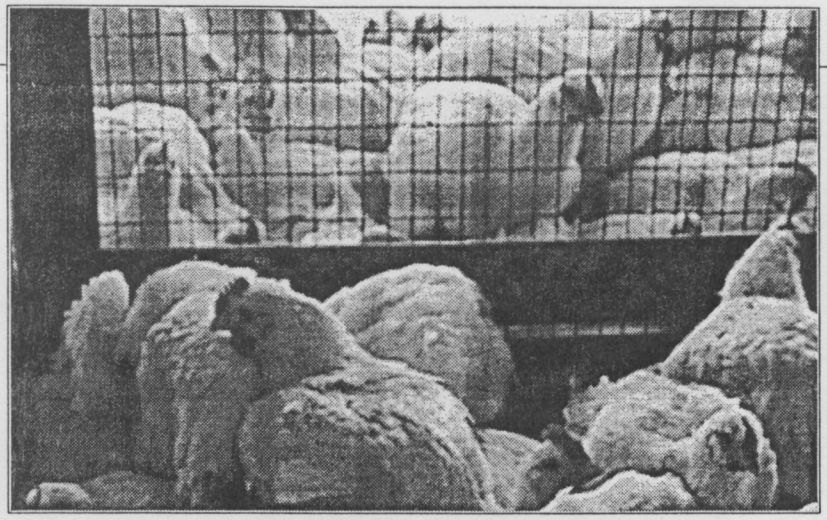


Research Update 1993

Poultry

Diet Density and Glucose Water Affect Broiler Shrinkage

Broiler weight loss, or shrink, can be significant when feed and water are withdrawn from market-age birds before slaughter. An AAES study investigated how shrink and carcass component yields were affected by varying diet density and adding glucose to water during the initial fasting period.

Male broilers were reared on deep litter and fed either high density (HD) or low density (LD) starter (1-21 days), grower (21-35 days), and withdrawal (35-42 days) diets. The three HD diets contained 22.6, 20.6, and 18.5% crude protein, and 1,475, 1,496, and 1,516 kilocalories (kcal) of energy per pound, respectively. LD diets contained 21.4, 19.5, and 17.7% crude protein and 1,396, 1,416, and 1,436 kcal per pound, respectively.

At 42 days, all birds were weighed and provided either water or 10% glucose solution for six hours after feed removal in pens. Birds were reweighed before slaughter and processing at the AU Poultry Science Research Processing Plant.

Broilers reared on HD diets were significantly heavier than those reared

continued on page 2

Restricted Light Program Maximizes Growth, Prevents Problems

Maximum broiler growth generally occurs with near-continuous light, but rapid growth rate may cause circulatory and skeletal problems. Broiler survival can be improved by providing light that approximates daylength, thus reducing feed intake. However, broilers subjected to extended periods of darkness may develop a higher incidence of breast blisters.

An AAES study used restricted light treatments (as seen in the table) with the addition of one or two periods of light to stimulate bird movement and prevent breast blisters. Standard management procedures were used, and birds were processed and deboned at 49 days of age.

Live body weight, chilled carcass weight, and percentage Grade A carcasses were greatest in the treatment that provided two periods of light during the dark phase. In this treatment, 16 hours of continuous light were followed by three two-hour periods of darkness. The dark periods were alternated with one-hour light periods. This is expressed in the table as 16L:2D:1L:2D:1L:2D.

Total mortality, feed efficiency, weights of parts, and incidence of breast blisters were not significantly different among treatments, although the 16L2D:1L:2D:1L:2D program still resulted in the best numbers.

The 16L:2D:1L:2D:1L:2D treatment provided performance equivalent to near-continuous light and may have greater impact on strains that have high incidence of blisters.

J.A. Renden, E.T. Moran, Jr., and S.A. Kincaid

Carcass and Yield Components of Male Broilers (Ross x Ross) Exposed to Four Light Programs

	Light program[1]			
Variable	23L:1D	16L:8D	16L:3D:1L:4D	16L:2D:1L:2D:1L:2D
Body weight, lb.	6.3	6.2	6.3	6.5
Chilled carcass, lb.	4.3	4.2	4.3	4.5
Abdominal fat, lb.	.13	.13	.13	.14
Wings, lb.	.50	.49	.50	.52
Drumsticks, lb.	.60	.60	.61	.63
Thighs, lb.	.67	.66	.67	.70
Tenders, lb.	.19	.18	.19	.20
Fillets, lb.	.84	.80	.82	.86
Grade A, pct.	57.8	45.5	58.7	59.9
Breast blister, pct.	33.2	33.9	25.2	27.2
Mortality, pct.	8.5	4.0	3.0	5.5
Feed efficiency, g:g	1.85	1.86	1.86	1.84

[1]Hours light:hours dark.

Alabama Agricultural Experiment Station Auburn University
Lowell T. Frobish, Director Auburn University, Alabama

Character of a New Foodborne Pathogen

Escherichia coli 0157:H7 has recently emerged as a recognized foodborne pathogen, and most recently has been implicated as the cause of a major foodborne disease outbreak involving hamburgers from a fast-food chain in the western United States. Although most types of *E. coli* are not harmful to humans, this type (0157:H7) is highly virulent and can cause severe health problems and even death.

Because *E. coli* 0157:H7 has only recently emerged as a foodborne pathogen, little is known regarding its behavior in foods, including poultry products. To date, poultry has not been involved in disease outbreaks. According to the U.S. Department of Agriculture, broilers taken directly from processing plants are free of this bacterium. However, other studies do show that poultry products can become contaminated with this pathogen, probably from cross contamination as these products move through food processing and distribution channels. Thus, there is keen interest in knowing the growth and survival characteristics of this pathogen in poultry products.

To this end, AAES research is focusing on defining the conditions under which *E. coli* 0157:H7 can persist in poultry products and survive cooking processes. Such research is directed toward the development of safe handling, processing, and cooking guidelines.

Much of this work has initially focused on developing highly sensitive laboratory methods, which would lead to more accurate data. Research has shown that cells of *E. coli* 0157:H7 that have been subjected to treatments, such as freezing or undercooking, are difficult to detect by traditional methods, even though these cells are still alive and would pose a health risk if consumed.

An evaluation of different microbiological methods for recovering these treated (injured) cells led to the identification of a microbiological medium (PRSA + MUG) that is highly effective for recovering injured *E. coli* 0157:H7 and for differentiating this pathogenic type from nonpathogenic types. Furthermore, these studies indicated that some testing methods currently being used are inadequate and can lead to inaccurate results if used for evaluating the safety of cooking processes for food products.

In other studies, it has been shown that different isolates of *E. coli* 0157:H7 vary in their ability to survive cooking. An isolate originally obtained from retail pork demonstrated significant heat resistance and was subsequently used to determine the ability of this pathogen to survive cooking in lean (3% fat) and high fat (11% fat) poultry meat. Addition of fat increased the ability of the pathogen to survive heating. As in other meats, fat in poultry protected *E. coli* 0157:H7 from the heat of cooking. Temperatures of greater than 140°F may be required to provide a reasonable margin of safety in such products. Subsequent research will be done to verify this under commercial cooking conditions.

Data from studies so far verify that the use of safe food handling practices, including proper hygiene and adequate cooking temperatures, is the best means of preventing foodborne disease.

D.E. Conner

Composting Poultry Carcasses the Alabama Way

Alabama's broiler industry faces the challenge of responsibly disposing of 800 tons of cull and dead birds each day. When properly managed, composting is a safe, relatively inexpensive, and environmentally sound method for converting carcasses into a valuable byproduct. Poultry compost may be safely applied to crop or pasture land as a soil amendment and fertilizer when used at recommended rates.

AAES research has revealed valuable information for poultry growers who want to establish composting facilities. For example, straw once was used as a composting medium, but AAES studies indicate that litter alone provides a suitable medium. Carcasses, litter, and water in a ratio of 1:3:0.25 comprise the composting formula. Once composted, carcasses can be successfully used as the primary medium in a second composting cycle.

Other studies revealed that harmful bacteria can be rapidly inactivated. Two-stage composting with aeration is required to destroy these pathogens. This process involves transferring the material to a secondary bin, where a well-managed composter will generate temperatures above 130°F for three consecutive days. Such temperatures can destroy many avian and human disease causing organisms.

J.P. Blake, D.E. Conner, and J.O. Donald

Broiler Shrinkage, continued

on LD diets, regardless of water treatment. Abdominal fat weight and yield were highest on birds reared on HD diets and given glucose. Birds reared on LD diets lost less weight when given glucose.

Availability of glucose during the initial stages of feed withdrawal appeared to alleviate shrink losses, presumably by reducing fat and protein catabolism. Use of glucose or commercially available products, which are often supplemented with electrolytes and vitamins, during periods of stress (temperature extremes, feed withdrawal, catching-crating, and live transportation) has been shown to reduce shrink losses and increase product yields.

S.F. Bilgili and E.T. Moran, Jr.

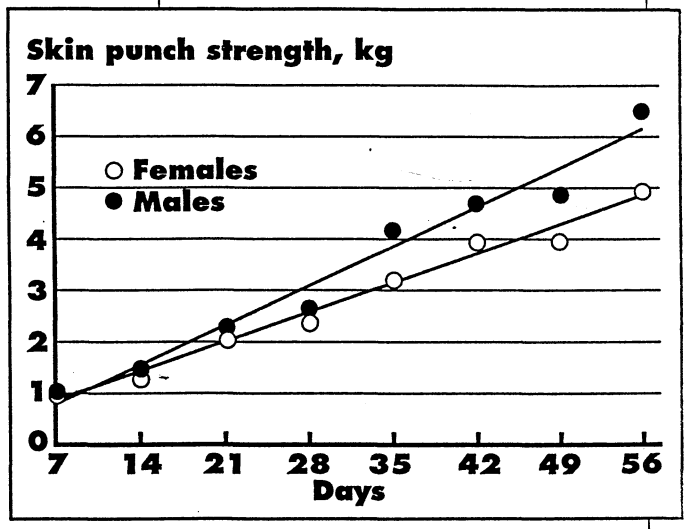
Age, Sex, and Feathering Rate Influence Broiler Skin Strength

Skin contributes significantly to the appearance and quality of broiler carcasses, and skin strength is an important element in ensuring a quality product. AAES research is helping to determine what factors improve skin strength in poultry.

Skin-related problems, such as cuts and tears due to weak skin, frequently occur during processing and cause substantial economic losses to the broiler industry in the United States. Cuts and tears on skin accounted for 4.6 and 6.2% of the total downgrades in 1986 and 1990, respectively.

Skin integrity of broilers is evaluated either by assessing the extent of cuts/tears encountered during processing or by determining the skin breaking strength. Genetics, sex, nutritional factors, flock management, and various feed additives have been shown to affect skin quality of broilers. An AAES- developed skin punch method has been used to measure the elastic properties of chicken skin. This method was used to evaluate the age-related changes in broiler skin strength.

The study used male and female broilers from two strain-crosses (SC) differing genetically in feathering rate, such as slow and fast-feathering lines. Seven hundred and twenty birds were raised to 56 days of age in floor pens by following standard management procedures. Starting at seven days of age and at weekly intervals thereafter, skin punch measurements were made on five randomly selected birds within sex and SC.



Skin punch strength measurements.

Skin strength of both male and female broilers increased linearly with age. However, skin punch strength was higher in males than females (see figure). Female broilers are usually marketed at younger ages for fast-food markets as compared to males grown to heavier weights (older ages) for de-boned broiler meat products.

The differences between the two SC were limited to skin displacement, which is an indirect measure of skin elasticity. Skin from slow feathering SC was less elastic as compared to those from fast-feathering SC.

The data generated in this study provide baseline information on the developmental pattern of skin strength in male and female broilers. Current research is focusing on influence of nutritional factors (vitamin C and zinc) and medicinal feed additives on skin strength and quality.

S.F. Bilgili

Salinomycin, Amprolium, and Coccivac Control Coccidiosis

Salinomycin, Amprolium, and Coccivac were shown in an AAES study to provide broiler breeders adequate protection against acute coccidiosis and to allow breeder replacements to develop immunity to the bacterial disease.

Arbor Acres chicks were placed in six pens (165 birds per pen) where the litter was seeded with *Eimeria acervuline, E. maxima,* and *E. tenella,* the bacteria that cause coccidiosis. Birds in two of the pens were treated with either Salinomycin at 60 parts per million (ppm) for birds up to three weeks and 40 ppm, four to 12 weeks; Amprolium (113.5 ppm, 0-12 weeks); or Coccivac (one dose on day three). At eight weeks, some of birds in each pen were caged, fed nonmedicated feed for 48 hours, and inoculated with *E. tenella, E. maxi-ma,* and *E. acervuline* eggs.

Signs of disease were virtually nondetectable in treated groups, while nontreated groups had moderate to severe traces of the bacteria in fecal droppings. Almost all treated birds had minor or no intestinal lesions, while all nontreated birds had lesions, many severe. Average weight gain of treated birds was 497.18 grams, compared to 13.47 grams for the nontreated.

None of three treatments made differences in egg production, feed consumption/conversion, live or production performance, or semen volume and concentration.

L.A. Martinez, G.R. McDaniel, and M.K. Eckman

Recycling Works Best with Feed and Daylength Restrictions

AAES research has shown that egg producers can decrease the duration and increase the effectiveness of layer recycling programs by using daylength and feed restrictions concurrently.

A hen's laying capacity declines to nonprofitable levels after about one year in production. At that point, recycling is required to prepare layers for a second production cycle by stimulating regression and regeneration of the reproductive tract.

Single Comb White Leghorns that

continued on page 4

had been laying for 37 weeks were subjected to one of four treatments that included combinations of these feed and daylength restriction regimens: (A) 84 days of free choice feed; (B) nine days of fasting, 33 days of limited feed, and 42 days of free choice feed; (C) 84 long daylengths; (D) or 42 short daylengths followed by 42 long day-lengths.

In general, the combination of feed restriction and short daylength most rapidly and effectively accomplished the goals of recycling — termination of egg production, decrease in body weight and fat, and stimulation of reproductive tract regression and molting. Egg production by hens subjected to short daylengths increased most rapidly and attained the greatest levels during the last week of the study. These hens would be expected to have the best post-recycling production.

R.J. Lien

Broiler Quality Suffers From Lack of Phosphorus

Phosphorus is expensive to provide in most broiler feed, but the cost is warranted because it helps carcasses withstand the stresses of processing, thus increasing product value.

AAES experiments showed a strong relationship between phosphorus adequacy and carcass quality. In these tests, some broilers were given feeds with recommended levels of phosphorus, while others were fed 10% less of the nutrient for comparison.

Weight gain during the first three weeks of production was less for broilers on reduced-phosphorus feed; however, birds given inadequate phosphorus had a distinct advantage in feed conversion, which was prominent prior to marketing. Live hauling increased weight loss before slaughter, regardless of phosphorus treatment.

Processing increased bruising near the hock in birds on the low-phosphorus diet, and bruising was worse in birds subjected to live hauling. Deformed drumsticks also increased with low phosphorus, but transportation did not effect this problem.

When chilled carcasses were further processed, there were deboning problems in the broilers given less phosphorus. Additional breakage of the femur and separation of the rib cage during deboning increased labor during meat removal. There also was increased blood splash, particularly of the thigh meat.

An unexpected disadvantage of providing adequate phosphorus is a higher death rate due to leg disorders and other problems. However, this increased mortality does not outweigh the advantages of feeding an adequate amount of the nutrient.

E.T. Moran, Jr., and M.C. Todd

Calcium Recommendations for Optimal Performance (Phase I)

In an effort to produce larger eggs, egg producers will often limit the amount of calcium (Ca) in feed during Phase I (weeks 20-36). AAES research indicates that limiting the percent of Ca in feed may be restricting production and shell quality.

Many feeds formulated for this phase of production limit the percent dietary Ca to 4% or less. This upper limit has been placed on percent dietary Ca because of the belief that if Ca is increased enough to obtain a constant Ca intake, as feed intake decreases, egg size will be reduced and production and feed consumption will be adversely affected.

This upper limit may have been sufficient in past years, when hens typically consumed 20 to 21 pounds of feed per 100 hens per day. However, it now is common for birds to peak in production while consumption is only 16 to 17 pounds per 100 hens per day. If hens are eating less, they will not be consuming enough Ca if the percent Ca is restricted in feed.

An AAES study was conducted to determine if optimizing eggshell and skeletal strength by manipulating dietary Ca had any adverse effects on egg size, production, or feed consumption during this phase. For the study, W_{36} pullets (20 weeks of age) were randomly divided into 12 treatments with six treatments housed at 60-74°F and six treatments housed at 70-84°F. Hens in each treatment were fed diets containing 2.5, 3.0, 3.5, 4.0, 4.5, or 5.0% Ca from 20-32 weeks of age.

Results indicate that increasing dietary Ca causes a significant linear increase in egg production. Because of the improvement in feed efficiency of today's bird (as low as 2.2 pounds per dozen eggs during peak production), they simply cannot optimize performance on percent dietary Ca levels that were adequate just a few years back. Environmental temperature had no influence on egg production and there were no interactions among environmental temperatures and Ca levels.

Egg specific gravity was directly related to dietary Ca level.

Within two weeks, hens housed in the cool environment had significantly higher egg specific gravities. This indicates that hens housed in the warm environment were not receiving enough Ca, even at the highest Ca level.

The higher dietary Ca levels had no adverse influence on egg weight. Egg weight of hens fed the 4.5 or 5% Ca was even numerically greater than hens fed 2.5 to 3% Ca. This result was expected because hens fed the higher Ca levels had a greater egg specific gravity (more shell). Therefore, it is believed that attempts to maximize egg weight by limiting Ca may actually be reducing egg size up to 0.2 grams simply because of reduced shell weight. Decreasing environmental temperature increased egg weight an average of 0.8 grams. Hens housed in the cool environment consumed seven grams more feed per hen per day than hens housed in the warm environ-

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Reducing *Salmonella* Contamination of Ready-to-Cook Poultry

Salmonella bacteria are a major concern to poultry and other food industries because of their wide distribution in nature and their ability to cause foodborne illness in humans. Presently, *Salmonella* are a leading cause of foodborne disease worldwide.

Salmonella occur naturally in the intestines of animals commonly used for human food, such as cattle, swine, and poultry. Although totally eliminating *Salmonella* from the food supply is unlikely, improvements that supplement current production and processing techniques may provide ways of reducing the risk of this pathogen occurring in final poultry and meat products. AAES research is examining ways to reduce *Salmonella* throughout the stages of poultry production-processing. One main thrust is to develop effective means of alleviating *Salmonella* and other potential pathogens from ready-to-cook carcasses during processing.

Contamination of carcasses can occur in a processing plant if bacteria are transferred from various sources to the surface or skin of the chicken. Research has shown that *Salmonella* can embed in or attach to chicken skin, and that embedded or attached bacteria are more resistant to antibacterial treatments applied to the carcass. Processing steps, such as carcass washings and immersion chilling, effectively reduce but do not completely eliminate bacterial contamination of skin. Therefore, researchers have recently investigated the antimicrobial activity of six potential carcass treatments that could be incorporated into existing processing plant settings.

Treatments included acetic acid (5%); trisodium phosphate (8%); sodium metabisulfite (1%); and chlorine at 20, 400, and 800 parts per million (ppm). Each of these was examined in simulated chiller (34°F for 60 minutes), scalder (124°F for 2 minutes), and post-process dip (68°F for 15 seconds) applications. The skin attachment model (SAM) developed at Auburn University was utilized to determine the ability of these chemical treatments to kill attached *Salmonella*. The SAM represents a novel and more sensitive approach to evaluating potential carcass disinfectants, and increases the likelihood of identifying treatments that will not only prove effective in the lab, but also in the processing plant.

Chlorine at 20 ppm, which quickly kills "free-swimming" *Salmonella*, showed little activity against attached *Salmonella*. The higher levels of chlorine, which are not approved for commercial use, did prove to be lethal, particularly in the chiller application. Sodium metabisulfite showed no activity at all; whereas, trisodium phosphate was effective in all applications. The U.S. Department of Agriculture recently approved the use of trisodium phosphate in poultry processing. Acetic acid was highly effective against firmly attached *Salmonella* in the scalder application.

Results verify that *Salmonella* attached to poultry skin are highly resistant to chemical carcass treatments. It is also apparent that the method of application (chiller, scalder, or post-dip) plays an important role in the effectiveness of any treatment. Results from this work provide the necessary basis to move to subsequent research to define acceptable treatments that can kill *Salmonella* embedded in or attached to the skin. Treatments that can kill these *Salmonella* and prevent cross contamination by killing free-swimming *Salmonella* will likely prove to be effective when applied in actual processing plants.

K.C. Tamblyn and D.E. Conner

Calcium Recommendations, continued

ment. However, hens fed the higher Ca levels did not consume less feed. As dietary Ca level increased, there was a significant linear increase in feed consumption. This is contrary to what many producers might expect.

These results suggest that Hy-line W_{36} hens housed under warm environmental conditions should be fed diets containing a minimum of 4.25 and possibly 4.5% Ca during Phase I. Because price of eggs and feed, percent undergrades, and other factors that influence profits vary, the Ca requirement should be re-evaluated if any of the above variables change sharply.

D.A. Roland, Sr.

Broiler Litter Not Source of Weeds

A major constraint to using broiler litter as fertilizer on cropland and some pastures is the perception that the litter will introduce problem weeds. Increased weed growth is common on pastures where broiler litter is applied. The increased weed growth is probably coming from the fertilizing effect of the litter and not from new weed seeds in the litter itself. Surprisingly, few researchers have looked into this widespread concern.

A greenhouse incubation study evaluated 18 broiler litter samples collected from houses throughout Alabama in 1992. The objectives of the study were to see if any weed seed were introduced when the litter is added to a sterilized soil and to determine the effect of the litter on growth of weeds that were planted in the soil.

No weeds came up during a two-month incubation period in soil treated with broiler litter samples. The different litter samples did, however, affect the germination and growth of morningglory, sicklepod, spiny amaranth, and large crabgrass seeds that were placed in the soil. High rates of litter from some sources actually killed crabgrass and spiny amaranth seedlings, presumably from ammonia toxicity. This was not observed in the fertilized control.

These results suggest that row crop farmers and cattle producers should not be concerned about introducing noxious weeds into their fields, pastures, and hayfields when broiler litter is used as a fertilizer source.

C.C. Mitchell and R.H. Walker

A New Vaccination System

Vaccinating poultry against most viral and bacterial diseases is now a common procedure, but some available vaccines cause serious side effects, such as sterile abscesses and arthritis. A new formulation developed through AAES research could replace such problematic vaccines.

Researchers found that dead viruses could be attached to latex microbeads to create a suspension that can be safely injected into poultry, causing an immune response to the viruses over a prolonged period of time. The microscopic latex beads are readily engulfed by white blood cells, which then produce antibodies to combat the attached viruses. The microbeads are eliminated by the chickens over time and have not induced unwanted side effects.

After adequate field trials and approval by the U.S. Department of Agriculture, this vaccination system should benefit the poultry industry.

E.C. Mora

EDITOR'S NOTE

The 1993 Poultry Update is a publication of the Alabama Agricultural Experiment Station (AAES) at Auburn University. It contains the latest results of AAES studies relating to the poultry industry. Mention of company or trade names does not indicate endorsement by the AAES or Auburn University of one brand over another. Any mention of nonlabel uses or applications in excess of labeled rates of pesticides or other chemicals does not constitute a recommendation. Such use in research is simply part of the scientific investigation necessary to fully evaluate materials and treatments.

Information contained herein is available to all persons without regard to race, color, sex, or national origin.

Broiler Protein Requirements Can Differ Among Strains

Feed formulation in the United States is based largely on levels of protein and energy that optimize performance of domestic strains, but broiler strains used commercially are no longer exclusively of U.S. origin.

Nutrient requirement values in this country are almost solely the result of research conducted with birds of domestic origin, which were evaluated for performance while being fed corn-soybean feeds. Broiler strains from Europe (the EEC) and Australia are increasingly being used in the United States. Feed in most of these countries depends largely on wheat, which provides a high level of protein and low level of energy compared to corn.

In an AAES experiment, commercial broiler crosses developed in the United States and United Kingdom (UK) were compared using corn- and wheat-based feeds. The wheat-based starting and growing feeds had approximately 3% additional protein, while corn-based feeds had 5-6% advantage in metabolizable energy.

Both strains had similar live performance on the corn-based diet, which was based on U.S. nutrient standards. However, the UK strain weighed more when given the wheat-based feeds. Wheat also favored the UK broilers in terms of abdominal fat, appearance of physical defects, and yields of parts.

Growth and carcass characteristics can be enhanced by genetic selection. Results of this study indicate that nutrition during development of broiler parents influences the nutrient levels required by their progeny to attain the selected traits.

E.T. Moran, Jr., X. Chen, and J.P. Blake

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