

# CORNELL POULTRY POINTERS

Cornell Cooperative Extension

Vol. 51 No. 1 January, 2001

Barb Smagner, Managing Editor

## ***Mark Your Calendar for June 20, 2001 Cornell Poultry Conference***

The 2001 Cornell Poultry Conference will be held on Wednesday, June 20, 2001, at the Ramada-Inn-Ithaca-Airport. The Roche Vitamins Inc. pre-conference symposium (with complimentary breakfast) will start at 7:30 a.m. and continue to 9:30 a.m. The pre-conference symposium will cover two topics; Ronozyme™ P - a new phytase source for the poultry industry, and, an update on vitamins in poultry nutrition. The Cornell Poultry Conference will start at 9:50 a.m. and continue to 6:00 p.m. The following are among the topics that will be discussed at the conference: an update on waste management on New York State poultry farms; cropping systems for maximizing the uptake of phosphorus from the crop lands; flock-friendly molting methods; breeding for strains that do not need beak trimming; Infectious bronchitis - past, present, and future; impact of the recent welfare recommendation on the economics of egg production; investigations on the possibility of reducing egg cholesterol, fly management in poultry facilities; an update on poultry diseases in New York State, and a Poultry forum. We would like you to be informed about the date of the conference early so that you can mark your calendar and make every effort to attend since the program has been arranged particularly for your benefit.

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### CONTENTS

- 1) Mark Your Calendar for June 20, 2001, Cornell Poultry Conference
- 2) Darkling Beetle Impact on the Fly Predator *Carcinops Pumilio* in Caged-Layer Houses
- 3) How to Increase Early Egg Size: The Results of Research at Cornell University
- 10) Outbreak of Avian Infectious Coryza in Maine
- 10) Developments in Research

# DARKLING BEETLE IMPACT ON THE FLY PREDATOR *CARCINOPS PUMILIO* IN CAGED-LAYER HOUSES

## INTRODUCTION

Biological control plays an extremely important role in a fully integrated fly management program. Enclosed poultry houses offer a stable environment for supporting potentially large populations of pest species, particularly the house fly, *Musca domestica* L., and the darkling beetle, *Alphitobius diaperinus* (Panzer). In addition, this environment supports a number of beneficial species including parasitoids, predatory mites, and the predaceous hister beetle, *Carcinops pumilio* (Erichson).

Given the proper conditions, naturally occurring predators such as *C. pumilio* impose significant natural mortality on house flies. Both adult and larval stages of this beetle feed on house fly eggs and small larvae. Poultry houses with abundant predaceous beetle populations generally experience greatly reduced fly problems.

Unlike the hister beetle, the darkling beetle, *A. diaperinus*, is a common pest of chicken and turkey houses. All life stages are found in poultry litter and manure where they feed on manure, litter, meal, dead birds, and other insects. Darkling beetles harbor and transmit numerous diseases such as: Newcastle disease, avian influenza, infectious bursal disease, Marek's

disease and fowl pox. Furthermore, darkling beetles have been shown to transmit several other infectious agents including *Salmonella*, *Aspergillus* spp., *Escherichia coli*, *Bacillus* spp., *Streptococcus* spp., Reovirus, Rotavirus, *Eimeria* (coccidiosis), and tapeworms. In addition to the potential to spread disease, darkling beetles also cause severe structural damage and can be the object of nuisance complaints from neighbors.

The primary objective of this study was to explore the potential for improving house fly suppression using *C. pumilio*. Establishment of *C. pumilio* depends on several abiotic and biotic factors including available prey. To establish an optimal beetle to fly population ratio for fly management, we chose to monitor hister beetle and house fly populations in poultry houses and to observe any darkling beetle interaction. Laboratory studies were then conducted to evaluate the impact of the darkling beetle on the survival of *C. pumilio*.

## EXPERIMENTAL DESIGN

Five high-rise caged-layer poultry houses were selected for the field study. Houses One and Two were negative flow, turbo houses. Houses Three and Four were conventionally ventilated high-rise poultry houses. House Five was a positive flow turbo house.

House fly larvae, and adult and larval life stages of both hister beetle and darkling beetle, were surveyed in each of the houses. Houses were sampled weekly for 18 weeks from 1 June through 30 November 1995. From these manure samples we estimated the hister beetle, darkling beetle, and larval house fly densities for each house. The impacts of hister beetles were estimated from changes in house fly larval densities. Similarly, darkling beetle population densities were used to estimate the impact on the house fly and hister beetles

populations.

Adult house fly densities were monitored using sticky cards (3 x 5 in). Data collected from these surveys were used to compare house fly and hister beetle populations so that the number of beetles required to hold the fly population at tolerable levels (i.e., as determined by the producer) could be established.

Laboratory experiments were conducted to test the hypothesis that darkling beetle adults or larvae could negatively impact *C. pumilio* egg and larval survival. Fresh chicken manure was collected and frozen to kill any arthropods within. Zero, 10, 20, and 50 adult or larval darkling beetles were added to containers with thawed chicken manure which was inoculated with either 10 *C. pumilio* eggs or larvae. Following a 14-day holding period the numbers of surviving *C. pumilio* larvae were counted, recorded and the percent mortality calculated. The ratio of fly larvae to hister beetles was calculated by dividing the number of fly larvae by the number of beetles.

## CONCLUSION

House fly populations in houses with abundant *C. pumilio* appeared to have been effectively controlled, based on a subjective evaluation by the producer and the research team. House fly larva and *C. pumilio* populations reached the desired ratio of 1:1 within 9 weeks in House Three. However, manure condition, insecticide use, house design, and the presence of darkling beetles must all be considered as contributing factors. Increases in fly populations soon after new flocks were placed in the houses confirmed the positive response of flies to fresh manure. Older and drier manure is less conducive to fly development. Furthermore, the judicious use of insecticides to control adult fly populations may have further enabled hister beetle establishment, which was particularly evident in House Three where adult and larval

*C. pumilio* appeared to be somewhat tolerant of pyrethrin space sprays. Of the caged-layer houses selected for this study, House Three was older and of conventional design.

It was apparent that established populations of *C. pumilio* contributed to the management of house flies in turbo houses as well. However, population sampling in the turbo houses demonstrated that most of the *C. pumilio* were adult beetles with few larval cohorts. We found darkling beetles to be the most common beetle in four out of the five study houses; coincidentally these houses contained relatively few immature *C. pumilio*. We reasoned that because darkling beetles are omnivorous, the *C. pumilio* larvae may not have survived either because of reduced food supplies and starvation or perhaps they were preyed upon by darkling beetles. The relatively low population of darkling beetles probably contributed to the successful hister beetle colonization of House Three.

These results suggest that managing both the darkling beetle and the house fly are extremely important for the successful use of predatory *C. pumilio* beetles in poultry houses. Based on our results the establishment of *C. pumilio* in the poultry house can best be accomplished through integration of several management practices. These include: 1) Release *C. pumilio* at a rate of one adult beetle for every fly larva. However, prior to releasing *C. pumilio*, the *A. diaperinus* population should be sampled. If darkling beetle densities are twice that of the released *C. pumilio*, establishment could be severely impacted. 2) Keep the fly population low by using insecticides judiciously, targeting adult fly populations until the hister beetle population becomes established. Use pyrethrins, applied as a space spray, or use fly baits. Such insecticides are recommended because of the minimal impact they have on beneficial insects. 3) After

clean-out, treat the entire house with an insecticide to kill the darkling beetles. Always strive to keep the darkling beetle population level below that of *C. pumilio*. Do not move manure containing darkling beetles into a new house as a mechanism for releasing *C. pumilio*. Use black light pitfall traps, passing the trap contents through sieves, or Hister House traps to collect *C. pumilio* for transfer and release into repopulated houses. Although our laboratory studies demonstrated that darkling beetles could affect successful re-introduction and establishment of hister beetles in caged-layer houses, further field and laboratory studies are needed to determine the overall negative interactions between these insects.

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## HOW TO INCREASE THE EARLY EGG SIZE:

## THE RESULTS OF RESEARCH AT CORNELL UNIVERSITY

Selection for early sexual maturity has received a great deal of emphasis in breeding programs in recent years for two reasons: first to reduce the growing costs, and second, to increase egg production up to a certain chronological age. The breeders have been quite successful in advancing the age of sexual maturity. The current strains of the White Leghorn pullets are coming into production at 16 to 17 weeks of

age as compared to 20 to 21 weeks of age for their counterparts of several years ago. Although an effort was made by the breeders that concurrent with the advancing the age of sexual maturity, also increasing the early size, the extent of success for increasing the early egg size has not been as effective as for the advancement of the age of sexual maturity. As a result of these processes, a large proportion of eggs produced by the current early maturing strains during the early parts of the egg production cycle are of small and peewee size categories that do not have a real market value to egg producers. During the past several years, we have conducted a series of experiments to determine whether early egg size of the current early maturing pullets can be increased by dietary manipulation of nutrients and certain managerial approaches during the growing and laying periods. Seven experiments were conducted during the past several years. The objective of this article is to provide you with a brief summary of the results of these experiments.

### GROWING EXPERIMENTS

It is well established that a positive relationship exists between the body weight of pullets at the onset of egg production and egg size during the entire laying cycle. Consequently, three experiments were conducted during the growing periods to determine whether body weight at the onset of sexual maturity and as a result of this, early egg size can be increased by dietary manipulation of nutrients and certain managerial maneuvers during the growing period.

#### Growing experiment 1

The objective of this experiment was to determine whether body weight at the onset of egg production and as a result of this, early egg size can be increased by dietary manipulation of energy, protein and fat during the late stage of the

growing period (14 to 18 wk of age). The experiment consisted of a 2 X 2 X 2 factorial arrangement of treatments with two levels of energy (1280 vs 1380 kcal/lb), two levels of supplemental blend of animal-vegetable fat (0 vs 4%), and two levels of protein (14 vs 18%). The pullets were fed the experimental diets from 14 to 18 wk of age. They were then moved to the laying house and fed a layer diet containing 16.5% CP from 18 to 34 wk of age.

Body weight at 18 wk of age was significantly increased only due to use of a higher energy or fat-supplemented diets during the growing period. However, the extent of increase in body weight due to these experimental variables was small at 18 wk of age and was about 10 to 20 grams. As can be expected, such increases in body weight are not large enough to result in increasing early egg weight. Measurement of egg weight during 18 to 34 wk of age did not result in a noticeable increase in early egg weight due to various dietary regimens used during the growing period. The results of this experiment indicated that increasing the dietary level of energy or protein, or adding fat to the diet during the late stage of the growing period (14 to 18 wk of age) had a minimal effect on body weight at the age of housing, and consequently, without a noticeable effect on the early egg size.

### Growing experiment 2

Dietary manipulation of nutrients started from 14 wk of age in experiment 1. We speculated that 14 wk of age may have been too late for manipulating the dietary nutrients to show their beneficial effect on body weight at 18 wk of age and early egg size. Consequently, in experiment 2, the use of experimental treatments started from 8 wk and continued up to 18 wk of age. The experiment consisted of a 2 X 2 X 2 factorial arrangement of the treatments with two floor space per

pullets (45 vs 55 square inches), two levels of energy (1280 vs 1380 kcal/lb) and two levels of protein (14.5 vs 17.5%). We were interested in determining whether providing the pullets with a greater floor space than the level normally used by the industry (45 vs 55 square inches) could have a beneficial effect on body weight at 18 wk of age. Pullets were transferred to the laying house at 18 wk of age and fed a 16.5% protein diet up to 38 wk of age. Body weight at 18 wk of age was significantly greater for pullets grown on a more liberal floor space, or fed a higher energy or higher protein diets. In fact, pullets grown on a more liberal floor space and fed a high-energy and high-protein diet, had body weight at 18 wk of age that was about a quarter of pound (100 grams) heavier than those grown on a modest floor space and fed the lower energy and protein diet. However, the main effect data indicated that increases in body weight at 18 wk of age due to providing the birds with more liberal floor space or increasing the dietary energy or protein levels during the growing period were about 20 to 40 grams and these increases in body weight were not large enough to result in increasing early egg weight.

### Growing experiment 3

Dietary manipulation of nutrients from 14 to 18 wk of age in experiment 1, and from 8 to 18 wk of age in experiment 2, were not effective in increasing the body weight adequately at the age of housing to result in increasing early egg size. Consequently, in experiment 3, the effect of dietary manipulation of energy and protein from day-old to 18 wk of age on body weight at the onset of egg production and early egg size was investigated. Additionally, the effect of two growing light regimens on body weight at the onset of sexual maturity and early egg size was investigated. The experiment consisted of a 2 X 2

X 2 factorial arrangement of the treatments with two energy levels (1280 vs 1380 kcal/lb), two protein sequences (18-16-14% vs 22-18-16%, which were used for age periods of 0 to 6, 6 to 12, and 12 to 18 wk of age, respectively), and two light regimens (short-day vs step-down light regimen). The birds of the short-day light regimen were exposed to 23 hours light and 1 hour dark (23L-1D) during the first 24 hours after hatching and then, the light hours were abruptly reduced to 8 hours per day and kept constant at this level up to 18 wk of age. At 18 wk of age, the light hours abruptly were increased to 13 hours per day and then gradually increased by 30 minutes per wk until the daily light hours reached to 16 hours per day. Thereafter, light hours were kept constant at 16 hours per day until the end of the experiment (66 wk of age). The birds of the step-down light regimen received 24 hours of light per day during the first wk of life, and thereafter, the light hours were reduced by one hour per week. By using this regimen, the daily light hours reached to 8 hours per day at 15 wk of age. Thereafter, light regimen was similar for the birds of the step-down and the birds of the short-day light regimen up to the end of the production cycle. The use of step-down light regimen was effective to provide the birds with more feeding time during the growing period and also, postpone their sexual maturity. As a result of these, it was anticipated that the use of step-down light regimen could be effective to increase the body weight at the onset of sexual maturity and the early egg size. From 18 to 66 wk of age, the birds of all the growing regimens were fed a normal diet with 16.5% protein. The use of step-down light regimen was effective to significantly increase body weight during the entire growing and laying periods, except at 18 wk of age. Increasing the protein level during the growing period also was effective

to increase the body weight consistently during most parts of the growing and laying periods. Energy level did not have an effect on body weight at the age of sexual maturity in this experiment. Age at first egg and 50% production were postponed by about 10 days due to use of the step-down as compared to the short-day light regimen. Egg weight consistently was greater during the entire laying period for birds of the step-down than the birds of the short-day light regimen. For the entire experiment, extra-large plus large-sized eggs were significantly greater for the birds of the step-down than the birds of the short-day light regimen. However, egg production for the entire egg production cycle was significantly lower for the birds of step-down than the birds of short-day light regimen. Due to this, egg mass and feed conversion were inferior for the birds of the step-down than the birds of the short-day light regimen. The higher electric costs for the birds of the step-down light regimen during the growing period combined with lower egg production and inferior feed conversion made the step-down light regimen economically less attractive for commercial use than the short-day light regimen.

In summary, the results of the above three growing experiments indicated that increasing the dietary energy, protein or fat during various stages of the growing period or providing the birds with a more liberal floor space than the level normally used in commercial practice had the potential to increase the body weight at the onset of egg production. However, the extent of increased body weight due to these experimental variables were not large enough to result in increasing the early egg size. With regard to light regimen, although the use of a step-down light regimen was effective to increase the egg size and extra-large plus large-sized eggs for

the entire experiment, apparently the step-down light regimen used during the growing period was too stressful, and resulted in loss of egg production. The information obtained suggested that other step-down light regimens that would not be as stressful as the one used in this experiment and may have the potential to increase early egg size without loss of egg production warrants further investigation.

### LAYING HEN EXPERIMENTS

The effect of a number of nutrients such as dietary levels of energy, fat, protein, methionine and linoleic acid on egg size are well established. However, most of the investigations regarding the effect of these nutrients on egg size have been conducted after the hens have reached peak egg production and formation of small-sized eggs have not been a problem. Investigations concerning the effect of these nutrients on egg size during the early stages of egg production have been the subject of sporadic research with conflicting results. The laying experiments were conducted to determine whether early egg size can be increased by dietary manipulation of energy, protein and fat during the early parts of the egg production cycle.

#### Laying experiment 1

Experiment 1 was conducted to determine the effect of dietary manipulations of energy, protein and fat during the early stages of egg production on early egg size and egg components. More specifically, this experiment was conducted to find answers to two questions: 1) with a conventional level of energy that normally is used in the layer diets (1280 kcal/lb), can early egg size be increased by increasing the dietary level of protein or adding fat to the diet under isocaloric conditions?, and 2) in the presence of a constant level of supplemental fat in the diet, can early egg size be increased by increasing the level of

protein or energy in the diet? Finding an answer for the latter question appeared to be quite important. In commercial practice, the energy content of the diet is increased by increasing the level of fat in the diet. Consequently, concurrent with increasing the dietary level of energy, the level of fat also is increased in the diet. As a result of this, it is not possible to determine whether the beneficial effect that might be obtained on early egg size is due to increasing the energy content of the diet or the presence of fat *per se* in the diet. Six dietary treatments were used in this experiment to find answers to these two questions. The energy, fat, and protein levels in these diets were: T<sub>1</sub>) 1,280 kcal/lb, 0%, 17%, T<sub>2</sub>) 1,280 kcal/lb, 0%, 21%, T<sub>3</sub>) 1,280 kcal/lb, 4%, 17%, T<sub>4</sub>) 1,280 kcal/lb, 4%, 21%, T<sub>5</sub>) 1,380 kcal/lb, 4%, 17%, and T<sub>6</sub>) 1,380 kcal/lb, 4%, 21%. Treatments 1 to 4 were isocaloric (1,280 kcal ME/lb) containing 0 or 4% of a source of animal-vegetable fat and each with 17 or 21% protein. Treatments 5 and 6 contained 1,380 kcal ME/lb diet, 4% supplemental fat and either 17 or 21% protein. The data were analyzed as two separate 2 X 2 factorial arrangement of the treatments with energy constant and fat and protein variables (Treatments 1 to 4), and fat constant and energy and protein variables (Treatment 3 to 6). The experimental diets were used from 18 to 34 wk of age. Egg weight increased significantly throughout the experiment due to increasing the protein level both when energy or supplemental fat were constant. With a constant level of energy, supplemental fat also has a beneficial effect on egg weight throughout the experiment. On the other hand, in the presence of supplemental fat, increasing the energy level did not have a beneficial effect on egg weight. The individual egg weight and egg grade classification means indicated that with a conventional level of energy (1,280 kcal/lb), early egg weight and

extra-large plus large-sized eggs were increased due to increasing protein level or adding 4% fat to the diet. Furthermore, the data indicated that a greater egg weight response was obtained by concurrently increasing the protein level and adding fat to the diet under isocaloric conditions (1,280 kcal/lb). Also, the data indicated that in the presence of supplemental fat, increasing dietary energy did not have a beneficial effect on early egg weight. Consequently, it appears that with isocaloric diets, adding fat to the diet can increase the early egg size and this beneficial effect of fat is due to the presence of fat *per se* rather than due to its energy effects.

### Laying experiment 2

The results of experiment 1 indicated that early egg weight can be increased by increasing the dietary protein above the level that is normally used by the industry. However, in experiment 1, the level of methionine was kept at 2% of the dietary protein; consequently, methionine level was increased concurrently with increasing the dietary level of protein. Due to this, it was not possible to determine whether the beneficial effect of a higher protein level on early egg weight was attributed to increasing the methionine intake or was due to a higher intake of total nitrogen and other essential amino acids. From an economic point of view, it was important to determine whether a similar egg weight response as obtained by increasing the protein level can be obtained by only increasing the methionine level. Experiment 2 was designed to find an answer to this question. Nine diets in a 3 X 3 factorial arrangement of the treatments were used in this experiment. The treatments consisted of three levels of protein (17, 19, and 21%), and each protein level with three levels of methionine (0.34, 0.38, and 0.42%). The diets were isocaloric and contained similar level of choline

and linoleic acid. The experimental diets were used from 18 to 38 wk of age. Egg weight was not influenced ( $P > 0.05$ ) by protein levels during three periods (18 to 26 wk and 34 to 38 wk of age), but it was significantly ( $P < 0.05$ ) greater for hens fed 21% than those fed 17% protein during two periods (26 to 30 wk and 30 to 34 wk of age). Egg weights and extra-large plus large-sized eggs for the entire experiment were not influenced by protein levels ( $P > 0.05$ ), although, they tended to be greater for hens fed the higher levels of protein. Increasing the dietary level of methionine did not have an effect on early egg weight for two periods, but increased egg weight in three periods. For the entire experiment, egg weight and extra-large plus large-sized eggs were significantly greater for hens fed the higher level of methionine. The methionine intake was 345, 390, and 428 mg/hen/day, and the total sulfur amino acid (methionine plus cystine) intake was 619, 667, and 709 mg/hen/day for hens fed 0.34, 0.38 and 0.42% methionine, respectively. These results indicated that 0.38% methionine (an intake of 390 mg/hen/day) was required to optimize egg weight during the early stages of the egg production cycle. This is somewhat higher than the NRC (1984) estimated methionine requirement of 350 mg/hen/day or a more recent recommendation of 300 mg/hen/day (NRC, 1994). The results of experiment 2 indicated two phenomena: 1) although, egg weight and extra-large plus large-sized eggs for the entire experiment were increased significantly only due to increasing the methionine level, the extent of improvement of these traits were almost similar to those observed due to increasing the protein levels. This, together with the fact, that in certain periods of the experiment, egg weight was increased due to increasing the protein level and examination of the individual means which revealed for

the entire experiment egg weight and extra-large plus large-sized eggs were greatest for hens fed the highest level of protein (21%) in combination with the two highest levels of supplemental methionine, cannot rule out the involvement of a higher total nitrogen (protein) and other essential amino acid intake as a factor in improving the early egg weight. 2) The extent of improvement of early egg weight and extra-large plus large-sized eggs due to increasing the dietary level of protein was quite less pronounced in experiment 2 than those observed in experiment 1. For example, the extent of improvement of early egg weight due to increasing the dietary level of protein from 17 to 21% was only 0.4 g for the entire experiment (18 to 38 wk) in experiment 2 as compared to 1 gram for the period of 18 to 34 wk in experiment 1. The possible reasons for this discrepancy will be discussed in a later section.

### Laying experiment 3

The information from experiment 1 indicated that the beneficial effect of supplemental fat on early egg weight was not due to its energy effect. In experiment 1, the unsupplemented-fat diets contained adequate linoleic acid (1.3%) to satisfy the NRC (1994) suggested requirement of 1% for laying hens. However, adding 4% of a blend of animal-vegetable fat to the diets increased the linoleic acid content considerably above the NRC (1994) suggested value (1.7-2.1%). The linoleic acid requirement of laying hens for production of optimum egg size is a controversial issue. Consequently, we thought it might have been possible that the beneficial effect of supplemental fat on early egg size in experiment 1 could have been due to increasing the linoleic acid content of the diet. On the other hand, egg weight response could have been due to the presence of fat *per se* in the diet. The information in the literature indicates that the rate

of passage of ingesta from the digestive system is reduced due to the presence of fat in the diet. Consequently, it is possible that the beneficial effect of supplemental fat on early egg weight observed in experiment 1 might have been due to reducing the rate of passage of ingesta from the gut, which this, in turn, could have increased the availability of the nutrients that otherwise might have been limiting for optimize the egg weight. Experiment 3 was conducted to determine whether the beneficial effect of supplemental fat on early egg weight observed in experiment 1 was due to a higher intake of linoleic acid or the presence of fat *per se* in the diet. Seven diets were used in this experiment. These consisted of a corn-soybean meal diet with no supplemented fat, and diets containing 2 and 4% tallow, a blend of animal-vegetable fat, or corn oil. The nutrient contents of the diets, with the exception of linoleic acid, were identical (1,250 kcal ME/lb, 17% protein, 0.34% methionine, 0.59% methionine plus cystine and 550 mg/lb diet choline). This experiment was conducted concurrently with experiment 2 and the period of experiment was from 18 to 38 wk of age. For the entire experiment, egg weight was not different ( $P > 0.05$ ) among treatments, although it tended to be heavier for birds fed the two levels of corn oil and the higher level of blended fat. The birds on these diets were receiving the highest levels of linoleic acid. The information obtained on egg weights and egg grades were not adequate to determine whether the beneficial effect obtained from fat on early egg weight in experiment 1 and a partial improvement of these traits in the current experiment were due to increasing the linoleic acid intake or the presence of fat *per se* in the diets.

The information obtained from experiments 2 and 3 were generally consistent with those of experiment

1 regarding the beneficial effect of increasing the dietary protein or adding fat to the diet on increasing early egg weight. However, the extent of increased early egg weight due to increasing the dietary protein or adding fat to the diet were quite less pronounced in experiments 2 and 3 than in experiment 1. The lower egg weight responses could have been due to differences in body weight of pullets at the start of the experiments. The pullets used in experiments 1 to 3 were of the same commercial strain (Babcock B-300). However, the pullets in experiment 1 were about 60 g lighter than the breeder guidelines (1,260 *vs* 1,300 g), while in experiments 2 and 3, which were conducted concurrently, were 60 g heavier than the breeder guidelines (1,360 *vs* 1,300 g) at the beginning of the experiments (18 wk of age). It is logical to believe that response to increasing nutrient density is more pronounced with the lighter than the heavier body weight pullets at the onset of sexual maturity. It was assumed a heavier body weight of about 120 g at the start of the experiments 2 and 3 as compared to experiment 1 might have been a reason for a smaller egg weight response obtained due to dietary manipulation of nutrients in the latter two experiments.

#### Laying experiment 4

Experiment 4 was conducted with two objectives: 1) to determine whether the early egg weight responses to dietary manipulations of nutrients could be influenced by the body weight of pullets at the onset of egg production, and 2) to determine whether the effect of nutrient density on early egg size would persist after changing the feed to a conventional layer diet. Finding answers to the latter question was particularly important due to the negative effect that larger eggs could have on shell quality during late stages of the egg production cycle. The design of the experiment was a

2X2X2 factorial arrangement of the treatments with two body weights (light and heavy), two levels of supplemental fat (0 and 4%) and two levels of protein (17 and 21%). The diets were isocaloric (1,280 kcal/lb). At 17 wk of age, from a group of 1,200 pullets, 480 birds with the lightest and 480 birds with the heaviest body weight were selected for the experiment. At 18 wk of age, the pullets were moved to the laying house and fed one of the four experimental diets up to 38 wk of age. From 38 to 62 wk of age, all the pullets were fed a conventional layer diet containing 16.5% crude protein.

The results of experiment 4 which were consistent with the results of Experiments 1 to 3 indicated that early egg size can be increased by several approaches. This information can be seen from the individual egg weights and extra-large plus large-sized eggs means which are depicted in **Table 1** and can be summarized as follows:

- 1.) The information from **Table 1** re-emphasized the importance of growing pullets to target body weight at the onset of egg production for achieving an optimum egg size during the early stages of the egg production cycle. The individual mean data revealed that the average egg weights and extra-large plus large-sized eggs for the period of 18 to 38 wk were 2 g and 12.4%, respectively, greater for the birds from the heavy-weight than the light-weight groups when both groups were fed a conventional layers diet (1,280 kcal ME/lb diet, 17% protein and no supplemental fat) during 18 to 38 wk of age. The egg weights and extra-large plus large-sized eggs differences between the birds of the two body weight groups were consistent with each specific diet used. This information is consistent with the previous reports in the literature which indicated a positive correlation exists between body weight of pullets at the onset of sexual maturity and the egg size throughout

the laying cycle.

2.) The early egg weight and extra-large plus large-sized eggs can be increased by increasing the dietary protein above the conventional levels that are routinely used by the industry during the early stages of the egg production cycle. The beneficial effect of dietary protein on early egg weight was consistent with both light- and heavy-weight pullets.

3.) The beneficial effect of a higher protein level on early egg weight and extra-large plus large-sized eggs can be enhanced by adding fat to the diets under isocaloric conditions. This information was consistent both with light- and heavy-weight pullets and indicated a synergistic effect exists between supplemental fat and a higher protein level in increasing early egg weights and egg size.

4.) The beneficial effects of the combination of a higher protein level and supplemental fat in increasing egg weight and extra-large plus large-sized eggs during the early stages of the egg production cycle is more pronounced with the light-weight than with the heavy-weight pullets. Egg weight and extra-large plus large-sized eggs were increased by 2.5 g and 17.2%, respectively, with the light-weight pullets due to the combination of a higher protein level and supplemental fat during 18 to 38 wk of age. The corresponding increases for the heavy-weight groups were 1.8 g and 13.9%. This information, in part, explains the greater egg weight and egg grade responses obtained with the light-weight pullets (experiment 1) as compared to lower responses observed with the heavy-weight pullets (experiments 2 and 3).

5.) Egg weights and extra-large plus large-sized eggs of the light-weight groups fed the high-protein, fat-supplemented diet were nearly similar to those of the heavy-weight groups fed a conventional diet with 17% protein and no supplemental fat, during 18 to 38 wk of age. This

result suggests two practical applications: a) when due to various reasons pullets reach the age of sexual maturity with light-body weights, their early egg weights can be fully restored to normal levels by providing them with a high-protein, fat-supplemented diet, and b) it re-emphasizes the importance of raising pullets to target body weight for increasing early egg weight.

6.) A difference of 3.8 g for egg weight and 26% for extra-large plus large-sized eggs exists for the birds of the light-weight groups which were fed a conventional 17% protein diet with no supplemental fat as compared to birds of the heavy-weight groups fed a high-protein, fat-supplemented diet during 18 to 38 wk of age. This information indicated that early egg size can be increased considerably by proper management during the growing period for raising the pullets to target body weight at the onset of egg production and by using proper diets during the early stages of the egg production cycle.

7.) For the most part, the beneficial effects of increasing the dietary protein or supplemental fat on early egg weight is confined to the period when these diets are being used. Consequently, it is unlikely that increased early egg weight by dietary manipulation of nutrients would have a prolonged effect to the extent that contributes to the inferior shell quality during the late stages of the egg production cycle.

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Table 1. The effect of treatments on egg weight and egg grades (Experiment 4)

Body Wt	<u>Treatments</u>		<u>Egg weight (wk)</u>			<u>XL &amp; L eggs (wk)</u>		
	Protein	Fat	18-38	38-62	18-62	18-38	38-62	18-62
			————— (g) —————			————— (%) —————		
Light	17	0	50.1	58.9	54.9	11.0	70.5	43.5
Light	17	4	50.9	59.0	55.3	16.0	71.5	46.3
Light	21	0	51.3	59.1	55.5	19.1	71.4	47.6
Light	21	4	52.6	60.0	56.6	28.2	77.8	55.3
Heavy	17	0	52.1	60.8	56.9	23.1	83.2	55.9
Heavy	17	4	51.7	60.2	56.3	21.2	79.1	52.8
Heavy	21	0	53.0	60.4	57.0	29.5	80.1	57.1
Heavy	21	4	53.9	61.3	57.9	37.0	84.7	63.0

# OUTBREAK OF AVIAN INFECTIOUS CORYZA IN MAINE

## Risks

The spread of AIC from Maine to NYS farms depends a great deal on the traffic of products between the infected farm(s) and susceptible flocks. The NYS producers will greatly reduce the risk of introducing AIC to their farms bringing chickens that are free of AIC to their farms. Transmission by egg crates, humans and other means play a minor role in AIC, but should not be dismissed all together, especially when considering the consequences.

## Consequences

The most devastating effect of AIC is on egg production. Depending of the pathogenicity of the strain, AIC may cause up to 60% drop in egg production. Affected flocks take several weeks to recover, and they never recover completely. AIC causes from 5 to 15% mortality, even higher when complicated with *Mycoplasma gallisepticum*, *E. coli*, or infectious laryngotracheitis. Also, the percentage of culled birds goes up drastically. A multiple-age farm will have to inject every single flock brought in, unless the farm is depopulated and disinfected.

AIC is an acute to chronic disease that affects the upper respiratory system. AIC is caused by *Hemophilus paragallinarum*, a bacterium that does not survive well out of the host. Nevertheless, *Hemophilus paragallinarum* survives at least 24 hrs in exudates and tissues at 72 F, several days at 36 F, but dies within minutes at 115 F. This may explain why AIC is more frequently observed in the fall and winter.

## Signs

The first sign of AIC is dirty neck feathers and nostrils, resulting from the bird cleaning the nostrils on the neck, and dust adhering to the nasal discharge. Drop in egg production follows soon afterward, there may be foul odor, facial swelling, eye discharge, and sticky eyelids. Chronic lesions include swollen face and occasionally swollen wattles. When infected with mild strains, in absence of complications, the chicken may have only "dirty" nostrils, without overt signs of disease.

## Transmission

Infected chickens remain carriers, and they are the main source of infection for healthy birds. Pullet flocks, free of AIC are generally infected within 6 weeks of movement to an infected farm. Transmission of AIC by sparrows or other free-flying birds has not been documented.

## Prevention

Because Hp is susceptible out of the host, common biosecurity measures prevent its spread. Given the carrier state, especially important is introduction of only AIC-free chickens to a farm. Moving crews, vaccination crews, and other personnel that are exposed to infected flocks should take biosecurity measures. To prevent spread of the disease by mechanical means, it is advisable to have a complete change of foot-ware and clothes after having been in contact with the infected flock and a rest period of 3 to 4 days before visiting a clean flock.

Those farms where AIC is prevalent use bacterins to ameliorate the effects of the disease. Unfortunately, the bacterin does not prevent infection, and every single flock brought into the farm has to be immunized.

[Note: This information has already been sent to producers.]

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# DEVELOPMENTS IN RESEARCH

## THE EFFECT OF EXCESS DIETARY SODIUM, POTASSIUM, CALCIUM, AND PHOSPHORUS ON EXCRETAMOISTURE OF LAYING HENS

The following information is from an article by Smith et al. (2001) that appeared in the latest issue of Journal of British Poultry Science [Volume 41 (5):598-607]. The investigators in the introduction of this paper reminded the readers about the economic disadvantages of production of excreta with high moisture level in laying houses. Among the disadvantages the following were mentioned: 1) high water vapor losses from the stored manure in controlled environmental houses increase the rate of deterioration of house structure and electrical equipment, 2) the increased weight and volume of high moisture excreta increases the storage and disposal costs of poultry manure from an egg production unit, 3) high moisture excreta provide a more favorable environment for fly larvae development and increases the survival rate of viruses implicated in the etiology of respiratory disease, 4) high moisture excreta increase the rate of proliferation of the microflora that deaminate nitrogen-containing compounds within the excreta, thereby increasing the rate of loss of ammonia into the environment.

The major contributing factor in increasing the moisture content of excreta in a caged laying house is incorrect installation or poor maintenance of drinking water equipment. However, composition of the diet is also an important factor that directly affects the excreta moisture produced by laying hens. Among the major dietary factors that

contribute to excreta moisture is mineral composition of the diet. High dietary intake of sodium and potassium will give large osmotic changes within the intestinal lumen of birds, which, in turn, increase the water content of excreta. Additionally, high intake of these minerals would, in turn, increase their urinary excretion which contribute also to more water loss through the kidney. Calcium and phosphorus may occur in relatively large concentrations in poultry feeds. There is a diurnal variation in phosphorus utilization associated with egg shell formation. Excess dietary phosphorus intake to daily requirement is also excreted via the kidneys. In mammals, it has been reported that excess dietary calcium intake stimulates the thirst center in brain and results in increasing water intake and excretion. However, the effect of excess dietary calcium intake in water intake and excretion has not been studied in birds.

Four experiments were conducted, utilizing laying hens (ISA Brown), to gain quantitative information about the effect of increasing the dietary concentration of sodium, potassium, phosphorus and calcium on daily water intake and the moisture content of excreta. The fifth experiment compared the effect of two sodium sources (sodium chloride and sodium bicarbonate) each at two levels on water intake and excretion and their interaction with two dietary levels of phosphorus. The period of each experiment was 7-8 days. Water consumption and excreta moisture belonging to the last 24 h was determined in each experiment. The basal diet used was mainly a wheat based-diet. Additional drinkers which contained water but birds did not have access to them were used to correct the evaporative loss from the drinkers during the course of each experiment. Additionally, in the first experiment, excreta was collected both in trays with and without

mineral oil to correct the evaporative losses from excreta during the 24 h of excreta collection. Each dietary mineral was used at six levels. The added minerals were replaced with washed sand in the basal diets. The first level of each mineral used was the NRC (1994) requirement for that mineral for the laying hens. The rationale for choosing the higher levels of each mineral was to cover the range that expected to be observed in practice because of differences in feedstuff used, ingredient contamination, ingredient separation during the transport and mechanical delivery of feed, and possibility undetected error in ingredient mixing at the feed mill.

The results of Experiments 1 to 4 are shown in Table 1. Due of the large volume of data, the information belonging to the lowest two levels and the highest two levels of each mineral used in each experiment are shown in this table.

1) **Increasing dietary level of sodium:** With increasing dietary level of sodium, feed intake linearly decreased, and water intake and water:feed ratio were increased. Consequently, there was a linear increase in the moisture content and total weight of excreta produced. The discrepancy between water balance (water intake minus water content of excreta) may have been to increase water accretion, increase respiratory water loss and some evaporation after excreta being voided and reaching to collecting pans. The higher moisture content of excreta collected in oil as compared to open trays is probably due to water evaporation from open trays during 24 h of excreta collection. The difference between these two measurements was about 3% which did not change greatly with the quantity of moisture in excreta or tier level. This rate of evaporation loss in 24 h in open trays was used in other experiments for correcting the water content of excreta, without

additional attempt to collect excreta in oil in other experiments as well.

2) **Increasing dietary level of potassium:** Similar to sodium experiment (experiment 1), water intake and water:feed ratio were linearly increased, and feed consumption linearly decreased with increasing the potassium content of the diet. Total weight of excreta, its moisture content, and daily water excretion were increased linearly with increasing the water intake.

3) **Increasing dietary level of phosphorus:** Feed intake was not significantly influenced by increasing the dietary level of phosphorus. Consequently, with increasing the dietary phosphorus, its intake was increased. As a result of this, daily water consumption and water:feed ratio was increased with increasing the dietary level of phosphorus. Similar to sodium and potassium, increasing the dietary level of phosphorus resulted in increasing the total daily excreta output, percent moisture in excreta, and daily water output.

4) **Increasing dietary level of calcium:** Feed intake was reduced with increasing the dietary level of calcium. However, daily calcium intake still increased. The increased daily calcium intake did not have an effect on moisture content of excreta or elevating the daily water intake.

The results of Experiment 5 showed that the effect of two minerals (sodium and phosphorus) on water intake and excreta moisture were additive, and no differences were detected with regard to two sources of sodium (chloride *vs* bicarbonate) in water intake or excreta moisture content.

The results of the above experiments clearly indicate that every effort must be made in feed formulation so that the unintentional mistake of increasing the levels of minerals in the finished feeds do not take place. Increase the level of most minerals above their requirements

would result in increasing the daily water intake, loose droppings, cost of removal of manure from the laying house due to its higher weight and volume, and increase the ammonia level in the house and fly population. Additionally, the researchers generated a number of equations that might be useful to you in estimating the daily water intake (gram water intake/hen/day), and the moisture content of excreta (%), by having the percentages of sodium, potassium, phosphorus, or calcium in the diet. These equations are as follows:

#### Sodium:

Excreta moisture (%) =  $(693.7 + 9.04x)10$ ; where x is "g sodium/kg diet".  
Water intake (g/bird/day) =  $130.7 + 13.67x$ ; where x is "g sodium/kg diet".

**e.g.;** assuming that diet has 0.16% sodium or 1.6 g/kg finished feed:  
Excreta moisture (%) =  $(693.7 + 9.04 \times 1.6)10 = 70.8\%$ .  
Water intake (g/bird/day) =  $130.7 + 13.67 \times 1.6 = 152.6$

#### Potassium:

Excreta moisture (%) =  $(570.7 + 11.95x)10$ ; where x is "g potassium/kg diet".  
Water intake (g/bird/day) =  $172.4 + 9.19x$ ; where x is "g potassium/kg diet".

**e.g.;** assuming that diet has 0.5% potassium or 5.0 g/kg finished feed:  
Excreta moisture (%) =  $(570.7 + 11.95 \times 5)10 = 63.1\%$ .  
Water intake (g/bird/day) =  $172.4 + 9.19 \times 5 = 218.0$

#### Phosphorus:

Excreta moisture (%) =  $(723.5 + 5.59x)10$ ; where x is "g available P/kg diet".  
Water intake (g/bird/day) =  $192.1 + 7.43x$ ; where x is "g available P/kg diet".

**e.g.;** assuming that diet has 0.4% available P or 4.0 g/kg finished feed:  
Excreta moisture (%) =  $(723.5 + 5.59 \times 4)10 = 74.5\%$ .  
Water intake (g/bird/day) =  $192.1 + 7.43 \times 4 = 221.8$

#### Calcium:

Excreta moisture (%) =  $(755.5 - 1.24x)10$ ; where x is "g Ca/kg diet".  
Water intake (g/bird/day) =  $204.2 - 0.41x$ ; where x is "g available P/kg diet".

**e.g.;** assuming that diet has 3.5% Ca or 35.0 g/kg finished feed:  
Excreta moisture (%) =  $(755.5 - 1.24 \times 35)10 = 71.2\%$ .  
Water intake (g/bird/day) =  $204.2 - 0.41 \times 35 = 189.8$

## *THE INFLUENCE OF DRINKING WATER CONTAINING SODIUM CHLORIDE ON PERFORMANCE AND EGGSHELL QUALITY OF MODERN, COLORED LAYING STRAIN*

The following information is from an article by Chen and Balnave (2001) that appeared in the latest issue of Journal of Poultry Science [Volume 80 (1):91-94]. Previous investigations by this group in Australia (Balnave, 1993; World's Poultry Sci. J. 49:109-111) have shown that tap water containing 0.2-2 g per liter sodium chloride have an adverse effect on shell quality with only little effect on egg production, feed intake and egg weight. The mechanism of this adverse effect by several investigators have been shown to be due to the effect of chloride in reducing carbonic anhydrase activity (an enzyme in the shell gland mucosa which is needed for formation of bicarbonate,  $\text{HCO}_3^-$ ), for shell formation. Such an adverse effect

from saline drinking water (water with sodium chloride concentration of 0.2-2 g per liter) have also been reported by investigators in several other countries including Germany, Israel, and Iran. It is worth noting that the bore water in Australia has a sodium chloride concentration of 0.01 to 3.0 g per liter. In contrast, studies by several investigators in the USA failed to show an adverse effect from saline water (0.2-0.8 g sodium chloride per liter) on shell quality. The USA investigators suggested that strain differences may be the reason for the differences observed in the USA and Australian studies. Balnave's (1993) studies revealed two preventive approaches for the adverse effect of saline water on shell quality; the use of ascorbic acid (vitamin C) in feed or drinking water and also the use of a proteinated form of zinc (Zn methionine). Although the mechanism of the preventive action of ascorbic acid in alleviating the adverse effect of saline water on shell quality is not as yet understood, the beneficial effect of Zn methionine was thought to be attributed to the effect of Zn in carbonic anhydrase; a zinc-requiring enzyme.

During the past decade, egg producers in Australia have discarded established layer strains in favor of new colored overseas strains. The investigators felt that this choice might have influenced the sensitivity of current commercial layer flocks to saline drinking water. Consequently, an experiment was carried out to evaluate the sensitivity of one of these new strains to saline drinking water, and to evaluate the benefit, if any, of ascorbic acid and Zn-methionine supplement. The experiment was conducted under two constant environmental temperatures of 64 and 86 F (or 18 and 30 C).

Hubbard ISA-Brown were fed the experimental diets from 20 to 60 wk of age. The four experimental diets used in each environmental

temperature consisted of: T<sub>1</sub>) a basal diet with local drinking water; T<sub>2</sub>) basal diet with local drinking water containing 0.2% NaCl; T<sub>3</sub>) as T<sub>2</sub> plus 200 ppm ascorbic acid, and T<sub>4</sub>) as T<sub>2</sub> with 360 ppm Zinpro 100, which provided 36 ppm Zn and 72 ppm methionine in the diet. The results failed to show any effect from dietary treatments on performance or shell quality, although various indices of shell quality were consistently lower for hens fed the saline drinking water, and both ascorbic acid and Zinpro had some ameliorating effect in improving the shell quality of hens fed the saline drinking water. From the results of this experiment and previous work in this area, the investigators concluded that a factor other than genotype may be involved with regard to the adverse effect of saline drinking water on shell quality which was originally observed with Australian breeds. They felt that because Australian breeds have been selected and maintained on low-sodium chloride diets as compared to strains in the USA, they are more susceptible to external sources of sodium chloride such as saline drinking water than strains in the USA that are selected on diets with a higher sodium chloride content and are accustomed to such types of diets. From the results of this experiment, it may be concluded that the current commercial strain of laying hens in the USA are not as sensitive to consumption of saline drinking water as original Australian breeds, and the presence of sodium chloride at levels used in the previous investigations should not expect to produce adverse effects on shell quality with the current USA strains.

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Table 1. Effect of excess minerals on water intake and excreta moisture of laying hens (ISA Brown)

	Dietary sodium (%)				Dietary potassium (%)			
	0.16	0.55	1.72	2.11	0.23	0.75	1.00	2.00
Water intake (g/d)	142	193	347	413	205	220	305	368
Feed intake (g/d)	113	100	60	48	120	113	87	69
Water:feed ratio	1.43	2.19	7.14	9.64	1.75	1.96	3.60	6.12
Excreta output (g/d)	72.3	99.6	148.4	176.0	61	72	86	90
Excreta moisture <sup>1</sup> (%)	69.8	79.0	85.3	87.5	55.4 <sup>3</sup>	65.9 <sup>3</sup>	74.3 <sup>3</sup>	80.0 <sup>3</sup>
Excreta moisture <sup>2</sup> (%)	65.1	74.0	84.8	85.2	—	—	—	—
Dry matter in excreta (g/d)	23.2	23.4	22.0	26.0	29.0	26.7	24.9	20.4
Water in excreta (g/d)	49.0	76.1	126.3	149.9	31.9	45.3	61.5	68.6

  

	Dietary available P (%)				Dietary calcium (%)			
	0.30	0.40	1.00	2.00	3.00	3.50	4.50	5.00
Water intake (g/d)	225	225	257	347	232	186	178	175
Feed intake (g/d)	135	142	147	147	144	133	121	121
Water:feed ratio	1.73	1.60	1.77	2.41	1.59	1.40	1.70	1.48
Excreta output (g/d)	105.8	115.8	122.9	182.9	109.4	105.2	77.9	73.2
Excreta moisture <sup>3</sup> (%)	71.1	71.6	74.4	80.8	71.8	72.9	69.5	70.0
Dry matter in excreta (g/d)	30.5	32.7	31.3	34.1	30.4	28.6	23.3	27.7
Water in excreta (g/d)	75.3	83.0	91.5	148.7	79.0	76.7	54.6	65.5

<sup>1</sup>Collected in oil.

<sup>2</sup>Collected in air.

<sup>3</sup>Corrected for air losses.



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