes from the north in North Dakota. We have had a million and a quarter to two million blackbirds in this cattail marsh every fall for the last five years. In the north of it, in the James River basin, there are 7 to 20 million young blackbirds reared every year, overshadowing this population around Sand Lake refuge (the maximum number we have damaging corn at any one time).

When we looked at this situation, we realized that even if we removed every blackbird around the Sand Lake marsh, we would have a backup population of ten times that, that could conceivably move in on us. We don't know the interchange of this cattail population, how many are leaving and others coming in; we haven't determined this through banding yet.

Our men have searched for five years, starting out with one man on the project, John Degrazzio, who was kind of buried in this situation to start with, but through some hard work he's come up with some solutions. Now the first thing that worked here was exploders. Any farmer who was really attentive to his job, and really went after them hard was able to protect his corn; he sometimes pushed them onto his neighbors, of course, but one by one they picked it up.

By the time we wanted to start some chemical tests, many of the farmers were pretty well settled with their success on exploders. We were thinking: well no, this is working, if they only adopt it and use it, fine. But we made one simple observation in the field one day, on the food habits of the blackbirds, (we knew that they were eating corn and some weed seeds, and we wondered where they were getting them.) One of the boys noted that, in addition to corn in their bird's crop, there was also a lot of Setaria (foxtail). The Setaria is growing as weeds in the cornfield. Watching closely, we saw some of the birds go onto the ground. You probably heard of some of our experiments with treating ears with Avitrol, and on two acre plots throughout the field, getting repellency, driving the blackbirds out of the field. We haven't been satisfied with this because of the possibility of residue and contamination. So the men got the idea of ground baiting.

And a year ago, they tested both some aerial baiting, and ground baiting by hand, and by tote goat through the field (with the wings clipped on the handlebars so they could get down into the rows), and by machine baiting. And then they came up with the idea of using some of the highboys (spray rigs), with an electric seeder or by hand.

So we made provisions for a rather grand trial this year. We set up an area of about a ten-mile radius from Sand Lake--that means an area 20 miles across. We estimated that within this area, there would be about 10,000 acres of corn subject to damage. We decided to treat the whole works to see what would happen to this flock. Final results of this test are not in yet, but we found that we don't have to bait nearly as much the second or third time after our first baiting. The damage appears very light--we have complete damage measures to make yet. From our preliminary observations, the damage looks about the same as last year, and they reduced it about 90% through ground baiting in a 94-section study area of corn adjacent to the marsh.

Now I don't propose this as an answer to the problem anywhere else, because corn conditions are different—height of corn, amount of cultivation and undergrowth, the behavior of the birds. But under intensive study here, I want to show that we have been able to develop a solution. Now the farmers bought this bait, they paid 50¢ per pound for it (some thought they would go back to exploders). But this work shows that the grain damage problems can be solved. Unfortunately, we haven't been able to do it on milo and rice yet, but I'm not ready to give up.

J. STECKEL: You spoke of aerial baiting. What do you mean by this?

DR. BALSER: This technique is touchy because it's difficult to control, but we felt that we could get good, even dispersal of grain without having piles on the field border, and it would be a fast, economical method of application. Your labor's reduced. It's strictly experimental now. It would be extremely difficult to sell the idea of doing this.

R. SMITH: One thing you have to bear in mind when you do this: you must know what the biological community is, what other animals are involved, etc.

DR. BALSER: There are a few things that I didn't mention. There are built-in safeguards in this technique. We've gone to an extreme dilution on this bait; we dilute one to thirty. It's only applied as one pound per acre, so there are very few kernels there. They are kept in from the field borders. There are constant surveys on the doves and pheasants to make sure that we don't affect them. But we've gone through with dilution baiting technique that we can sometimes poison the target species and protect the nontarget species by virtue of differences of body weight and feeding preferences. With dilution baiting, a nontarget animal may feed on bait without getting enough kernels to receive a lethal dose. We hope to apply this dilution baiting technique in other control situations.

J. STECKEL: I'm curious about some of the spray techniques which you use. Have you done anything with aerial sprays other than wetting agents?

J. CASLICK: The answer is yes. Very early in the game, three or four years ago, some organophosphates were tested in bird roosts.

J. STECKEL: Is there any possibility of some of the heavy liquid gasses being suspended in water or spray used as controls?

J. CASLICK: We haven't investigated this at all. It might be worthwhile looking into. Do you have any specific ideas?

J. STECKEL: There was some work done in Germany where they used calcium cyanide in water which would give a kill of any species which was there at the time and no problem of secondary poisoning nor of persistence of chemicals.

J. CASLICK: These are the kind of ideas we appreciate.

C. SHICK: We have another problem in Michigan and I believe the people in Canada are experiencing it also, which is the effect of grosbeaks which come down in winter and eat off the terminal buds of Christmas trees.

R. SMITH: It is also a problem in Pennsylvania. We tried to think of a way to repel these birds. We have no answer right now. We have programmed some work for 1967. Ki?

C. FAULKNER: This damage has been assessed in Pennsylvania and in Maine as to the economic loss and the recovery rate of the trees. Considering the expense of repelling a protected grosbeak, it would not pay to do it for one thing. We tried Arasan at very high levels, which was totally ineffective as far as repelling the grosbeaks. Killing permits may be issued with a jaundiced eye.

R. SMITH: Arasan is a seed repellent. We recognize the problem and for this one we really don't have an answer.

J. STECKEL: Is DRC-1339 being used experimentally in the control of red-winged blackbirds?

DR. BALSER. Yes.

J. STECKEL: Satisfactorily?

DR. BALSER: Yes, it will kill them.

R. SMITH: How do you evaluate it?

DR. BALSER: This is the big problem. It's a slow-acting toxicant which takes 8 to 12 hours to kill. You have to be able to locate the roosts and run survey transects through the roosts to get any kind of a good evaluation. We can't rely on counts before, during, and after treatments at the feedlots, as you can well imagine the problems. It works well on grain baits in cattle feedlots; in fact, I'm sure they've cleaned out some cattle feedlots of redwinged-blackbirds. When they are trying to attract starlings with grain baits, the redwings will take the bait more readily because it is a grain feeder.

D. SCHNEIDER: What is the name or designation of the sleep inducing agent you mentioned in your talk, Mr. Caslick?

J. CASLICK: These have coded names, unfortunately, for you as well as us. The only published reports call it PRC-661 (Patuxent Research Center).