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PROCEEDINGS :

FUTURE TRENDS IN THE MANAGEMENT OF STORED PRODUCT INSECTS

Informal Conference

Joint Meeting of the
Entomological Society of America
Entomological Society of Canada
Entomological Society of Ontario

Toronto, Canada
December 1, 1982

F.V. Dunkel, Moderator
S.R. Loschiavo, Scribe

UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Entomology,
Fisheries, and Wildlife
219 Hodson Hall
1980 Folwell Avenue
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April 8, 1983

To: Those who attended the 1982 informal conference on "Future Trends in Management of Stored Product Insects." Joint meeting of the Entomological Society of America, Entomological Society of Canada and the Entomological Society of Ontario.

Re: The Proceedings

Dear Colleague:

Enclosed is your copy of the proceedings from our 1982 conference on Future Trends in Management of Stored Product Insects. In our continued efforts to keep this informal, no written matter was solicited from contributors. This is solely the tape transcript with slight grammatical changes and modifications to improve readability.

With the widespread cuts in travel budgets in both universities and government agencies in both the U.S. and Canada, communications of this sort may provide an important substitute. Even in areas of more liberal travel budgets, the geographical dispersion of our kind - stored grain entomologists - makes informal printed communication of this sort a help. Hopefully this will also be an easy-to-read way of communicating with our counterparts in other disciplines dealing with stored grain.

This copy is free, courtesy of the University of Minnesota and Phillip Morris Company. If one of your colleagues desires a copy we are charging $5.00 which exactly covers xerox and binding costs.

It took several 24 hour days to produce this. I am interested in your response. Let me hear from you.

Sincerely,

Florence V. Dunkel

Florence V. Dunkel
Grain Storage Entomologist

FVD/wab

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March 1982

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ABSTRACT OF CONFERENCE

Passive dispersal of 3 seriously damaging species was reported: the greater grain borer, Prostephanus truncatus (Horn) from southern North America to central Africa (Tanzania); the khapra beetle, Trogoderma granarium, Everts from the Middle and Far East into the U.S. and the larger black flour beetle, Cynaeus angustus (LeConte) from concentrations in the SW and North Central United States to stored tobacco in the SE. The future trend suggested by the latter 2 movements is that we may send such seriously damaging insects to countries where neither control measures nor adequate border detection techniques have been developed to arrest their establishment in new territory. These seriously damaging insects may arrive in a non-food commodity, but contamination of transportation containers which later carry grain or dispersal to adjacent grain stored at port terminals are an important problem. Changes in U.S. border detection for T. granarium may result from future studies at the newly quarantined APHIS khapra beetle lab (Hoboken, NJ).

Methoprene studies, investigations with diatomaceous earth and other insect growth regulators (IGR) and dessicants such as sorbic acid and tricalcium phosphate show new long-term effectiveness for stored products and empty structures. Unusually high LD_{50}'s are also typical of these 'new' insecticides. One of the carbamate-type IGRs was reported to have an LD_{50} of 16,000 mg/kg. Underground grain storage in Brazil and Africa at the small farm level was reported. Studies of that and larger size structures are underway at the University of Minnesota.

Detection devices such as metal probe traps, plastic probe traps

and hanging paper traps are on the verge of having widespread commercial use. Studies of their efficacy continue at the Winnipeg Research Station, University of Wisconsin, Ohio State University and in the private sector. Research results also present a continually better defined picture of the behavioral chemistry of these insects. Although synthesis of newly defined pheromones is occurring frequently, concentration and release rate from traps and other devices still creates a fine line between success and failure.

The future may bring an enlightened understanding of the impact of insects in stored products. Evidence presented was the development of stored grain scout systems and consultants in the private sector and conferences such as the 1982 NC 151 meetings where storage engineers, economists and plant pathologists gathered to learn the extent of insects in U.S. grain and the ramifications.

OPENING REMARKS

F. Dunkel: This is the 4th annual Informal Conference on Stored Product Insects and I am pleased to welcome you all here this evening, gathered from throughout the United States, Canada and Mexico. Looking out over those assembled I see some of the main research scientists in this area from both government and university laboratories: I see several extension entomologists who are specifically designated to work in this area: I see representatives from industries currently working on or supplying exciting new products for this area: I also see entomologists who have, in this past year, had experiences working with stored product entomologists on other continents such as in South America, Africa and Asia. There is a form now being circulated among you on which we would like you to add your name, mailing address, present position and specific topic(s) of interest. This, along with the proceedings of this conference, will be mailed to you early in 1983.

Some distinct changes and strong predictions of change in the management of stored product insects have occurred in the past few years:

1. In the grain area alone there has been a strong movement away from a merchandising economy into a storage atmosphere. 15 months ago U.S. grain under government control totaled 3.999 billion bushels. Tremendous surpluses of grain in the U.S. have been further exacerbated by the world economy. In some cases, international politics is simply not conducive to export growth. The impact of insects of these 3.999 billion stored bushels could be significant. The destruction of

insects of in-transit export grain could make a presently bad situation much worse.

2. The computer is swiftly becoming an important tool in the management and marketing of this grain. As of March of this year, the USDA printed a list of 50 computer programs available for extension use in the area of grain storage, drying and handling. A larger management program is now being planned to predict losses due to insects with other abiotic and biotic factors during storage.
3. After almost 2 decades of careful laboratory and field experimentation, pheromones are becoming a realistic method of monitoring storage situations for insects.

Tonight we are going to focus on these and other future trends in the management of stored product insects. The suggested format is being passed out to you now. Although many of you were sent this list in early October and have indicated you wish to contribute to certain of these topics, anyone else is strongly encouraged to contribute.

This conference has a tradition of informality and 100% audience participation and sometimes heated discussions. In no way do I suggest a break in this tradition. In each of the 10 areas listed we welcome comments from researchers, extension entomologists, international workers, industrial representatives, and private consultants.

At this time I would like to introduce my appointed scribe for this evening, Dr. Sam Loschiavo, Head of the Stored Product Insect Section of the Agriculture Canada Research Station, Winnipeg, Canada. We will send you the proceedings of our discussion this evening if you so indicate on the address form.

Before we begin the specific topics, I would like to make several announcements regarding future events in the area of stored product insect management.

1. The Tribolium Information Bulletin has been reinstated and will be published in 1983. Deadline for submission of lists, addresses and research notes is February 28, 1983.
2. The Third International Working Conference on Stored Product Insects will be held October 23-27, 1983 in Manhattan, Kansas. Bob Davis, who is present this evening, is chairperson of the permanent committee.
3. Also on the international level, I have just returned from 5 weeks with the grain storage and transportation section of the Chinese Ministry of Commerce and want to announce the possibility of developing a cooperative research program with them on protectants, other insect control techniques and resistance to control of stored product insects. One source of funding for this is the USDA. Deadline for the USDA cooperative grants program is August 1983. I will be organizing this and combining it with funding from other sources.
4. My final announcement is the production of an Integrated Pest Managemcnt manual edited by Harley Rliey, University of Kentucky. It will be printed by the USDA and ready for distribution in the latter part of 1983.

Are there any other announcements?

The only rules that I wish to impose as moderator this evening are that each of the 10 topics be dealt with in order. We will begin with

those who have requested time, then those who wish to contribute may do so after that. At the close of the evening we will decide if we want to do this at the national ESA meeting next year, and if so, elect a moderator.

So let's begin.

The first topic this evening is Future Trends in the Development of Insect Detection Techniques. Speed, accuracy and low cost are the important considerations here. Trap construction, pheromones and CO_2 detectors are some of the changing areas. To begin the discussion is Dr. Wendell Burkholder, director of the USDA Stored Product Insect Lab, University of Wisconsin, Madison. Wendell...

W. Burkholder: I would first like to review what we have been doing for the past several years. We have developed lesser grain borer pheromones to a point that now it is being used successfully in field studies. We went through the biology and, with cooperating chemists, identified the pheromone. It worked quite nicely in the field. Perhaps some of you heard the paper by Jose Leos this morning on his field studies in Texas. Bob Cogburn at the USDA Rice Research Laboratory in Beaumont, Texas has been doing this work also and has completed a manuscript on his field studies. This will be published soon. The pheromone works well on sticky traps hanging up in warehouses or in grain bins. Bob has also found out you can go outside his facility and quite easily obtain insects from the surrounding areas some distance from the bins. For various reasons we have not had as good success working directly in the grain bin with probe traps. We don't know all the answers yet. The sticky traps work well. The probe trap out in the open worked well also.

The lesser grain borer pheromone is a population aggregating pheromone produced by the males. It brings in both males and females. I won't say anything more because Leos and others perhaps will follow up on that. I might add one thing, however, and that is there is a slight problem if you get too high a concentration. Those working with this pheromone should be aware of this. Release rate is extremely important. So with that I will let someone else say something more about the lesser grain borer.

We're working on the granary weevil, the rice weevil, and the maize weevil. Again, these have a male-produced population aggregating pheromone. It works quite nicely in the laboratory. At the present time we only have natural material to work with. We have made a tentative identification, but we've not completed all the chemistry. Hopefully, within the next month or 2 we will have it finished. Again, it's going to be a similar situation to the lesser grain borer. The weevils present a similar pattern of behavior. We also have been working recently on the Trogoderma pheromone. Perhaps some of the others will want to say more about this. The Trogoderma pheromone is a sex pheromone. It is produced by the female and brings in only the male. It is being used by some people for trapping work in warehouses. We've done some work but much more work needs to be done. It seems to be quite effective if you have the right time of year, the right temperature, the correct concentration of pheromone, and the right time of day. The khapra people are interested in this, particularly those at APHIS. There is a new APHIS lab at Hoboken that will be working on the khapra beetle.

We have done some trap development along with Al Barak and Zoecon.

I have made an improvement on Sam Loschiavo's probe trap. Mine is made out of plastic. It seems to work better than the metal trap. It's bigger and seems to be cheaper. It's the kind used by Bob Cogburn (Beaumont, Texas) and Bob Mills (Manhattan, Kansas). A number of people are currently using it. It is available commercially now. If anyone is interested they can see me after we adjourn.

F. Dunkel: Thank you. It may be important to note that the studies Bob Cogburn did were with rice. Bob Mills studies were with wheat. Jose's studies were in a warehouse. Perhaps we should stay with beetle pheromones now before discussing new trends in moth pheromones. Jose would you elaborate on the lesser grain borer trapping?

J. Leos: At Texas, we used dominicalure last year with the probe trap in stored sorghum. We placed the pheromone in rubber bands hanging inside the probe trap. We used 2 other sampling techniques at the same time: 1) the traditional (trier) probe and also the cutting and quarters method. We related the trier results with that of the pheromones. There was a good correlation between real density and detected density. This year we worked with aerial traps. We are working with plastic baseballs covered with plastic bag. We put the ball in the sticky-coated plastic bag. Then in the field or the warehouse we turned the bag inside out and hung the ball up in it. We put the pheromone in a small test tube. Then when we finished the test we put the ball with the insects stuck on it back in the bag. Back in the lab it's very easy to count the insects in the bag. The ball can then be reused. We found the bulk compound of dominicalure I & II and also 2 mixtures: 50:50 and 60:40 were equally effective both in a

warehouse and in the field (i.e. about 30 m. outside warehouse). Those without pheromone caught a mean of 1 insect. Traps were spaced 4 m apart. Then we tested fluorescent and non-fluorescent colors and transparent balls. There was no significant difference between any of these whether they were used inside or outside the warehouse. Then we looked at height of the traps, but the warehouse we had for this test was only 4 m in height. Effectiveness was not attained by height. Then we worked with time of day for maximum capture. For this test we used a sticky cylinder in a thermohydrograph with a window on the present hour. We found the peak time of attraction was 7-8 p.m. during the month of June.

F. Dunkel: Thank you Jose. Sam, I believe that you are also working with beetles. Could you tell us about the future trends from your lab?

S. Loschiavo: I built a mousetrap and then Burkholder went ahead and built a better mousetrap. So I had to see if I could improve on that. The plastic one may be cheaper, but I don't think one is better than the other. His may be better adapted for use with pheromones while suspended. Ours has features that make it more suitable for use within the grain bulk. For those of you that are unfamiliar with this trap, the main feature is that, unlike the grain probe, it is escape proof and can be left in the grain mass any length of time without loss of insects, thus increasing the probability of detection. One problem is that if pushed into the grain deeper than 1 m, it tends to go off at an angle and consequently buckles in the area of the perforated brass. We solved this problem by adding a flange on the trap over which is placed an aluminum tube attached to the push-rod assembly. Thus, the

force exerted during insertion is absorbed by the flange. We have used our trap food studies on the rusty grain beetle pheromone in collaboration with John Borden and his colleagues at Simon Fraser University. The first field results showed that baited traps in annex bins caught significantly more beetles than unbaited traps. Tests conducted in farm bins during the summer of 1982 produced less spectacular results. Even though pheromone-baited traps were more effective than unbaited ones, beetles were caught in unbaited ones and probably produced natural pheromones. Under these circumstances, it would not be necessary to use a synthetic pheromone to monitor stored grain for beetle infestation except perhaps in low population situations.

W. Burkholder: Our plastic trap modification also now incorporates an aluminum conduit for insertion and flange modification.

Audience Question: Realistically, how far can these be inserted into grain?

S. Loschiavo: About 10 to 15 feet depending on how strong you are.

F. Dunkel: Thank you Sam. I understand Daryl Faustini and Jim Long will refrain from cigarette beetle pheromone discussion until their formal paper on Friday. So at this time we will move into Lepidoptera. Ken Vick will you begin the predictions for the future for stored grain Lepidoptera pheromones? Ken is at the Gainesville USDA Attractants Laboratory in Gainesville, Florida.

Ken Vick: We have a fairly large test going on now that tests the complex of pheromones from the Indianmeal moth, Mediterranean flour moth and the almond moth. For these phycitid moths we are trying to

relate catch to population size; catch versus height, in distribution center of up 20 mi^2. Thus far, we have a lot of data. We catch a lot more Plodia than the other two species.

F. Dunkel: Will there be a paper on this?

K. Vick: Not at these meetings but it will be written up in manuscript form January 1983.

F. Dunkel: Jim Sargent, will you continue the predicting picture for stored grain moths? Jim is extension entomologist at Ohio State University.

J. Sargent: I have had a student working with me and have done some work for both Albany International and Zoecon with trap testing and Indianmeal moth and Mediterranean flour moth pheromones. The efficiency of the trap is about 30%. So if you release some moths you can recapture about 30% within 24 hours. These traps, then are a sensitive monitoring device, but we don't see any indications, for them yet, that they are suitable for control. Just recently we have done a density test looking at different densities of traps and we find that the more traps one has the more moths are caught per trap. Perhaps we may in the future find there is some control potential there. We also looked at trap height and found that there is no significant difference in trap height until one reaches the ceiling. At that location dramatically more moths were always caught. We also put traps outside as a preliminary test and could not find any moths in them, even though Plodia is a very commonly trapped insect in bins and warehouses and homes and grocery stores in Ohio. An important consideration when there traps are used as an extension tool is that the lay public using them, often sees evidence of an infestation they hadn't noticed before.

Therein arises the danger that the public comes to consider these a control measure which they are not.

We also looked at distance, how far an individual trap will draw in moths. In another study we checked the traps over a 24-hr. period to determine when they are active.

F. Dunkel: Thank you, Jim. Alan Barak would you like to comment on your work with Zoecon?

A. Barak: Very briefly. Zoecon in cooperation with Wendell Burkholder is conducting research with the Tribolium pheromone. We have the entantiomeric as well as the racemic moisture. We are evaluating pheromone dispenser release rates and pheromone dispenser life. This will be reported at the North Central ESA meetings March 15, 1983.

J. Sargent: You mentioned trap longevity. We looked at longevity of Plodia traps in a feed mill. With white traps and glue the limiting factor was the glue being filled with dust. It happens quickly, in 4 to 6 weeks, reducing the catch 50 to 60%. The release mechanism, the rubber caps from Zoecon or the fibers from Albany International or the water, all last a long time but the glue does not.

W. Burkholder: Sam, I'm not sure if you found this out, but you can hang these probe traps up and use them as aerial traps outside or inside. It's necessary to put a platform for landing on them, however.

S. Loschiavo: These are then temperature-dependent for flight?

W. Burkholder: Correct. So we would not expect Trogoderma below 75°F. To be rainproof one needs to put a cap over them.

F. Dunkel: We have thus far centered on traps. Are there any other new detection devises that we can hear about at this time?

A. Barak: Another modification of Loschiavo's trap has been to make the perforations larger to admit the larger black flour beetle, Cynaeus angustus. In our study they were much more effective than deep cup probes even when they had no pheromone added. 'The farmer's loved them.'

F. Dunkel: We can move on now to other types of detection such as CO_2 and uric acid determinations.

Bill Bruce: (USDA stored products Lab. Savannah, GA). I think what people should keep in mind is that there are a number of ways to detect insects. For some agencies such as regulatory agencies, one insect per box car is not too few. There are two general methods of detection, passive and active. At Savannah we have always limited our investigations to passive techniques, i.e., monitoring some production of the insects themselves. Active techniques require some type of input such as pheromones, an electric charge, etc. The technology is there to accomplish whatever kind of detection you wish to do. Whether you are willing to pay the price for that technology is another matter. There are spinoffs from the space program, high intensity X-rays, thermoenergy, and photoacoustical spectroscopy. There are things that can do the job. I wanted to have the people in this room aware of this because as I discuss CO_2 detection I would like you to remember that it is often chosen because it is an on-the-shelf technique. It is cheap and very sensitive. By this technique one can detect different developmental stages. However, they are not an insect detector, they are a CO_2 detector. They will pick up CO_2 from the respiration of the grain and the fungi. Each has its advantages and disadvantages, but there are techniques that future investigation can develop into a new

generation of detecting devises.

F. Dunkel: Thank you Bill. To that I might add that at our lab at the University of Minnesota in collaboration with Minneapolis FDA labs we are developing a new uric acid detection technique which requires a few hours rather than a few days. We are looking at uric acid levels in corn in relation to different population densities of the larger black flour beetle.

Also, while I was in China this past month and a half and specifically in the national stored product research labs comparable to those at Savannah, Manhattan and Fresno, I noticed no new trends in insect detection except accoustical detection. In Kai Feng which is in Henan Province in central China, research is being done on detecting sound production in insects in stored grain.

At our lab in Minnesota last summer, we completed a detectability study in which we tested the ability of the federal and state grain grading process to detect live adult beetles. I will present details of this during discussion of the next topic.

To summarize our comments on the future trends in insect detection devices, we see on the horizon, the commercial use of pitfall and sticky traps containing multiple sex and aggregation pheromones which eventually will be able to lure any of the species in the stored product insect community. There are also on the shelf, receiving a little less intense research attention, various passive detecting devices which may hold promise in the near future. Those mentioned were CO_2, acoustical detection, and uric acid analysis.

Future trends in the grain grading process

This is one topic for which no one specifically volunteered. This summer at an NC-151 workshop on stored product insects and fungi, David Falk of the Federal Grain Inspection Service discussed possible changes in standardization process. Perhaps some of those who attended will summarize this.

W. Burkholder: The main issue here is that the terminology does not match the real situation. Namely, some insects which are considered "bran bugs" are actually internal infestors. In addition, these "bran bugs" which includes the fungivores, flour beetles, etc., are not treated as seriously or stringently as the weevils and yet they are some of our most common insects and potentially very destructive due to their long lives and adaptability.

F. Dunkel: Thank you Wendell.

This spring and early summer in Minnesota we tested the ability of 250 federal and state grain graders to detect grain spiked with known amounts but different densities of Cynaeus angustus, Tribolium castaneum, Cryptolestes pusillus and Oryzaephilus suraminensis. The grain sample was 1 kg whole corn. We found Cynaeus angustus which is over 3x the biomass of Cryptolestes pusillus to be 2.5 x as detectable. In no samples were 100% of the insects recovered. These results are part of our computer program of cost/benefit being written for the individual farmer. The program I will discuss later.

S. Loschiavo: I would like to bring up an interesting point regarding the "weevily" subject which Wendell introduced. In Canada, very often an elevator manager will reject a shipment of grain by a farmer just on the basis of seeing these fungus feeders rather than the

insects that we are concerned about, the primary grain feeders. As a result some Canadian farmers have spent money uselessly to fumigate. Fumigation certainly will kill the fungus beetles but won't solve the problem because the presence of the fungus feeders is simply an indicator that grain is going out of condition. By fumigating, the problem of the fungi has not been solved. After the grain has been purchased by the elevator, it will continue to deteriorate due to the microorganisms that can cause grain heating.

W. Burkholder: Supposedly the fungus beetles are the ones that succumb during transit and it is the internal feeders that survive.

F. Dunkel: On the other hand, one of those 'fungus beetles,' Cynaeus angustus can attack sound corn, and develop within the kernel to an adult after making only a small hole in the germ end. So some fungus feeders can behave, trophically, like internal feeders, a phenomenon the U.S. grain grades do not account for.

Unidentified Speaker: Whether or not changes come about in the grading process that more accurately reflect the insect problem will probably have more to do with political issues than biological principles.

Jim Sargent: With the moths, we could sit in a warehouse for an hour and not find any but 5 minutes after we would put a pheromone trap up - there would be Plodia in it.

B. Bruce: I agree, from a technological point of view, we can detect the insects.

F. Dunkel: To summarize the NC-151 U.S. grain quality workshop on insects last summer - there seemed to be expressed an urgent need for more accurate, quicker, inexpensive detection methods for insects.

There also was strong evidence presented that U.S. grading not only does not call for a zero insect tolerance but it also does not detect all the insects that are present. In some cases less than one-third of those actually present in the sample are detected.

The 3rd topic for this evening is Future Trends in Protectants for Grain and Milled Products. Top of the list here, of course, is methoprene and other Insect Growth Regulators. We will first hear from Al Barak, then Daryl Faustini and Ken Vick.

Al Barak, formerly of the University of Wisconsin and the University of Minnesota is now employed by Zoecon Corporation, Palo Alto, California. He resides in St. Paul, MN but has projects throughout the Midwest.

A. Barak: I have been conducting bioassays with methoprene. We have found in trials with the lesser grain borer in Australia that 0.25 ppm provides good control. These trials were with small bins combined with lower levels of residuals for high short term kill. We are testing it in a waste formulation. An experimental use permit allows us to combine it with dust suppresants such as Dust Sorb on wheat and corn at 200 ppm.

F. Dunkel: Thank you Alan. Our second contribution regarding new protectants on the horizon, comes from Daryl Faustini of the Phillip Morris Research Labs in Richmond, VA.

D. Faustini: I would like to talk about the use of methoprene to control the cigarette beetle in tobacco. The initial study that was conducted at Phillip Morris had 3 sections. For the first one, 8 hog heads were selected. Three of these were treated with methoprene at 10 ppm (this compound had the commercial label Kabat^{R}). Three hogsheads

contained 'stems' and 3 contained 'strips' that were treated with methoprene and 2 control hog heads, 3 that contained 'stem' and leaves and 3 that contained 'stems'. The study was initially started in May of 1978 and the hogsheads were periodically infested with insects until September 1978. This came to approximately 10,000 insects. The infestation occurred with live adult insects. They were put in a rotational position each week along the hogshead through the slats nailed on top. In the spring of 1979 the lid of the treated hogshead was removed and a circular disc of Tyvek was put on top of the tobacco.

Tyvek® is a Dupont product. It is a spun bounded polyethylene material which the insects cannot chew through. We laid a thin coat of tack trap on top of it so that those that were originally studied can't get out. In the Fall of 1979 the hogsheads were removed and opened up. Here you can see that on the stem controls, the small black dots are cigarette beetles. The tack trap had 2-3 generations of insects that had emerged by this time. Next slide shows you the stems treated with 10 ppm of the methoprene. These differ considerable than the stems in the previous slide. The control stems and control strips contained significantly more insects than those treated with methoprene. The mini-warehouse study was then expanded to take on a new picture and that was utilizing a larger scale design and a natural infestation. In the spring of 1980, in San Jose Costa Rica, stems and strips were treated with 10 ppm. In this case they treated about 100 hogsheads and put these in a warehouse that contained about 4000 hogsheads that were untreated. The methoprene treated hogsheads were not inoculated with insects, but were left to stand in the warehouse. In the fall of 1980, approximately 4 generations later, they removed 7 methoprene treated

hogsheads. They also removed 6 of the remaining untreated controls. They put a circular disc of ~~tybrek~~ Tyvek[R] on the top of each hogshead and then the lid was returned in the same manner as the earlier slides showed you. So all methoprene treated and untreated hogsheads were kept in separate warehouses. They put them in the warehouse until the spring of 1981. So 4-5 insect generations could have occurred in this time which was quite high for this geographic area. In the following slide the stems that were treated with 10 ppm of Kabat[R] are shown. The stem controls show a significant difference. A similarly significant contrast is shown for the leaves and the strip. This table summarizes the data. The control averaged about 20,000 cigarette beetles. They ranged from 45,500 to 3000. Whereas in the methoprene treated tobacco, the average was 9. A major warehouse study was then set up in Richmond. One of my colleagues, Marie Minor, used 19 warehouses for this study. In the fall of 1979, 4 warehouses were used in the experiment. The entire tobacco stock was methoprene treated. This was about 4,000 hogsheads per warehouse. Fourteen warehouses were selected which contained non-Kabat[R] (=non-methoprene) treated tobacco. All this tobacco was of the bright and burley grades. During 1980 the methoprene treated warehouses neither received the nightly DDVP insecticide treatment, nor the annual phosphine fumigation. However, the other 9 warehouses of the 14 that were untreated did receive the DDVP and the phosphine. In the summer of 1981 the Kabat[R] treated warehouses and 5 of the non-Kabat[R] warehouses received no insecticide control at all. The results are quite interesting. With no phosphine application, there was a mean of 77,000 insects per warehouse. Whereas the warehouses that received the DDVP and phosphine had 772 insects.

In the Kabat® warehouses where there was no application at all there was a mean of 649 insects per warehouse. The 3 studies demonstrate that methoprene has extreme potential in cost saving advantages: a one time application will hold for the entire period of the tobacco storage before processing; warehouses do not need to be sealed for the fumigation; insecticides do not need a repeated application and one is not using a restricted use pesticide. It is also extremely safe for humans. You do not have to worry about any employees entering the warehouse and inhaling dangerous fumes. The LD_{50} is ca. ~~3500~~ 34,600 mg/kg. It has been registered for use on tobacco as well as on other crops.

F. Dunkel: Thank you, Daryl. That is also really exciting. Are there any further comments regarding the Phillip Morris study.

Unidentified Participant: One thing I would like to add. If I export tobacco APHIS will issue a phytosanitary certificate.

F. Dunkel: Ken Vick will you continue with a summary of your work with insect growth regulators in Gainesville?

K. Vick: We are working on a IRG compound with peanuts. Peanuts are an expensive commodity. We have about 40 T of peanuts treated this year in an on-farm storage situation. We are using a Hoffman La Roche, Maag subsidiary material at 1 ppm. The test has been underway for 2-3 mo. It is thus far going exactly as the laboratory studies have suggested. We are getting excellent results. We have every indication that, by the time the test is completed this spring we will have controlled the insects with no other treatment than the Maag chemical. We have also worked with methoprene. It is effective on peanuts at 10 ppm. Both these materials give excellent results. No other treatment is used.

F. Dunkel: Thank you, Ken. Perhaps you can remind us what chemical class of compounds these 2 belong to.

K. Vick: MAAG is a carbamate. The Maag chemical has a particularly low mammalian toxicity ca. 5,000 mg/kg. Rick Stanton may want to mention something since this is your material that we are working with.

R. Stanton: The compound Ken is using is a carbamate, but not in the insecticide sense, in the chemical sense. When we talk about cholinesterase inhibitors, that is a methylcarbamate. This is a phenoxycarbamate. The oral LD_{50} has been rated at greater than 16,000 mg/kg.

F. Dunkel: At these meetings last year there was concern that the methoprene compound acts only later in the life of the Indianmeal moth, not until a large quantity of stored material had been eaten. The newer Maag chemical seemed to overcome this difficulty. Has any further research been done in this area?

K. Vick: Part of your statement still holds true. With the Indianmeal moth at least, at half concentrations, we obtain large larvae. It is also true for most IRG's if you put too much on, you get large larvae even if the IRG has been on the material a long time. We get a larger window with the Hoffman-LaRoche material than we do with the methoprene. You can easily get 25 mg larvae. These look like a hornworm. I think it is not a problem if a person does not get over enthusiastic when they put this material on their products.

F. Dunkel: With these juvenile hormones - like compounds, is there any future possibility of developing resistance, or has this been looked at yet?

K. Vick: There has been none yet reported and your guessing is as good as mine. It just has not been looked at yet as far as I know. The new Maag chemical is as closely related to actual juvenile hormone as the methoprene is.

F. Dunkel: Perhaps resistance of insects to IGR's should be a future research consideration of this group. Janet Klein, Department of Entomology, University of Wisconsin, however, has yet another type of methoprene data.

J. Klein: We have begun to work with methoprene and Trogoderma glabrum to address some of these problems. With Trogoderma specifically, methoprene causes prolonged larval life, that is prolongation of the feeding stage when commodity itself is treated. Dosage levels of 1 to 100 ug/cm^2 were also applied to surfaces. Applications were also made to cardboard and gauze surfaces. At 10 ug/cm^2 we recorded an 85% reduction in the population. Exactly what developmental stage the mortality occurred at in this particular test is not known. It is known that Trogoderma embryos are sensitive to methoprene in direct contact or when the the ♀ is in contact with the methoprene surface only prior to oviposition. In the later case, exposed ♀s lay fewer eggs and those that are laid may experience mortality when the 1st instar larva emerges. We are working toward the practical application of treating sites that larvae are likely to seek out for molting or for pupation. I am wondering if others are working on projects where the surface is being treated with methoprene and not the commodity.

B. Lehman: There is a registration application for topical application of methoprene to walls and floors.

W. Burkholder: An obvious spinoff of this is that everyone knows many of these insects prefer to move into cracks and crevices, or cardboard rolls just prior to pupation. The fact is that we have been talking for a while about various attractants, pheromones, food, etc. We can bring the insects into the site and then provide an acceptable pupation site that has been treated with methoprene. This becomes pretty much of a dead end for the insect.

F. Dunkel: Janet, is methoprene's action, then, as an adulticide or an ovicide or does it have a different role with Trogoderma?

J. Klein: It does not kill the adults. They will continue to live a normal life span, but it appears that they will lay fewer eggs during this time. There is a 90%+ reduction in the next generation.

R. Lehman: Juvenile hormone has been shown to play a role in vitellogenesis.

K. Vick: We found this out several years ago with the black carpet beetle, Attagenus megatoma. With these dermestids, apparently this is an important situation. Methoprene does not have this type of action with the pyralid moths. These moths have to be in contact with the material for at least half of the larval life cycle. We have run tests where we have raised larvae after exposing them to methoprene at various ages. We have found that if they are not put in contact with the material by the time they are 3rd instar, there will be no control. Also, it does not seem to have any affect on the adult insets at all or on the embryos. I think the beetle situation is very interesting.

R. Lehman: We have shown the ovicidal effect of methoprene on the cigarette beetle. We have also shown the reduced fecundity in females.

F. Dunkel: We need to remember that other data has shown there is

a basic difference in structure and probably physiological environment between the pyralid egg and the coleopteran egg. Our sorbic acid studies have shown it to be an excellent ovicide for Coleoptera and the gelicid moth, Sitotroga cerealella at 0.3% w/w but pyralid eggs can be laid in 100% sorbic acid and yet hatch at a normal rate. Methoprene seems to mimic the sensitivity pattern of storage insects for sorbic acid. Both compounds are pointing out to us basic physio-structural differences between the Pyralidae and the other stored grain insects, differences which need to be taken into account when one designs contact insecticides for them in the future.

S. Loschiavo: I would like to ask Ken how the material works against the merchant grain beetle, Oryzaephilus mercator.

K. Vick: The Hoffman-LaRoche material works very well against external feeders on grain. The angoumois grain moth, Sitotroga cerealella and the lesser grain borer, Rhyzopertha dominica have not been tested for sensitivity to this material. I have not yet tried the sawtoothed grain beetle or O. mercator.

F. Dunkel: There actually are other stored product protectants being developed for future commercial use. Would anyone like to discuss these at this time?

S. Hill: This may be a little bit like reinventing the wheel. I am not stored product person, but 8 months ago someone came to me with a request for information research project. It incorporated a bait rather than an insecticide like most residual protectant mixtures. I carried out a few experiments and compared it with the main insecticides containing pyrethroids. I found the bait was actually more effective. I thought it might be interesting to try a few other

baits with the pyrethroids. We found some baits that were more effective than the one originally presented. It has proved quite effective at 1 kg/MT, the 0.1% w/w level. It has been quite successful in Canada. It is now used in boxcars, in grain stores and warehouses. It is the first time we have had insect-free inspections in the whole history of inspections which seems rather surprising since it is such an old fashioned product. It has not been published yet because we have only been doing preliminary experiments i.e. our experiments have been confined to small glass jars in the lab and we have not done field experiments with grain either in farm bins or in the elevators.

It seemed to have some potential where grain was being exported to countries where storage facilities are less than ideal. I know several companies in our area who have had grain turned back or refused in Cuba and other countries where they do not have regulations that are so strict with respect to dustiness, or where it is being washed anyway before it is processed into flour where it does not matter it originally contained diatomaceous earth once.

Unidentified person: How do you use it in railcars?

S. Hill: It was fogged with a hand duster into the empty boxcars. Approximately 2/kg per car. This material contained a bait for both the larvae and the adults.

J. Klein: What was the nature of the bait?

S. Hill: The bait we are using now with the diatomaceous earth is proteinaceous and that is about all that I am allowed to say about it at this time.

H. Fairchild: Are you saying that after you treated an empty boxcar that you protected the grain inside with this same application?

S. Hill: No, it just meant that we were putting grain into clean cars. Whereas at the moment in Montreal we are putting grain into dirty cars even though it has been fumigated. In laboratory experiments, we have, until now been using wheat with Sitophilus granarius. These experiments use the bait whereas the boxcar applications used plain diatomaceous earth which was advertized in the ESA program and which is registered for use in empty box cars in Canada. It has also showed to have long-term protection in the sense that if the diatomaceous earth is added to wheat with Sitophilus larvae developing inside the kernels, these larvae die when they subsequently emerge as adults.

F. Dunkel: Thank you, Stuart. Tri calcium phosphate is another protectant that gives long-term protection and can be dry mixed with stored products. Bob Davis will be presenting a paper Friday morning on additional research with this compound. Would you like to comment on this now Bob?

B. Davis: Not at this time.

J. Baker: I might just say on this general topic that some of the work we were doing on tricalcium phosphate (TCP) several years ago indicated that 2% CSM (corn/soy/milk blend) resulted in excellent control. The mode of action appeared to be dessication or extreme water loss, similar to what supposedly happens with other dusts such as diatomaceous earth. Direct application of TCP to adult Tribolium caused dessication. We hypothesized that this was due to an interaction with the lipid epicuticle. Gas chromatographic and mass spectrophotometry of all the cuticular hydrocarbons showed that direct TCP application caused removal of only the branched chain alkenes. The

normal alkenes were not affected It might be interesting to see how these diatomaceous earth compounds react with specific lipids of the insect cuticle. We are presently analyzing the cuticular hydrocarbons of the weevils, including S. granarius which S. Hill used for his diatomaceous earth studies. Our data show the weevils are full of alkanes. As yet we do not know if this group is sensitive to TCP. We do know that when TCP is mixed with diet the cuticle responds not by releasing its branched alkenes but by producing larger amounts of that class of compounds. We are working on this right now. They have an extremely complex series of alkenes. These alkenes, I think, are very susceptible to absorption by this type of compound.

F. Dunkel: The other side of the question is whether these dust compounds abrade or scarify the surface of equipment used to transport the grain and other commodities.

J. Baker: Tricalcium phosphate is used as a dust releaser rather than as an abrasive. It also fulfills the calcium requirement in the CSM mixture. It is used in supplements all the time whenever calcium compounds are needed. It is fantastic as a supressant for moths.

Unidentified Speaker: When you said this is used in the mix, is that what they feed cattle as a mineral supplement?

J. Baker: This is for overseas shipment with AID program, I don't know if it is fed to cattle.

F. Dunkel: Before we continue, I want to remind you that it is 9:00 p.m. and we are not finished with the topics. Further, It has not been the tradition to finish by 9:00. I have no intention of curtailing our discussion. So with your permission I will continue.

The fourth topic this evening is Future trends in an ecosystem

approach to control put into practice. Translated into slightly simpler language, this may be integrated pest management. I had intended to have at this point a statement from Ron Sinha of the Winnipeg Research Station regarding new developments and practical applications of his work, but he was unable to come.

I do want to share with you the comments made this afternoon by David McNeal of the Pest Management Science Administration and Extension, USDA, Washington, D.C. In the wrap up presentation of a 4.5 hr IPM symposium here, he suggested for the next year these efforts should be post harvest and that should include marketing and distribution. He indicated that the only post-harvest such program he knows of is Harley Raney's in Kentucky which we will talk about more later and a seafood storage plan worked out by Virginia people.

At this moment, as far as I know, the only computer program being developed to help the farmer apply this integrated approach is being developed by me at the University of Minnesota. We have written the basic skeleton, have developed a relational diagram and have begun to add look up tables and rate values. It is written for the Apple II in Pascal and will be for corn. We hope to have it ready for field testing this summer. It is a predictive program. That is, given certain data from the farmer's grain bin, the market price and the geographical location, it will predict grain quality and estimate grain value 3, 9, 12 mo. in future. Eventually more than insect factors will be included. Later, other components of that system of deterioration will be added, it will be repeated for other commodities.

Is there any other comment in this area? Is anyone here from Nebraska? I know LeRoy Peters has also developed a scouting system for

stored grain in Nebraska.

S. Duffus: Centrol, in Minnesota, under the aegis of Cenex Corporation, is also developing a stored grain program for our field monitoring project in the Northern tier of states. It is very much in the developmental stage at present.

If anyone has any suggestions, I would be more than willing to have them share with me.

F. Dunkel: The 5th topic is Future trends in storage structure design. Comments aired this summer at the NC-151 session are probably the best summary from this area. I will summarize this session and those of you who were there can add in. Improvements needed are easy entry to detect insects with probes in bottom areas, in the lower sides as well as remote sensed temperature and relative humidity monitored.

J. Sargent: When the entomologists began to complain that the perforated floor of the aerated metal bins is a dust collector, which encourage insects and fungal development, the engineers present expressed surprise. Apparently, when the design was developed many years ago, it had never been checked with the biologists and no attempt to remedy this has reached the farmer as yet.

F. Dunkel: The only other topic I know of that is being looked at in structure design in underground grain storage. Underground storage is a traditional and ancient method independently evolved on several continents and still in use in many places. Some of this is larger scale. Funding from several areas has been received for this year by the Underground Center in the Department of Civil Engineering and me at the University of Minnesota. It will enable us to investigate new materials and designs. These will be tested outside in a lab facility

on campus and also inside in a laboratory.

Are there any others who would like to make statements regarding future trends in storage structure design?

M. Sartori: I would like to add that they have been working with underground storage in Brazil. I was involved with this project in 1974 and 1975. The project particularly involved corn and beans. The results have been published but because the government business is carried on in Portuguese, the publication is also written in Portuguese. The project involved pits lined with polyethylene and filled with 3 metric tons of corn during 8 months with 12% moisture content. We have excellent control of insects and no significant change in the usual 92% germination level. Essentially we have returned to this area of research in 1978. This time we worked with dry beans for 6 months. Again the results were good. We were interested in not only insect problems in dry beans, but technological properties as well, properties such as taste and cooking time. We had experiments in several farm locations around San Paulo, Brazil.

The dry beans were received for storage at 16% moisture content and for 4 months there was no problem. Beans were placed in jute bags before being placed in the polyethylene pits. However, there was no above ground control and O_2 levels are not available. Extension agents in Brazil are now recommending this type of storage for the farmers.

The polyethylene tarpulin was black. The thickness is not so important, but its lack of permability to moisture is very important. If it is too thick, it can not be closed very well. In the last few years they have developed a sealant for the gathered edge of the polyethylene.

I do want to clarify that we are not recommending 16% moisture content for storage of corn. We had asked all the farmers cooperating on this project for corn at 12% M.C. By the time we arrived at this particular farm the corn had moved up to 16%. Because the distance traversed to reach this farm was so great we opted, none-the-less, to build the underground silo for this grain. Our recommendation is for less than 13% MC in all our silos, however.

T. Granovsky: This experiment in Brazil is one type of underground storage which is being looked at by other countries. In Honduras, there are a number of storage structures under experimental evaluation by the Swiss group (COSUDE). The Swiss provide not only the funds but scientists as well. The structures that this group is looking at are wood buildings caulked with a local material, brick silos made locally and silos of the Guatemalean type with improved floor for cleaning.

H. Fairchild: My impression is that if you put any kind of stored product in a polyethylene bag at 16% moisture content, you would get mold, above ground, underground, or in any kind of environment.

M. Sartori: There is special care that you must take when you set up the storage. There must be no leaks and no air pockets.

H. Fairchild: One of the problems, however, is that if you fumigate your commodity with phosphine, it will be held by the polyethylene, but it will also be held by the commodity. When you transfer your product you then run the risk of fumigating the grain handler also. At best, you will tie up your product several weeks after opening the structure so that the fumigant can diffuse off. Three weeks may be too long for your product to be tied up.

In other words, you will have to aerate after using phosphine or a fumigant.

F. Dunkel: Do you use a vacuum system to evacuate the air from the pit before sealing it?

M. Sartori: No. We just take special care to fold and seal the polyethylene. We have tried using various sealants.

F. Dunkel: It is interesting how countries around the world evolved similar methods of underground storage.

V. Wright: Recently we have worked in Tanzania with Peace Corps volunteers that had been sent there to work with their grain storage problem. I will say more about the insect part of it later. One of the techniques that we encouraged the volunteers to use was underground pit storage. It had not been used in Tanzania previously. It had been used for hundreds of years in Sudan; and other countries near Tanzania. There are so many problems with chemical control in African nations with problems of getting the chemical when they need it, with transporting it to the village, and with its proper use. We felt, therefore, it was important for them to have an integrated approach, a system that did not use chemicals. We advised them to store the grain underground at a moisture content of 13% or less. If there already is an insect population in the grain they will take the O_2 content down to a level where they suffocate themselves. If there are not enough insects in the bulk, then we are working on methods of using microbes to decrease the O_2 tension.

F. Dunkel: Thank you, Valerie. Discussions of underground are difficult to separate from discussions of controlled atmospheres. Underground storage structures create a relatively ideal situation for

controlled atmospheres. One usually brings up discussion of the other.

The 6th topic is Future Trends in Private Consultantship in stored products. A scout system has been set up by both Harley Raney in Kentucky and Leroy Peters in Nebraska. These have been connected with the Universities. A small fee is charged each farmer who uses it. Harley has received funds from the USDA to create a manual for this system and the chapters are being written by various authors at this time. So there is nothing collected by Harley--not until February 1983.

What I really wanted to deal with tonight was actual private IPM type consultants who deal with post-harvest problems. There was a survey done in the Spring of 1982 among Minnesota IPM consultants and it showed that none provided services in stored grain. Is there any information about the Centrol/Cenex project or any project in another state. Scott, would you like to describe the future prospects for Minnesota?

S. Duffus: Right now we are at the developmental stage and I am assuming we will follow a program similar to what Kentucky has. The most important consideration when one does something of this sort in the private sector is that one can is that one can recover one's expenses and that it is profitable. Sometimes this is a very difficult thing to engineer. Thus far I have only been working on the project for 1 month. We are presently working on assigning a cost for the service. We are probably going to set the fees per storage rather than per bushel. The sampling effort, it seems, will be very similar for structures in a certain capacity range. So we are looking at a flat fee for a year and paid quarterly. A farmer will not have to commit

himself to a year of the program, but probably a quarter at a time.

Unidentified speaker: Are you thinking about the individual farmer rather than commercial storage?

S. Duffus: Yes, we are set-up right now as a pest management consulting service that works mainly with field crops, preharvest. We will, with the storage consulting, be working mainly with the same clientele.

J. Roberts: In Virginia one very seldom finds storage structures larger than 5000 bu.

S. Duffus: In Minnesota and the Dakota's the 5000 bu. size is used, but it is also common to have structures up to a 100,000 bu. capacity.

S. Loschiavo: This is becoming the situation in Canada. Farmers are going to ever increasing volumes for ever increasing time periods. Now, 15-20,000 bu. are quite common. What this means is that in these larger storages, no matter how dry it is when it goes into storage, there will be a moisture migration problem due to the nature of heat transfer in the grain mass. The rapidly decreasing ambient air temperatures of winter are not met by the slowly decreasing grain temperatures thereby creating a chimney effect or accumulation of moisture from the difference. This will really create problems during wintertime in storage, the very time when the farmer is not likely to be out in the bins inspecting the grain.n

F. Dunkel: Unless, of course, you can put that grain in underground storage and fill the bin with grain of the same temperature as the ground that is receiving it.

S. Loschiavo: For the moment in Canada, we see aeration as a

possible correction here.

F. Dunkel: Are there any other comments on the future trends in private consultantships?

J. Sargent: As far as I know about the Kentucky program, it worked very well as an educational tool. They had very few people signing up a second time. Once they learned how to inspect the grain, they found out they could very easily do it themselves.

S. Duffus: Yes, we invision this type of consulting as a very fluctuating thing. Certainly agriculture itself is in the process of change. We see a need at the present time, however, for this type of monitoring.

F. Dunkel: Thank you very much, Scott. The 7th topic is the Future Trends in Quarantine Changes. I had hoped to hear from some of the Toronto people involved with international grain trade. There was a representative from the quarantine section of Agriculture Canada, Dr. Jean Hollebone, here earlier who was to speak on this topic. I do not believe she is here now. I would also like to hear from Ted Spilman of the National Museum in Washington, D.C. Ted receives for identification and verification specimens intercepted by quarantine officials. Tenebrionidae is his specialty.

T. Spilman: My office is in Washington, D.C., but the specimens are actually sent to Dr. Lloyd Knutson at our main office at the Beltsville labs. If anyone has any specimens that need to be identified, they can be sent to the U.S. Department of Agriculture, Systematic Entomology Laboratory, Dr. Knutson. It is inappropriate for identification specimens to be sent directly to the specialist, even though one knows the exact person to whom it should be sent. I am sure

that whatever you send will be identified. There is a screening process, however, and a protocol form needs to be filled out by the person sending the specimen. We in the Systematic Entomology Laboratory are happy to collaborate with anyone in North America on the identification of specimens, that's, anyone inside the U.S. or any contact outside the United States concerned in United States Agriculture. Although my place of work is the National Museum, I work for the USDA. The only reason for this is that the collection is there. All of us that work there on stored product insects or on agricultural insects work for the USDA.

S. Loschiavo: I would like to thank Dr. Spilman for the help he gave us in Canada when we were caught in a bind last year due to that shipment of soybeans and flour to Cuba. You sorted out the species of Tribolium there and determined whether it was Tribolium audax or Tribolium madens. We finally succeeded in getting T. madens taken from the list of North American insects and then 2 years later we found that it did occur here. So we now have the American black flour beetle and the larger black flour beetle.

A. Barak: T. audax is now showing up in Minnesota.

T. Spilman: We also had a tremendous infestation of T. madens in West Virginia.

S. Loschiavo: The problem is that until now we have just accepted Hal Sted's definition that T. madens is an old world species and does not occur here and T. audax is a Nearctic species.

D. Faustini: Part of this problem is due to the misidentification of T. audax and T. madens in some collections.

T. Spilman: Some of the Tribolium species are pests in bee nests.

T. audax occur in Chili. T. audax and another Tribolium species was transported there in bee nests with shipments of bees to Chili that were sent to assist in pollination.

W. Burkholder: T. audax has been particularly bad in the western states this past year.

F. Dunkel: Is there any other movement that you would care to report? Has any record been recorded of Cynaeus across the ocean?

T. Spilman: None.

D. Faustini: This summer I found it in stored tobacco. It overwhelmed many of the warehouses in Richmond. I have it feeding right now on stems. It does not do well on bright tobacco or burley tobacco. It does well on cardboard boxes, however.

F. Dunkel: That is very interesting Daryl. This marks only the second record of it on tobacco. In 1964 it was intercepted in Ireland in a shipment of tobacco from Georgia. This represents the only time it was found outside of North America. I might refer you to my 1982 biogeography paper coauthered by Al Barak and Phil Harein, re: this and the other records of this insect.

J. Sargent: What about the Khapra beetle? I understand there has been a change in its status.

H. Fairchild (Plant Protection and Quarantine APHIS, Chief Staff Officer for Methods and Development): The Khapra beetle is the number one quarantine pest that APHIS deals with. The contractors will be finished this week. We will be sealing the lab in Hoboken, NJ this week and making sure that it is secure. We are trying to hire a specialist who will work with us to rear the khapra beetle and do some development of better protectants for it. In the meantime, we have

just fumigated the khapra infested port warehouse which is located in Brooklyn on Canal Street. I am sure some of you saw this on television. Purity Mills is nearby and people working 24 hrs/da there. There also are 20,000 people in low cost housing units nearby. Several cameramen received over exposures. In another fumigation a person working on a roof 5 miles awa, had exposure problems. So to fumigate the warehouse there presents many problems, but we hope to have that done this weekend.

We still have the khapra beetle reaching our shores. It is coming in mainly spices and condiments used in East Asian foods. That is the reason we are fumigating these warehouses in New York City. We are also getting it in passengers baggages. Here too it is coming in in condiments. It is surprising, the number of people throughout the world who carry their own rice. So we have a difficult problem doing anything about this pest. Dr. Burkholder has been working with us for some time to provide us with a better attractant, a better means of detecting this insect at low population levels. This is the one pest that is giving us real problems. We are trying to keep it out of our country so that we can certify that it doesn't exist here and thereby be helped in exporting our grain. The people in our export section are having trouble with our own grain because more and more developing countries are putting barriers for the kind of insect and the infestation level grain is allowed to have.

The APHIS group issues the phytosanitary certificate. We are different from the FGIS people, but we work together. There has been no change on the official status of the khapra beetle. We are doing everything we can to keep it out. We are fumigating as soon as it is

humanly possible. There are often many hurdles to overcome to do this. There are city ordinances, civic groups investigations and environmental impact statements to file. In addition, the buildings are old and difficult to seal for proper fumigation.

F. Dunkel: This is fumigation only after it is detected not prophylactically.

H. Fairchild: Yes, these fumigations are done only after detection. The Purity Mills that I mentioned earlier was particularly difficult. We tried to irradicate the khapra with a residual insecticide, but the building had 2 subbasements and it did not work. In order to get this beetle out of our country to protect our grain, we told them we had to fumigate. After much expense we completed the fumigation.

J. Sargent: By change, I meant there seems to be a difference in border inspection. Quarantine officers are no longer looking for it, but they will note it if they find it.

H. Fairchild: One of our basic problems is the pressure from the aviation people to process the arrivals quickly without the time required for a thorough inspection of their baggage. On the east coast we are attempting to detect fruits, plants and meats in the baggage by CO_2 detection. Over 1 million dollars has already been invested in this project. Another detection device we are testing is x-rays. Microwaves were tried, but not successfully. CO_2 of course, presents false positives when baggage contains dirty laundry or liquor. So we are working in this whole area of detection devices for the border inspection process. Dogs are another very excellent detection tool. It is an expensive technique and they must live with the individual

inspector for whom they work.

M. Sartori: Has magnesium phosphide been tried with the khapra beetle?

H. Fairchild: Unfortunately magnesium phosphide does not kill the khapra beetles. Even with other insects, the phosphides do not work below 40°F.

Unidentified Speaker: With the difficult-to-fumigate buildings you mentioned is the problem with these the accumulations of litter and debris?

H. Fairchild: The main problem with these buildings is that they are brick with old gas pipes. It is mainly that they are brick, painted, with the paint pealing. Many of these port warehouses were once part of a central system in which the phone and electrical wires went underground and were all connected. The problem with these facilities is that they can not be fumigated.

Unidentified Speaker: If debris were the problem, a formulation called dionex could be used can be placed on the debris. It prevents the diapausing stages from ecdysing to become adults the next spring.

H. Fairchild: Our problem is that these are old buildings with cracks which the stored product insects can use to hide in.

S. Hill: The diatomaceous earth also worked for warehouses. We put it in cracks, in false ceilings, anywhere they could crawl into. The diatomaceous earth will presumably last an indefinite period and it is fatal for any insect that crawls into it.

H. Fairchild: These are the types of materials we are going to be testing in the new khapra beetle lab which will be completely sealed in the next few months.

F. Dunkel: Will the new staff person be sealed with the lab?

H. Fairchild: The person we hire will come and go through a system of security checks, double showers, etc.

F. Dunkel: Thank you very much. It sounds as if future trends in detection devices and long-term residual insecticides will be affected by quarantine problems.

The 8th topic of this conference is the Increasing interest of non-entomologists in storage losses due to insects. This topic was derived mainly from my interaction with the North Central Committee on marketing and delivering quality cereals and oilseeds to domestic and foreign markets. During the past 4 years with what is affectionately called NC-151, I have seen a steady rise in interest of entomological aspects by the engineers, the economists, the plant pathologists and the government and the industry representatives who make up this committee.

At this point, I would like to call on Wendell who is the present chairperson of this committee, to explain its role and also its useful newsletter.

W. Burkholder: Many of you have received the newsletter which comes every 2 months. There is a distribution list of about 500. You are welcome to add your name to the mailing list. Florence's point was very interesting that these are non-entomologists who are showing the interest in the role of insects in storage losses. These are mainly engineers and plant pathologists. Finally, after many years, last summer the agricultural engineers economists and plant pathologists turned out to listen to the entomologists. The engineers I think, finally understood what the problems really were with relation

to insects. We, on the committee are now working very closely with some of the engineers in designing structures. It is a very interesting communication. These are university people, people from industry, economists. The organization has been going on for 5 years and we are, hopefully, beginning another 5 year plan.

F. Dunkel: Wendell mentioned this is a good forum for developing bioengineering teams. Part of the engineering/mycology team I worked with in China this fall came from this group. Unless anyone wishes to make additional comments, I will move on to the ninth topic, Future Trends in the International Scene. We will first hear from Ted Granovsky who has just attended the first Latin American Conference on post harvest losses of grain. It was held in Brazil September 20 to 24. We will also hear from Valerie Wright who is struggling with the greater grain borer problem in Tanzania. Following her remarks, I will comment on the discoveries of the bioengineering team I worked with in China this fall until my return yesterday.

T. Granovsky: Before I begin my specific comments, I would like to direct a comment to those of you in this room who have some expertise in the stored product area. International consulting is a very rewarding area. One place to begin is by submitting your application to the Food and Agriculture Association (FAO) of the United Nations. At the present they are looking for a post-harvest specialist in Guatemala for several months. Such persons are often difficult to find so you might consider submitting your application.

The meeting in Latin America pointed out that based on 1977 data, post harvest losses there were 20% (with a range from 10 to 40%). Excessive losses there are a matter of fact. It may be the same in

Africa or Asia but I choose to work only in Latin America. The following slides are from the conference attended by ca. 100 post harvest specialists from 16-17 Latin American countries trying to solve their own problems with each other. They have formed a small association of Latin american specialists and I believe that we are going to see good progress of this group in cooperation with the North Americans and the British. There were 2 other Americans at the conference, one who lives in the Dominican Republic and works with ICA and the other is an American plant pathologist who lives in Guatemala. The later scientist gave an excellent presentation of aflatoxins in Guatemala and I will present here a summary of her data. The humid hot areas of the country provided 27% of the aflatoxin samples and the dry temperate areas 2%. Levels in excess of 20 ppm were detected in 6% of all samples with aflatoxin. Another one of the outstanding papers that were presented by Hamilton P. Santos who is a graduate of Purdue University. He is a Brazilian working with Endrapal, a research group in Brazil which performs functions similar to the USDA. He is working with small farmers and their grain storage structures. The work he reported was a survey of 800 producers of grain in the tusa or on the cob and that 98% of them have trouble with insects in the post harvest system. Seventy four percent try to control the insects with a granular residual in levels of 15 cm. Five of them indicated problems with rodents. Therefore, in Latin America where more than 50-60% of the people are farmers. This slide shows Hamilton with one of the storage structures that he is working at the Endrapa station. He has tried a small scale experiment 8 different treatments. In this particular slide eucalyptus leaves are being layered in a traditional manner in

the grain bulk. He has also tried ash and other techniques. Control with eucalyptus leaves was not as good as farmers expect it to be. Another project presented by a student at Centreinare, Ms. Feda Ritta D'Antonio Faroni. She presented 3 systems. One was to leave the corn in the field until it is used. Another is to leave it in the field for drying and then to bring it in and store it. The 3rd system is to harvest it right away and then store it in a solar grain drying system raher than a subterranean system. From the onset of the experiment(1980) there was 40% damage with the first system. The experiment was run twice, once each in 1981 and 1982. At the onset 3-4% of the corn was insect damaged. With the first system this corn had 48% damage by the following September. With the second method, the grain contained 29-30% damaged kernels by the following September. By December this grain had 48-52% With the third method, the grain had only 4.5 to 5.5% damage. This same grain had only 4.5 to 8.0% moisture content by December. If corn was handled in the second method up to 90% damage was recorded. Whereas if corn was harvested immediately and placed in a drying silo and then stored, the damage and was much lower and the germination was good.

Another interesting project presented was by the Hondurans in cooperation with Swiss financing. They reported on loss figures with corn, beans and sorghum cropping systems. With corn in the field after it is mature and doubled over but before it is harvested 8.5% was lost. The part that goes to storage (ca. 61%) sustains a 10% loss prior to using or selling. An alternative would be at harvest to put it in a metal silo. Losses were reduced to zero with this system. The Honduran group is proposing/supporting the conversion to metal silos and solar

grain driers to reduce grain losses.

In the final portion of my remarks, I would like to provide more details for my comments re: the Guatemalan situation made at the North Central Branch meetings last spring. These slides show typical grain market activities where the corn is sifted and excessively damaged kernels are removed. A close look at this grain indicates there are large numbers of insects in this grain. A closer inspection of this 'poor' grin revealed that only 16 out of 300 were sound kernels. Part of this problem is now being solved by the use of the metal silos distributed by FAO. Wherever this silo has been used, Honduras, Costa Rica, Bolivia it was successful in decreasing storage losses due to insects. These structures hold ca 1 T of maize. They cost about $30-40 U.S./silo for the materials.

In conclusion, I would like to emphasize that you think of sharing your expertise internationally, whether it be through the Kansas State project or others. The farmers in Latin America and elsewhere in the developing world need technical assistance. The political climate in some of these countries often curtails the offering of this assistance from their own country. We can be of help by organizing some of this needed assistance.

F. Dunkel: Thank you Ted. Ted has illustrated one very important ability for those who offer their technical skills in international areas - that is facility with the host language. Of course, willingness to contribute is also very important.

Valerie would you like to present your comments regarding the Tanzanian problem?

V. Wright: We have been talking about the movement of insects from 1 geographical location to another. What I have to say has to do with dispersal of this sort, but also with the international grain trade. In the mid 1970's probably 1974-76, the larger grain borer, Prostephanus truncatus (Horn), a native of Central America, moved to Africa through grain aid shipments to refugee camps probably. There are no records of how it came into the country and prior to 1974-76 it was described only from Central America. This is our best guess because there were a number of refugee camps set-up from the Uganda moor. In the same area which is the Tabora region, a warm, dry area in Western Tanzania, the insect became established and is now causing devastating problems for corn storage in Tanzania. The seriousness of the problem is such that a number of international agencies have been involved in assessing the situation. I was involved through my work with AID and peace corps training. FAO had a team going into Tanzania to try to find out the extent of the infestation. Tropical Products Institute (Slough Bulks, England) had a research team there as well, looking at control methods as well. Prostephanus truncatus looks very much like the lesser grain borer. It is a bostrichid that eats continuously and is extremely devastating to corn. It can only reproduce on corn although the adults will feed on other commodities. The damage being done in Tanzania is in the range of 10 to 40% within the first 3 months after harvest. In some individual cases, as much as 100% loss has occurred. The FAO team considered irradication, but because of political problems involved, because of the way grain moves through Tanzania, irradication was not at all possible. Many of the African nations just do not have the personnel, the extension staff or

the persons knowledgeable in stored grain to implement any kind of extensive program. So what has happened is essentially nothing. We are very concerned that this insect is going to move into their corn growing areas in Africa and in times of poor harvest or famine it could be an extremely bad problem for the people there.

I think that we should seriously consider what we report with our grain when you consider that a situation such as this can occur. When we are exporting grain to countries that do not have the capability to inspect grain and quarantine materials like we do in the West. We should be concerned that we should be sending them pests that are going to be major problems for them in the future. I don't think it is ever looked at in that light.

Prostephanus truncatus needs a lot of research. Some has been done in Mexico, the Tropical Products Institute has done some work on its biology, and there is a good paper that has come out by Bell and Waters from the Winnipeg Research Station on the biology of this insect. There is still a lot unknown about it. It can grow and reproduce under quite a wide range of conditions very similar to the lesser grain borer and there is no reason why it can not move to other areas. So this is one insect that we need to be aware of in the future.

T. Granovsky: One of the comments I had to deal with at the conference in Brazil dealt with that very topic of export of insects to foreign countries. There was an individual from one of the Latin American countries who indicated his country imported 1 weevil for every person in his country. We in the U.S. have the responsibility to see that our grain inspection is doing the job it should.

W. Burkholder: With this particular insect which is absolutely devastating we need to be concerned that this insect could return in the emptied ships and boxcars up the river or by rail into the plains states.

T. Granovsky: It has, however, occurred in Southern Texas for many years and has not moved. It was documented in corn in the 1930's and 40's there. Why hasn't it spread? Perhaps we should not speculate too much regarding future dispersal.

W. Burkholder: But there is no reason that this insect in certain situations could not live in Kansas were it brought there. The English have apparently already identified the pheromone and are using it in their studies. So perhaps in the future we will have better detection tools to document the dispersal of this insect.

F. Dunkel: What about the change in storage techniques from on the cob to off the cob storage of corn?

V. Wright: One of the control measures for the greater grain borer is to shell the corn. It does much better when grain is on the cob. It needs the pressure or the structural habitat of grain that is still on the cob. If you shell the corn, this insect does not reproduce as well. This may also be part of the reason why it has not spread the countries where bulk grain is the main means of storage.

T. Spilman: I was involved in the identification of that insect from Tanzania along with some of the British taxonomists. I was asked many questions by the Department of State. They apparently were afraid this would become an international political situation. I looked into the distribution of this insect. It is known only from the southern United States, that is from southern Texas and part of Florida. I do

not understand how it can be involved in U.S. export grain if it only occurs in these 2 locations. Houston is the only export port in those areas.

V. Wright: Some of our grain is shipped to Mexico and then to other countries. But, we have no documentation as to where the African population came from whether from the U.S. or any other place. There is no proof that the AID shipments in which it was received came from the U.S.

D. Faustini: Did they trace the records of the ship itself?

V. Wright: There were essentially no records.

E. Thompson: When you look at a ship, they are just like railway boxcars. They carry everything, whatever is there. For example, Japan is obtaining khapra beetles from U.S. grain shipments. How did they get there? Those khapra beetles did not come from the U.S., they came no doubt from a shipment that was in that ship prior to the U.S. grain. This is the problem with insect dispersal. There are many places in a ship which are hospitable to many storage insects. Unless we can irradicate these insect populations from ships, we will be dispersing unwanted insects with our U.S. grain exports. Often the grain coming down from the central states will lay in the harbor for several weeks before it is shipped out. There is consequently, a large problem in the south with fumigating commodities for shipment in order to meet phytosanitary standards.

V. Wright: I think it is interesting in C. Storey's study, for example, that never detected even 1 specimen of Prostephanus truncatus in all the export material that he looked at.

F. Dunkel: It is difficult to distinguish the greater from the lesser grain borer?

V. Wright: No, actually not at all if you know what it looks like. It is quite a bit larger than the lesser grain borer, Rhyzoperta dominica.

F. Dunkel: When I originally heard the story of Prostephanus from Dr. Cutkomp of our department of Minnesota, after he had returned from the FAO investigative mission to Tanzania, I noticed many parallels in the recent geographical history of Cynaeus. We have documented the movement of this insect up from Mexico all the way in to Canada in just the past 40 years. This work has been published this month in the Journal of Biogeography. During this time large local outbreaks have been documented in all regions of the U.S. except the North East. It can be an internal feeder which attacks sound corn and it is no doubt just a matter of time before a dispersed propagule becomes established across the ocean and local populations reach an easily detectable and visible destructable level.

The third international stored grain situation we were to hear about this evening was that of the USDA team I took to China. I literally returned early yesterday morning so impressions are fresh, but not necessarily fully processed. This is my 3rd trip there in 3 years.

When I returned in 1981 from the research conducted in Guangdong in South China under the sponsorship of the U.S. National Academy of Sciences, it was suggested that I propose an interdisciplinary U.S. team to work with the bioengineering team I had conducted the field and laboratory research with. The project was selected by the USDA and then by the Chinese Ministry of Agriculture. The funding was from the USDA and the Ministry of Commerce. I then selected a rice storage

engineer and a mycotoxicologist to return with me to continue the joint research this year. Somewhere among those 3 groups, the USDA, the Chinese Ministry of Agriculture and the Ministry of Commerce which deals with post harvest commodities, the research portion of the proposal was lost. In the end, I do not believe the proposal was entirely read by those who made the arrangements for my team there in the Ministry of Commerce. The plan to move the USDA's OICD program into more of a research type of program did not succeed with this team. It is, however, felt on both Chinese and U.S. sides that the ground work is now laid so that the USDA will be funding more research oriented teams such as I proposed and this will be communicated and expected by the government personnel who receive the teams in China.

So, I brought there with me a rice storage engineer, David Calderwood, from the U.S.D.A. Rich Research Laboratory in Beaumont, Texas and a mycotoxicologist, Lloyd Bullerman, from the Food Science and and Technology Department at the University of Nebraska. Rather than doing the research which was proposed by me and anticipated by my Chinese Colleagues, who I worked with last year in Guangdong, we have a series of integrated seminars and spoke with the main grain storage entomologists, engineers and mycologists in the country. We also learned a great deal about the structure of the Ministry of Commerce which deals with stored commodities at the national, the provincial, municipality and the city level. That is all going to be part of an article for Cereal Foods where my earlier article was published which came out in September of which I now have copies available.

I will finish my comments about China as I did last year. This is not an ordinary developing country. It has a sophisticated grain

storage and monitoring system. After returning again and speaking with many more warehouse managers and observing the details of many more storage systems, I am still impressed with their techniques. I also encourage more entomologists to go there. This is not so much a case of helping as it is a case of learning and helping at the same time. It is just exchanging views. The main technique that they have evolved for long-term storage is controlled atmospheres. This is done, mainly with only an airtight, not using N_2 and CO_2. When the latter is used, it may be generated from CO_2 producing yeast which are cultured in a slurry of rice husks and wheat bran. Along with the controlled atmosphere, low levels of phostoxin have been used prophylactically for many years. Resistance of storage insects to phostoxin is a problem they are now struggling with there.

This concludes my comments on China's grain storage. Again, I would like to emphasize the importance of konwing the language, whether you are called tc work in a research, consulting or lecturing capacity. I am not quite as accomplished in Chinese as Ted is in Spanish, but it is very useful. Valerie is obtaining a working knowledge of Swahili.

The last topic in Future Trends in Establishments of Economic Thresholds for Stored Product Insects. There were no volunteered contributors to this topic. Are there any others at this time?

J. Sargent: One of my students has conducted a study with the Indianmeal moth (IMM) on popcorn, particularly on popping quality. He found that there was on statistical difference in popping quality in 1 qt. samples which sustained 15 IMM from egg to adult. However, the presence of 1 IMM per 40,000 lb will cause a refusal of shipment. So this is an economic pest even though it is not particularly a damaging

pest.

F. Dunkel: The idea of economic threshold is an important consideration of our laboratory with Cynaeus this year. We are looking at the effect of its activities in terms of beetle hours. Loss factors tested were test weight, % moisture content, increase in free fatty acids, total protein, total sugars, and uric acid content. We also tested the ability of this insect to be detected in the state and federal grain grading process. The grain buyers of Minnesota were then polled to determine what effect insects detected in the grading process have on the actual price of the grain.

I want to thank all of you for maintaining the informality of the seminar this evening. We have indeed had a non-time-bound discussion and I appreciate the free exchange of ideas and research results that has allowed.

We have one more item of business before we adjourn this evening, we first must decide if we want to have another informal Stored Product Conference at the meetings next year and if yes, we then must select a moderator. First a show of hands of those who wish this conference to happen next year. We will hold it next year.

J. Sargent: This has been a good format for discussion this evening, perhaps others would be interested if next year we would also print the topics in the program which is distributed to all ESA members.

F. Dunkel: Thank you Jim. We will try that. Are you suggesting that we make this more formal?

J. Sargent: No, just so that people, other than we who receive the mailing, are aware of the content.

F. Dunkel: The conference topics have been posted for 24 hours and I did use several lists to send out ca. 100 copies of the announcement material in September. Larger, more striking posters can be made also.

S. Hill: Room in the program is limited, but perhaps a few key words can be used for each topic.

F. Dunkel: Thank you for your suggestions. May we have moderator suggestions? (Daryl Faustini, Research Scientist, Phillip Morris Company, Richmond, Virginia was suggested and approved to be moderator at the informal conference in Detroit in 1983.)

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2. Barbara Anderegg, U.S. Grain Marketing Research Lab., Manhattan, KS 53703 (protectant metabolism)
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9. Bill Bruce, Stored-Prod. R & D Lab., Savannah, GA 31405 (insect detection)
10. Wendell Burkholder, USDA, Dept. of Ent., U of Wisconsin, Madison, WI 53706
11. Leslie Chong, Simon Fraser U.,. Biology Dept., Burnaby, BC (pheromone studies)
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15. Florence Dunkel, University of Minnesota, Dept. of Ent., Fish. & Wildlife, St. Paul, MN 55108 (computer-based management of stored grain; underground storage)
16. Walter Ebeling, Prof. of Ent., Dept. of Biology, UCLA 90024 (stored grain protection)

17. Homer Fairchild, USDA-APHIS, Plant Protection and Quarantine, 642 A Federal Building, Hyattsville, MD 20782 (methods and development of plant protection and quarantined organisms)

18. Daryl Faustini, Research Sci., Philip Morris USA, Richmond, VA (general storage)

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20. Ted Gramovsky, Texas A&M, Dept. of Ent., College Station, TX 77843 (stored grain pest management)

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22. Stuart B. Hill, Dept. of Ent., MacDonald Coll., P.Q. Haxico, Canada (diatomaceous earth formulations)

23. Ruth Lynn Hooper, US Army Natick R&D Labs., Attn: DRDNA-WP, Natick, MD (food packaging, , textile packaging)

24. Ernest Horber, Dept. of Ent., Kansas State, Manhattan, KS 66506

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26. Jim Keeve, VA Tech., Dept. of Ent., Blackburg, VA

27. Janet Klein, Dept. of Ent., U of Wisconsin, Madison, WI 53706

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29. Robert Lehman, Philip Morris USA, Richmond, VA 23261 (research)

30. J.S. Long, Philip Morris USA, Richmond, VA 23139 (plant sanitation)

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33. David Matthew, Purdue University, West Lafayette, IN 47907 (international grain storage)

34. K.L. Mikolajczak, USDA-ARS, N.R.R.C., 1815 N. University Street, Peoria, IL (insect attractants & pheromones)

35. A.M. Pierce, Simon Fraser U, Dept. of Chemistry, Burnaby, B.C. Canada (pheromones of Oryzaephilus)

36. H.D. Pierce, Simon Fraser U, Dept. of Chemistry, Burnaby, BC, Canada

37. Jim Roberts, VA Tech., Dept. of Ent., Blackburg, VA 24061

38. Maria R. Sartori, ITAL, C.P. 139, 13100 CCampinas, SP., Brazil (post harvest losses)

39. Jim Sargent, Ohio State U, Columbus, OH 43210

40. J.A. Siflientes, ASIA 2-103, Coyoacan Mexico, 21 D F Mexico (applied research)

41. Eric Smith, Orkin National Service Dept., 2170 Piedmont Rd., Atlanata, GA (commercial control)

42. Ted J. Spilman, Systematic Ent. Lab., USDA, Washington, DC 20560 (systematics)

43. R. Stanton, MAAG, Inc., P.O. Box X, Vero Beach, FL

44. E.G. Thompson, Armed Forces of Pest Management Board, Forest Glen Sec., Wramc, Washington, DC 20012 (processed food protection)

45. Valerie Wright, Kansas State U, Dept. of Ent., Manhattan, KS 66506 (insect storage fungi)

RECENT HISTORY OF INFORMAL STORED PRODUCT INSECT CONFERENCES AT NATIONAL ESA MEETINGS

YEAR	LOCATION	TITLE	MODERATOR - ADDRESS
1971	Los Angeles	none	- -
1972	Montreal	none	- -
1973	Dallas	none	- -
1974	Minneapolis	none	- -
1975	New Orleans	Chemical Control of Stored Product Insects	Del L Hue, U.S. Grain Marketing Research Lab., Manhattan, KA
1976	Hawaii	none	- -
1977	Washington, DC	Chemical Control of Stored Product Insects	Del LaHue, U.S. Grain Marketing Research Lab., Manhattan, KA
1978	Houston	Control of Stored Product Insects	John Quinlan, U.S. Grain Marketing Research Lab., Manhattan, KA
1979	Denver	Control of Stored Product Insects	William H. McGaughly, U.S. Grain Marketing Research Lab., Manhattan, KA
1980	Atlanta	Control of Stored Product Insects	William H. McGaughly, U.S. Grain Marketing Research Lab., Manhattan, KA
1981	Los Angeles	Informal Conference on Stored Product Insects	James Sargent, Ohio State University, Columbus, OH
1982	Toronto	Future Trends in the Management of Stored Product Insects	Florence V. Dunkel, University of Minnesota, St. Paul, MN
1983	Detroit	to be announced	Daryl Faustini, Phillip Morris Co., Research Division, Richmond, VA