THE EFFECT OF DEGREE OF DEBEAKING AND CAGE POPULATION SIZE ON SELECTED PRODUCTION CHARACTERISTICS OF CAGED LAYERS

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ABSTRACT

THE EFFECT OF DEGREE OF DEBEAKING AND CAGE POPULATION SIZE ON SELECTED PRODUCTION CHARACTERISTICS OF CAGED LAYERS

by Robert Carey Hargreaves

Debeaking is commercially used as one method of preventing cannibalism in young growing chickens, laying hens, turkeys, and game birds. In recent years, the relative severity of debeaking has increased. The primary purpose of this experiment was to determine the effects that severe degrees of debeaking might have on production characteristics of caged laying chickens.

Single Comb White Leghorn pullets were debeaked at 18 weeks of age and placed in 1-bird and 3-bird cages. Other birds from the same stock were debeaked at 24 and 25 weeks of age and placed in 2-bird cages and 21-bird cages. Three degrees of debeaking were used -- 1/2, 3/4 and all of the distance between the tip of the beak and the nostrils. Approximately the same amount of both upper and lower mandibles was removed. Non-debeaked birds served as the controls. The birds with all of the beak removed are referred to as "entirely debeaked".

Compared with birds in any of the other three treatments, entirely debeaked birds gave poorer results. They took longer coming into egg production, laid fewer eggs, ate less feed and made smaller body weight gains. All of these differences were highly significant.

Egg production of birds debeaked 1/2 and 3/4 was not significantly different from that of the controls, but feed consumption of birds debeaked 3/4 was significantly lower than that of the controls. Differences in body weight gain were highly significant between the controls

and birds debeaked 1/2 or 3/4. The difference in body weight gain between birds debeaked 1/2 and 3/4 was not significant.

In feed efficiency, highly significant interactions between degree of debeaking and cage population size were found. Birds in entirely debeaked treatments consumed significantly more feed per dozen eggs than birds in most other treatments. Birds debeaked 3/4 and housed in 21-bird cages consumed significantly less feed per dozen eggs than birds in most other treatments. Other differences in feed efficiency were not significant.

Birds in 1-bird cages laid significantly better than birds in 3-bird cages and highly significantly better than birds in 21-bird cages. The birds in 2-bird cages laid significantly fewer eggs than the birds in any of the other cage population sizes, but this was complicated by chronic mortality in this group during the initial stages of the experiment.

Birds in 1-bird cages ate significantly more feed than the birds in 3-bird cages and 21-bird cages, and the birds in 3-bird cages ate significantly more feed than birds in 21-bird cages.

There is a need for further research into the physiological basis for differences observed in this experiment. Practical recommendations, however, can be made in the light of this research. Debeaking 1/2 to 3/4 of the beak of 18-week-old pullets appears to be a normally safe practice without any adverse effects. Debeaking more than 3/4, however, could be disastrous. A significant reduction in egg production and a significant decrease in feed consumption can be expected in entirely debeaked caged layers.

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INTRODUCTION

With the development of modern high density laying systems, particularly multiple-bird cages, the problem of cannibalism among laying hens has become more serious in recent years. The most common method of dealing with this problem has been to debeak. As cannibalism increased, the severity of debeaking increased, and it is not unusual today to find recommendations for debeaking within 1/8 to 1/4 inch of the nostril (Price, 1959; Godfrey, 1960; Davis, 1962; Vandervort, 1962; Sink, 1964).

There is some question in the minds of many poultrymen as to the advisability of using such severe debeaking. The present study was carried out to establish a scientific basis for debeaking recommendations.

In cages, the severity of cannibalism has generally been observed to increase as the number of birds per cage is increased and as the space allowed per bird is decreased. Any study on the efficacy of debeaking, therefore, should take these factors into consideration.

REVIEW OF LITERATURE

Debeaking Broilers

Up to the present time most of the debeaking research has been conducted with broilers.

The efficacy of debeaking in broilers has been well-demonstrated. Darrow and Stotts (1954), Camp et al. (1955), and Huston et al. (1956) found significant decreases in feather picking and, consequently, significant improvement in market grade when broilers were debeaked. When feather picking was not a problem, differences in feather score and market grade were not observed (Lonsdale et al., 1957; Vondell and and Ringrose 1957; Keene et al., 1959b; and Krueger et al., 1961).

Debeaking one-half or less of the beak has no deleterious effect on growth rate (Darrow and Stotts, 1954; Camp et al., 1955; Huston et al., 1956; Lonsdale et al., 1957; Vondell and Ringrose, 1957; and Keene et al., 1959a). Camp et al. (1955) found that debeaking 1/3 to 1/2 of both mandilbes actually improved the growth rate of males but had no effect on females. Debeaking 2/3 of the beak, in most experiments, caused a significant decrease in growth rate up to at least 10 weeks of age (Camp et al., 1955; Lonsdale et al., 1957; Vondell and Ringrose, 1957). However, Huston et al., (1956) found no effect from debeaking 2/3 of the upper mandible.

Few studies have been made comparing the effects that the various methods of debeaking may have on broiler performance. Searing the beaks of day-old chicks prevented beak regrowth better than did block debeaking (Davis et al, 1957). Comparisons between research using block debeaking and research in which only the upper mandible is removed show

very similar results. That is, birds debeaked 1/2 did well regardless of the method used and birds debeaked 2/3 did poorly (Darrow and Stotts, 1954; Camp et al., 1955; Huston et al., 1956; Lonsdale et al., 1957; Vondell and Ringrose, 1957; Keene et al., 1959b; Krueger et al., 1961).

Feed efficiency has usually been found to be slightly, but not significantly, improved by debeaking (Darrow and Stotts, 1954; Camp et al., 1955; Huston et al., 1956; Lonsdale et al., 1957; Vondell and Ringrose, 1957; and Keene et al., 1959b).

Broilers debeaked at one day of age did not perform significantly different from broilers debeaked at two weeks (Krueger et al., 1961), three weeks (Darrow and Stotts, 1954), or five weeks of age (Camp et al., 1955. However, Davis et al., (1957) found that birds debeaked at 10 days of age were physically less capable of picking at 10 weeks of age than were birds debeaked at one day of age.

Huston et al., (1956) found that mandibles debeaked 1/3 at one day of age grew back to the same length as the controls by 10 weeks of age. Beaks debeaked 1/2 were still shorter than the controls at 10 weeks of age and were not significantly different from beaks debeaked 2/3.

Debeaking Pullets

Effects on birds during the growing period -- The effects of debeaking Leghorn-type chickens are very similar to those observed in broilers. Debeaking 1/2 of the upper mandible at one day of age had no effect on growth to five months of age (Morgan, 1957). Debeaking 2/3 or more of the upper or both mandibles at ages ranging from one day to 12 weeks significantly restricted growth rate (McDonald, 1956; Bramhall, 1962; Slinger et al., 1962; Bramhall, 1963; Slinger and Pepper, 1964).

Despite the favorable results observed from debeaking 1/2 or less, temporary growth depression has been found (McDonald, 1956; Keene et al., 1959a). Debeaking 1/2 caused a temporary drop in adrenal ascorbic acid in bursectomized birds (Perek and Bedrak, 1962). The addition of aureomycin to the diet hastened the return to normal adrenal ascorbic acid values.

An interesting observation reported in the literature was that birds debeaked 2/3 at 8 to 10 weeks of age consumed very little grit (Slinger et al., 1962; McIntosh et al., 1962). Feed consumption was significantly reduced in birds debeaked 1/2 at one day of age (McDonald, 1956). Apparently, impairment of the ability to eat was not involved since the debeaked birds consumed enough feed to maintain normal growth and spent the same amount of time at the feed trough as did the controls.

Effects on adult birds -- Debeaking 1/2 of the upper or both mandibles during the growing period had no adverse effects on egg production, mortality or egg weight when the birds were in floor pens (Morgan, 1957; Noles et al., 1962). Mortality was significantly reduced by block debeaking 1/2 in one experiment, but in a succeeding experiment by the same researchers significant differences in mortality could not be demonstrated (Noles et al., 1962). Debeaking 1/2 of the upper mandible twice (at one day of age and again just before sexual maturity) had no effect on egg production or mortality (Morgan, 1957).

Debeaking 1/2 of the upper mandible and 4 mm. of the lower mandible after the onset of laying had no adverse effect on egg production, except when done in January (Bray et al., 1960). Debeaking at that time produced approximately a 20 percent drop in egg production in White Rocks and Rhode Island Reds but had no effect on the egg production of White

Leghorns. Egg production in all three breeds for the 40-week test period was not significantly affected, but significant body weight losses were found.

Debeaking 2/3 of the upper mandible and 1/3 of the lower mandible at 8 weeks of age significantly retarded age of sexual maturity and decreased feed consumption but had no effect on egg production for the first 20 weeks of lay (Slinger and Pepper, 1964). In the same experiment, debeaking at 20 weeks of age did not retard age of sexual maturity and feed consumption was decreased only during the first 4 weeks after debeaking. The birds debeaked at 8 weeks of age weighed significantly less than the controls through 20 weeks of lay, but birds debeaked at 20 weeks of age showed no significant differences in body weight at any time of measurement.

Bauermann (1959) measured feed wastage and found that prior to debeaking, his birds wasted 5 to 25 percent of the feed. After debeaking, only 0.5 to 2.0 percent of the feed was wasted. Non-debeaked controls were not used for comparison, however. In a later trial with controls, the non-debeaked birds wasted five times as much feed as did the debeaked birds. Noles et al., (1962) found that feed efficiency was highly significantly improved by debeaking 1/2 of both mandibles. However, in a preceding experiment, the controls had highly significantly better feed conversion. A Texas commercial producer (Sink, 1964) reported that severe debeaking reduced feed consumption "too far". After debeaking within 1/8-inch of the nostril, feed consumption did not increase beyond 18 pounds per 100 birds per day by 32 weeks of age.

Cage population size

The severity of debeaking is usually increased as the number of birds per cage is increased and as problems with cannibalism increase. It would appear, therefore, that an adequate study of debeaking should take into consideration possible interactions between level of debeaking and cage population size.

Presently available research evidence which compares the performance of different cage population sizes is fairly inconclusive. Research which has been statistically analyzed is very sparse, but a number of non-statistical reports have been published. Research literature cited herein on cage population size was NOT statistically analyzed unless so stated. The general trend of these reports indicate that, as a rule, a decline in egg production and an increase in mortality occurs as the number of birds per cage is increased.

The difference in egg production between birds in 1-bird and 2-bird cages has usually been reported as negligible (McCluskey, 1962; Anon., 1963b; Johnson and Zindel, 1963; Michalson, 1963; Ostrander, 1963; Bezpa, 1964; Lowe and Heywang, 1964; Quisenberry et al., 1964; Wilson and Harms, 1964). Lowe and Heywang (1964) statistically analyzed egg production data from 1-bird and 2-bird cages and found no statistically significant differences. The differences in egg production between birds in 1-bird and 2-bird cages versus 3-bird cages is a little more clear-cut, but again, statistical differences have not been reported. In most experiments reported, birds in 3-bird cages laid fewer eggs than birds in 1 or 2-bird cages (McCluskey, 1962; Anon., 1963a; Anon., 1963b; Bell, 1963; Michalson, 1963; Quisenberry et al., 1964; Wilson and Harms, 1964). Comparisons between 1-bird and 5-bird cages have also indicated that birds in 1-bird cages lay better (Ostrander, 1963; Lowe and Heywang, 1964; Quisenberry et al., 1964). On the other hand Quisenberry et al., (1964) found that birds in 5-bird cages laid better than did birds in 3-bird cages. Lowe and Heywang (1964) found a significant difference in egg production between birds in 1-bird and 5-bird cages when calculated on a hen-housed basis but not when calculated on a hen-day basis.

The egg production of birds housed in units of 7 to 25 birds per cage has also been reported as being lower than that of birds in 1-bird cages (Shupe and Quisenberry, 1961; Michalson, 1963; Ostrander, 1963; Quisenberry et al., 1964). Shupe and Quisenberry (1961) found that egg production of birds in 1-bird cages was significantly higher than the production of birds in 25-bird cages. Carlson and Strangeland (1960), however, found no consistent differences between the production of birds in 1-bird cages and birds in 18-bird cages.

Statistical analyses of differences in mortality have not, to our knowledge, been reported in the literature. Very little numerical difference in mortality between 1-bird and 2-bird cages has been reported (McCluskey, 1962; Anon., 1963b; Michalson, 1963; Lowe and Heywang, 1964; Quisenberry et al., 1964; Wilson and Harms, 1964). In comparisons of 1-bird and 2-bird cages with 3-bird cages, the results reported in three experiments showed differences of less than two percent (Anon., 1963a; Anon., 1963b; Michalson, 1963); one experimenter simply reported "greater mortality" in 3-bird cages (McCluskey, 1962); and three reports showed a 4 to 7 percent higher mortality in 3-bird cages (Bell, 1963; Quisenberry et al., 1964; Wilson and Harms, 1964). Research comparing 1-bird cages with 5-bird, 10-bird or 25-bird cages showed 8 to 35 percent less mortality in the 1-bird cages (Shupe and Quisenberry, 1961; Ostrander, 1963; Lowe and Heywang, 1964). A six-month progress report by Quisenberry et al., (1964), however, showed only 1.1 percent mortality in 10-bird cages as compared with 0.0 percent mortality in 1-bird cages. Although the overall mortality picture may be somewhat clouded, when vent picking occurs this form of mortality can be directly correlated with the number of birds per cage (Bell, 1963; Lowe and Heywang, 1964).

Comparisons of body weights of birds in 1-, 2-, 3-, 5-, 7-, 10-, and 25-bird cages have not revealed any clear-cut differences (Shupe and Quisenberry, 1961; Lowe and Heywang, 1964; Quisenberry et al., 1964).

Michalson (1963) and Lowe and Heywang (1964) found practically no differences in feed conversion between 1, 2, 3, 5, and 20 birds per cage. Shupe and Quisenberry (1961), however, reported that birds housed in single cages had significantly better feed conversion than did birds in 25-bird cages.

Comparisons of egg weights from birds in 1-, 2-, 3-, 5-, 7-, 10-, and 25-bird cages have not revealed any consistent differences (Shupe and Quisenberry, 1961; Quisenberry et al., 1964).

OBJECTIVES

The objectives of this project were:

1. To determine the effect of severe debeaking on egg production, feed consumption, mortality, body weight, egg weight and beak regrowth of caged laying hens.
2. To determine the presence or absence of interaction between the degree of debeaking and cage population size.
3. To determine the effect of cage population size on egg production, feed consumption, mortality, body weight and egg weight of caged laying hens.

EXPERIMENTAL PROCEDURE

Pullets from a closed population of pure line Single Comb White Leghorns (Michigan State University) were debeaked at 18 weeks of age and randomly placed in 1-bird 8" x 16" cages and 3-bird 12" x 18" cages. Other pullets from the same strain were debeaked at 24 weeks of age and placed in 21-bird 3' x 4' cages. None of the birds had been previously debeaked. Another group of pullets which had been debeaked 1/2 one to five weeks prior to the initiation of this experiment were debeaked again at 25 weeks of age and placed in 2-bird 8" x 16" cages. The "controls" in this case were not debeaked a second time. The number of birds used for each group is presented in Table 1.

Three degrees of debeaking plus a non-debeaked control were used. The three degrees were 1/2, 3/4, and all of the distance between the tip of the beak and the nostrils. The group in which all of the beak in front of the nostrils was removed will be hereinafter referred to as "entire" or "E". Both upper and lower mandibles were removed with one stroke of the electric debeaker, with the throat held back in such a manner as to leave the lower mandible slightly longer than the upper mandible. This method is referred to in the literature as "block debeaking". Photographs of the resultant gradations are presented in Figures 1 through 13.

Understandably, the conditions of the experiment do not permit completely comparable management conditions between the different cage sizes. These conditions are presented in Table 2 so that they may be taken into consideration. A lighting period of 13.5 hours per day was used throughout the experiment. An all-mash feed containing 15 percent protein, 756 calories per pound of productive energy, 2.8 percent calcium and 0.9 percent phosphorus was used. The ration fed is presented in Table 3.

The characteristics measured were egg production, feed consumption, egg weight, body weight, beak length and mortality. Feed consumption was measured weekly from four replicates of each treatment in the 1-bird and 3-bird cages and from each of the four treatments in 21-bird cages through the first 20 weeks of lay. From the twentieth week of lay until the end of the experiment, feed consumption was measured in 28-day periods. All eggs were collected for five continuous days at the end of each 28-day period and weighed to the nearest gram. Eggs were stored from two to five days at 60° F. before weighing. All eggs collected on any one date were stored for the same length of time. Body weights and beak length were measured at the end of each 28-day period, beginning 6 weeks after debeaking. The 28-day periods were based both on age of birds and weeks after debeaking in order to compare measurements between the different cage sizes. All measurements were continued until the birds were 500 days of age.

All birds that died before 25 weeks of age were removed from computation. In addition, one bird that exhibited male characteristics and failed to lay any eggs during the experiment was removed from the computation of egg production, body weight and beak length. This bird still consumed feed, however, so it could not be removed from the computation of feed consumption. There was no predominance of any treatment group among the birds thus removed.

Statistical analyses were based on several forms of analysis of variance (Guenther, 1964). In analyzing egg production, feed consumption and feed efficiency, averages for each treatment were used as a single observation and the pooled variance (S^2) of all individual observation was used as error mean square in a two-way analysis of variance[1]. Days to first egg, changes in beak length, and changes in body weight were analyzed by the one-way analysis of variance.

Egg weight, body weight, and beak length would normally be expected to be affected by the age of the bird, so a three-way analysis of variance in which time was used as the third variable was used to analyze these factors. All significant differences demonstrated by analysis of variance were further tested by use of Tukey's method for multiple comparisons (Guenther, 1964).

[1]Dr. Stapleton, Statistics Department, Michigan State University.

RESULTS AND DISCUSSION

The two birds per cage group did not have a comparable non-debeaked control and consequently, the data for this group are reported separately from the data for the other groups.

A. Egg Production: Egg production figures are presented in Tables 4, 5, and 6 and Graphs 1 and 2. An analysis of variance showed that significant interactions between degree of debeaking and cage population size did not occur, and therefore, all data except that for the 2-bird cages were combined. Consistent differences in egg production between treatments during the first 20 weeks of lay were noticeable (Graph 1), but significant differences were found only in comparisons between entirely debeaked birds and the other three treatments. These differences were all highly significant ($P < 0.01$). While the differences appeared to be smaller through the rest of the experiment (Graph 1), the differences between the entirely debeaked birds and the other treatments were highly significant ($P < 0.01$) over the entire experimental period from 25 weeks of age to 500 days of age. The results observed for the birds in 2-bird cages followed the same trend, but the only significant difference ($P < 0.05$) found in this group was between the "controls" (debeaked prior to this experiment) and entirely debeaked birds. The lack of significance in comparisons of egg production between the controls, 1/2 and 3/4 debeaked birds in all cage sizes in this experiment are in agreement with the findings previously reported in the literature (Morgan, 1957; Bray et al., 1960; Noles et al., 1962; Slinger and Pepper, 1964).

A significant difference ($P < 0.05$) in egg production was found

between birds in 1-bird cages and birds in 3-bird cages during the first 20 weeks of lay. The differences between birds in 3-bird cages and birds in the other two cage sizes were not significant. The differences in egg production were increased with time, however, and the difference between egg production in 1-bird cages and 21-bird cages was highly significant ($P < 0.01$) for the entire experimental period. Egg production over this period was also significantly different ($P < 0.05$) between 1-bird and 3-bird cages. The highly significant difference in egg production observed between birds in 1-bird cages and birds in 21-bird cages is in accord with the results previously reported by Shupe and Quisenberry (1961).

B. <u>Days to First Egg</u>: The number of days from hatching to the first egg laid in a regular production cycle are presented in Table 7. Unfortunately, initial egg records are available only for the birds in 1-bird cages. Consequently, comparisons between cage population size and age at sexual maturity could not be made. The birds debeaked 3/4 took slightly longer (13 days) than the controls in coming into production, but this difference was not significant. The birds that were entirely debeaked, however, were highly significantly longer ($P < 0.01$) in coming into lay than birds in any of the other three treatments. Slinger and Pepper (1964) found that sexual maturity was significantly delayed when birds were debeaked 2/3 at 8 weeks of age, but no significant difference was observed when birds were debeaked 2/3 at 20 weeks of age.

C. <u>Feed Consumption</u>: The pertinent data on feed consumption are reported in Tables 8 and 9 and Graphs 3, 4 and 5. No significant

interaction was found, so the various treatments were combined for analysis. For the first 20 weeks of lay feed consumption differences were all highly significant ($P < 0.01$). Feed consumption decreased as degree of debeaking increased in severity and feed consumption decreased as cage population size increased. Feed consumption over the entire experiment, however, was more variable, although the same trend was still evident. Differences in feed consumption between the controls and birds debeaked 3/4 or entire were still highly significant ($P < 0.01$) for the test period, but birds debeaked 1/2 were not significantly different from the controls or birds debeaked 3/4. Differences in feed consumption were significant ($P < 0.05$) between entirely debeaked birds and birds debeaked 3/4, and highly significant ($P < 0.01$) between entirely debeaked birds and birds debeaked 1/2. These results are somewhat at variance with results reported in the literature. Slinger and Pepper (1964) found no significant differences in feed consumption between controls and birds debeaked 2/3 over the first 20 weeks of lay when the birds were debeaked at 20 weeks of age. However, feed consumption differences were significant when the birds were debeaked at 8 weeks of age.

The differences in feed consumption for the entire experiment between the different cage population size groups were highly significant ($P < 0.01$).

D. Feed Efficiency: Feed efficiency figures are presented in Tables 10 and 11. Analysis of variance revealed that a highly significant ($P < 0.01$) interaction in feed efficiency occurred between degree of debeaking and cage population size. Consequently, each treatment was treated separately. With 66 possible combinations of comparisons, complete understanding of the results is difficult. In the first 20 weeks of egg production, most differences were highly significant ($P < 0.01$). The birds subjected to entire debeaking required highly significantly ($P < 0.01$) more feed to produce a dozen eggs than birds in any of the other treatments. Eleven of the 17 non-significant differences observed were between 1/2 and 3/4 debeaked groups.

Overall feed efficiency to 500 days of age, however, shows few significant differences. Three treatments (1-bird entire, 21-bird entire, and 21-bird 3/4) accounted for all highly significant ($P < 0.01$) differences. Twenty-one-bird 3/4 was highly significantly different ($P < 0.01$) from all other treatments except 1-bird 1/2, 21-bird 1/2, and 3-bird 3/4. Twenty-one-bird 3/4 was significantly ($P < 0.05$) different from 1-bird 1/2 and 21-bird 1/2. One-bird E and 21-bird E were highly significantly different ($P < 0.01$) from all but one (3-bird 1/2) of the 1/2 and 3/4 treatments. Twenty-one-bird entire was significantly different ($P < 0.05$) from 3-bird 1/2. The 3-bird control treatment was significantly different ($P < 0.05$) from 21-bird 3/4 and 3-bird 3/4. All other differences in feed efficiency to 500 days of age were non-significant. These data must be viewed in the light of the findings of Noles et al., (1962) that a highly significant difference in feed efficiency can be completely reversed in a subsequent experiment.

E. Feed Wastage: Feed wastage was measured for one week among one-fourth of the birds in 3-bird batteries. The results are reported in Table 12. Attempts at measuring feed wastage were discontinued because of problems in feeding and egg collection. The reliability of these data

is unknown, since statistical analysis was not possible. The magnitude of the differences reported here is much less than that reported by Bauermann (1959).

F. Body Weight: The pertinent data on body weight are presented in Tables 13, 14 and 15 and Graphs 6, 7, 8 and 9. The well-known effect of age on body weight prevented direct comparisons between body weights of birds in all treatments, since debeaking and housing was performed at different dates for the different cage groups. However, the birds in the 1-bird and 3-bird cages were debeaked and housed at the same age, so valid comparisons could be made between the two. The difference in body weight gains between birds in 1-bird and 3-bird cages was highly significant ($P < 0.01$) for the first 6 weeks after debeaking. During the following 8 weeks, however, no significant differences in body weight were observed. The net change in body weight over the entire 50-week period was not significantly different between the birds in 1-bird and 3-bird cages.

In comparing debeaking treatments in 1-bird and 3-bird cages, the body weight gains of the controls, 1/2 and 3/4 treatments were highly significantly greater ($P < 0.01$) than that of the birds in the entirely debeaked treatments during the first 6 weeks following debeaking. The controls made significantly higher gains than the birds debeaked 1/2 ($P < 0.05$) and 3/4 ($P < 0.01$). Significant differences in body weight gain during the first 6 weeks after debeaking were not found between birds debeaked 1/2 and 3/4. Body weight gains over the following 8 weeks were not found to be significantly different between any of the debeaking treatments. The net change in body weight over the entire

50-week period was significantly different between treatments at the same significance levels as at 6 weeks after debeaking.

In the 2-bird cages the same results were found -- the "controls" weighed highly significantly more ($P < 0.01$) than the birds in the other treatments, and the entirely-debeaked birds weighed highly significantly less ($P < 0.01$). The birds debeaked 1/2 and 3/4 were not significantly different from each other in body weight.

The relationship of body weight to severity of debeaking in 21-bird cages, however, was quite different from the relationship found in the other cage sizes. In 21-bird cages the birds debeaked 1/2 and 3/4 attained the highest average body weights. The differences between these two treatments and the controls and entirely debeaked birds were highly significant ($P < 0.01$). The average body weights of the birds debeaked 1/2 and 3/4 were not significantly different from each other. The controls weighed significantly ($P < 0.05$) more than the entirely debeaked birds. It is possible that the lower body weight of the controls reflected a greater incidence of feather picking among this group. However, this would not explain why the debeaked birds in 21-bird cages would gain more than debeaked birds in other cage population sizes.

Previous research, although sparse, supports the present findings. Studies of birds in floor pens (Bray and Ridlen, 1960; Slinger and Pepper, 1964) showed that debeaking 1/2 significantly reduced body weight. Comparisons of body weights between cage population sizes have not revealed any significant differences (Shupe and Quisenberry, 1961; Lowe and Heywang, 1964; Quisenberry _et al._, 1964).

G. _Beak Length:_ Beak length data are reported in Tables 16 and 17 and graph 10. Photographs of beaks at different ages are presented in

Figures 1 through 13. Initial beak length was measured only on birds in 1-bird cages, so analysis is restricted primarily to this group. Beak length was measured to the nearest millimeter with calipers. An increase in beak length appeared to occur in all debeaked treatments until 14-18 weeks after debeaking (Graph 10). Statistical analysis, however, did not reveal any significant differences between the beak growth of the controls, 1/2 and 3/4 debeaked birds for the first 18 weeks following debeaking. The difference in beak growth rate between controls and entirely debeaked birds for this period, however, was highly significant ($P < 0.01$). Eighteen weeks after debeaking, the length of the beaks of the entirely debeaked birds was no longer significantly different from that of the birds debeaked 3/4. Visual observations, however, showed the presence of the usual horny covering on the beaks of birds debeaked 3/4, while the beaks of the entirely debeaked treatment had a leathery covering (see Figures 1 - 13). Changes in beak length in the debeaked treatments from 18 weeks after debeaking to the end of the experiment were not significantly different from the controls.

It is interesting to note that the beaks of the 2-birds per cage "controls" grew back to where they were not significantly different from the beak lengths of non-debeaked controls in the other treatments. This would tend to indicate that complete beak regrowth occurs when less than 1/2 of the beak is removed. However, records were not available on the exact level of debeaking initially performed on the "controls" in 2-bird cages.

The degree of beak regrowth was comparable in most of the cage population size groups. Some differences were noted, however. Highly significant differences ($P < 0.01$) occurred between the birds debeaked 1/2 in 1-bird, 3-bird and 21-bird cages. The entirely debeaked birds in 21-bird cages finished the experiment with highly significantly shorter ($P < 0.01$) beaks than birds in the other entirely debeaked treatments. The possibility exists that these differences existed at the time of debeaking. The magnitude of difference between the different levels of debeaking, however, is such that these differences would not appear to seriously affect interpretations of results.

H. Egg Weight: Average egg weights for the experiment are reported in Table 18. Differences in egg weights between debeaking treatments were not significant. Differences in egg weight between 1-bird, 3-bird and 21-bird cages were not significant. Egg weights from 2-bird cages were significantly higher ($P < 0.05$) than some, but not all, of the other treatments.

I. Mortality: Mortality data are reported in Tables 19 and 20. A total of ten blow-outs and pick-outs occurred among the 98 deaths. Four of these occurred in 2-bird cages, five occurred in 3-bird cages, and one occurred in the 21-bird cages. Three blow-outs occurred in controls, five in birds debeaked 1/2, one in a bird debeaked 3/4, and one in an entirely debeaked bird.

SUMMARY AND CONCLUSIONS

The results of this experiment clearly demonstrate that there is a practical limit to the severity of debeaking that should be used in commercial caged layer operations. Block debeaking just in front of the nostrils caused highly significant changes in production characteristics: age to sexual maturity was prolonged, egg production was decreased, feed consumption was decreased, feed efficiency was poorer, and body weight gains were smaller.

Intermediate degrees of debeaking did not cause any significant loss in egg production. Debeaking 3/4 produced a significant drop in feed consumption, and the drop in feed consumption from debeaking 1/2 approached significance. A corollary improvement in feed efficiency, however, was obscured by interactions with cage population size. Debeaking both 1/2 and 3/4 produced significantly smaller body weight gains than in the controls.

The results of this experiment tend to indicate that debeaking 1/2 to 3/4 at 18 weeks of age is a normally safe practice without adverse effects on egg production. Indeed, the savings in feed consumption may make it desirable to debeak even where cannibalism is not a problem. However, it is possible that the lowered feed consumption might mean that debeaked birds would be more susceptible to stresses that increase the feed requirement. The present data indicate that debeaking beyond 3/4 should be avoided.

The reasons why changes in production characteristics result from debeaking have not been established. It is popularly assumed that de-

beaking reduces the ability to waste feed, thus reducing feed consumption. However, a reduction in feed wastage would be expected to result in an improvement in feed efficiency. This did not occur in the entirely debeaked birds used in this experiment. A brief attempt at measuring feed wastage during this experiment failed to show any great differences in relative feed wastage. The sharp drop in feed consumption below physiological needs immediately after debeaking would tend to indicate a loss of desire or ability to eat rather than a loss of ability to waste feed. The beak is plentifully supplied with nerves, so it should not seem overly speculative to postulate that severing the beak would affect the sensitivity of the beak. It is interesting to note that many birds reacted to the placing of the calipers on the beak when taking beak measurements. Even controls often reacted to the placing of the caliper point at or near the nostril. A response could always be elicited by scraping a fingernail over the beak.

If debeaking made the beak over-sensitive, the birds would have an incentive to eat less feed. The reduction in feed consumption alone could be used to explain most of the other results obtained. The moderate reduction in feed consumption in birds debeaked 1/2 and 3/4 was not severe enough to affect egg production but was reflected in lower body weight gains. The feed consumption in entirely debeaked birds, however, was reduced below physiological needs for normal egg production.

Other reasons for the results obtained are certainly possible. Further research must be conducted before a physiological basis for the results observed in this experiment can be established.

The data on beak regrowth help clarify one of the reasons commonly

given for the use of severe levels of debeaking. It is claimed that beaks of lightly debeaked birds grow back to their former size. In this experiment, however, regrowth was limited. What actually happened was that the beaks tended to resume their former shape even though they were not quite as long. The results from the 2-bird "controls" indicated that complete regrowth can occur when lighter debeaking is practiced.

Statistical interaction between levels of debeaking and cage population size was found only in measurements of feed efficiency, beak length, body weight and egg weight. If more cannibalism had occurred, more interaction would probably have occurred.

Significant differences in egg production and feed consumption were found between the different cage population sizes. The birds in 1-bird cages laid significantly better and ate significantly more feed than birds in 3-bird and 21-bird cages. Social interaction between birds probably caused some of the difference, but how much is unknown. Recommendations for optimum cage population size cannot be based entirely on these results since economic factors must also be taken into consideration.

Table 1. Experimental design. Upper figure is number of cages; lower figure is number of birds

	Control	1/2	3/4	Entire
1-bird	24/24	24/24	24/24	24/24
2-bird	18/36	18/36	18/36	18/36
3-bird	12/36	12/36	12/36	12/36
21-bird	1/21	1/21	1/21	1/21

Table 2. Functional housing conditions

	Feeder space lin. in./bird	Waterer space lin. in./bird	Floor space sq. ft./bird	Cubic ft./bird
1-bird	8.0	8.0	0.90	1.26
2-bird	4.0	4.0	0.45	0.63
3-bird	4.0	4.0	0.50	0.70
21-bird	2.3	2.3	0.58	0.99

Table 3. Composition of diet

Ingredients		Percent
Ground yellow corn		34.5
Ground oats		20.0
Wheat bran		15.0
Flour middlings		10.0
Alfalfa meal (17% dehyd.)		3.0
Dried skim milk		2.0
White fish meal		2.5
Meat scraps		3.0
Soybean oil meal (44% prot.)		2.5
Ground oyster shell flour		5.0
Steamed bone meal		1.5
Salt		0.6
Fish oil (400D, 2000A)		0.4
	Total	100.0

Table 4. Egg production -- 20 weeks of lay (25 to 44 weeks of age)

A. Average total production:

	C [1]	1/2	3/4	E [2]	Average
1-bird	88	87	71	38	71
3-bird	79	71	71	44	66
21-bird	71	67	63	40	60
Average	79	75	68	41	

Debeaking L.S.D. .05 = 12.7 | Cages L.S.D. .05 = 9.9
.01 = 17.3 | .01 = 13.6

B. Percent production (hen-housed)

	C	1/2	3/4	E
1-bird	63.1	62.3	50.5	29.5
3-bird	56.6	50.6	51.0	31.2
21-bird	50.3	48.0	45.2	28.6

C. Percent production (hen-day)

	C	1/2	3/4	E
1-bird	63.1	62.3	52.0	30.5
3-bird	58.3	52.2	52.0	32.1
21-bird	50.3	49.5	45.6	28.6

[1] C = control

[2] E = entire

Table 5. Total egg production (25 weeks to 500 days of age)

A. Average total production:

	C [1]	1/2	3/4	E [2]	Average
1-bird	218	213	181	135	187
3-bird	174	169	172	137	163
21-bird	171	156	165	108	150
Average	188	179	173	127	

Debeaking L.S.D. .05 = 27.7; .01 = 37.3   Cages L.S.D. .05 = 21.4; .01 = 29.4

B. Percent production (hen-housed)

	C	1/2	3/4	E
1-bird	67.0	65.6	55.7	45.3
3-bird	53.5	51.9	52.8	42.1
21-bird	52.6	48.1	50.7	33.3

C. Percent production (hen-day)

	C	1/2	3/4	E
1-bird	67.6	66.4	58.7	47.4
3-bird	57.7	56.3	57.4	46.0
21-bird	53.8	50.4	53.5	33.9

[1] C = control

[2] E = entire

Table 6. Egg production, 2-bird cages (25 weeks to 500 days of age)

	C /1	1/2	3/4	E /2
Total average production	132	126	112	88
Percent production/ hen-housed	28.3	24.7	20.2	16.4
Percent production/ hen-day	46.2	42.6	39.0	31.6

/1 C = debeaked control

/2 E = entire

Table 7. Days to first egg (1-bird cages)

Control	178	L.S.D.	.05 = 27.8 .01 = 35.7
1/2	178		
3/4	191		
Entire	234		

Table 8. Feed consumption (lbs./bird/day) 25 to 44 weeks of age

	C /1	1/2	3/4	E /2	Average
1-bird	.329	.289	.248	.244	.278
3-bird	.299	.269	.251	.223	.261
21-bird	.289	.260	.226	.207	.246
Average	.306	.273	.242	.225	

Debeaking L.S.D. .05 = .014, .01 = .017 Cages L.S.D. .05 = .011, .01 = .014

Table 9. Feed consumption (lbs./bird/day) 25 weeks to 500 days of age

	C /1	1/2	3/4	E /2	Average
1-bird	.329	.307	.283	.259	.293
3-bird	.302	.279	.259	.235	.269
21-bird	.255	.234	.214	.187	.223
Average	.293	.273	.252	.227	

Debeaking L.S.D. .05 = .023, .01 = .028 Cages L.S.D. .05 = .019, .01 = .023

/1 C = control

/2 E = entire

Table 12. Feed wastage (3-bird cages, 44 weeks of age)

Treatment	Total feed (lbs/bird/day)	Wasted feed (lbs/bird/day)	Percent wasted
Control	.357	.033	8.9
1/2	.270	.025	9.2
3/4	.254	.018	7.1
Entire	.259	.019	7.3

Table 13. Body weight gains (lbs.)

	C [1]	1/2	3/4	E [2]
A. 0 - 6 weeks after debeaking:				
1-bird	0.74	0.50	0.45	0.23
3-bird	0.91	0.82	0.69	0.47
B. 6 - 14 weeks after debeaking:				
1-bird	0.27	0.32	0.32	0.19
3-bird	0.22	0.22	0.27	0.32
C. 14 - 26 weeks after debeaking:				
1-bird	0.50	0.65	0.63	0.75
3-bird	0.29	0.41	0.46	0.54
D. 0 - 50 weeks after debeaking:				
1-bird	0.62	0.40	1.24	0.55
3-bird	1.47	1.17	1.11	0.85

[1] C = control

[2] E = entire

Table 14. Body weight averages (lbs.)

	C [1]	1/2	3/4	E [2]
A. At time of debeaking:				
1-bird	3.0	3.0	2.9	2.9
3-bird	2.9	2.9	2.9	2.8
21-bird	3.6	3.5	3.6	3.5
B. At 25 weeks of age:				
1-bird	3.7	3.5	3.3	3.1
3-bird	3.8	3.6	3.6	3.3
21-bird	3.6	3.6	3.6	3.5
C. At 44 weeks of age:				
1-bird	4.5	4.4	4.3	4.0
3-bird	4.3	4.3	4.3	4.1
21-bird	4.1	4.3	4.5	4.0
D. At 500 days of age:				
1-bird	4.5	4.5	4.1	3.7
3-bird	4.3	4.2	4.0	3.7
21-bird	4.5	4.7	4.9	4.2

[1] C = control

[2] E = entire

Table 13. Body weight gains (lbs.)

	C [1]	1/2	3/4	E [2]
A. 0 - 6 weeks after debeaking:				
1-bird	0.74	0.50	0.45	0.23
3-bird	0.91	0.82	0.69	0.47
B. 6 - 14 weeks after debeaking:				
1-bird	0.27	0.32	0.32	0.19
3-bird	0.22	0.22	0.27	0.32
C. 14 - 26 weeks after debeaking:				
1-bird	0.50	0.65	0.63	0.75
3-bird	0.29	0.41	0.46	0.54
D. 0 - 50 weeks after debeaking:				
1-bird	0.62	0.40	1.24	0.55
3-bird	1.47	1.17	1.11	0.85

[1] C = control

[2] E = entire

Table 14. Body weight averages (lbs.)

	C [1]	1/2	3/4	E [2]
A. At time of debeaking:				
1-bird	3.0	3.0	2.9	2.9
3-bird	2.9	2.9	2.9	2.8
21-bird	3.6	3.5	3.6	3.5
B. At 25 weeks of age:				
1-bird	3.7	3.5	3.3	3.1
3-bird	3.8	3.6	3.6	3.3
21-bird	3.6	3.6	3.6	3.5
C. At 44 weeks of age:				
1-bird	4.5	4.4	4.3	4.0
3-bird	4.3	4.3	4.3	4.1
21-bird	4.1	4.3	4.5	4.0
D. At 500 days of age:				
1-bird	4.5	4.5	4.1	3.7
3-bird	4.3	4.2	4.0	3.7
21-bird	4.5	4.7	4.9	4.2

[1] C = control

[2] E = entire

Table 15. Body weight averages, 2-bird cages (lbs.)

	C [1]	1/2	3/4	E [2]
At time of debeaking:	3.5	3.4	3.5	3.5
At 44 weeks of age:	4.1	3.9	3.9	3.8
At 500 days of age:	4.6	4.4	4.5	4.1

[1] C = debeaked control

[2] E = entire

Table 16. Beak length (cm.) 1-bird cages

		Weeks after debeaking						
	Before	0	10	18	26	34	42	50
Control	1.8	1.8	1.8	1.9	1.8	1.9	2.0	1.8
1/2	1.8	0.7	0.9	1.1	1.1	1.0	1.1	1.0
3/4	1.8	0.4	0.6	0.6	0.6	0.6	0.7	0.5
Entire	1.8	0.0	0.4	0.5	0.5	0.5	0.5	0.5

Table 17. Beak length (cm.) 1-bird, 3-bird and 21-bird cages

	C /1	1/2	3/4	E /2
A. 10 weeks after debeaking:				
1-bird	1.8	0.9	0.6	0.4
3-bird	1.8	0.9	0.5	0.5
21-bird	1.8	1.2	0.5	0.3
B. 18 weeks after debeaking:				
1-bird	1.9	1.1	0.6	0.5
3-bird	1.9	1.2	0.7	0.6
21-bird	1.8	1.4	0.7	0.4
C. 50 weeks after debeaking:				
1-bird	1.8	1.0	0.5	0.5
3-bird	1.8	1.2	0.5	0.5
21-bird	1.9	1.5	0.6	0.3

/1 C = control

/2 E = entire

Table 18. Average egg weight (gms) 25 weeks to 500 days of age

	C [1]	1/2	3/4	E [2]
1-bird	54	53	55	56
2-bird	57	60	59	56
3-bird	54	55	54	55
21-bird	53	54	55	54

[1] C = control

[2] E = entire

Table 19. Mortality (%) 25 weeks to 44 weeks of age

	C [1]	1/2	3/4	E [2]
1-bird	0.0	4.4	8.3	13.6
2-bird	16.7	11.1	8.3	16.7
3-bird	5.6	8.6	2.8	8.3
21-bird	0.0	4.8	4.8	0.0

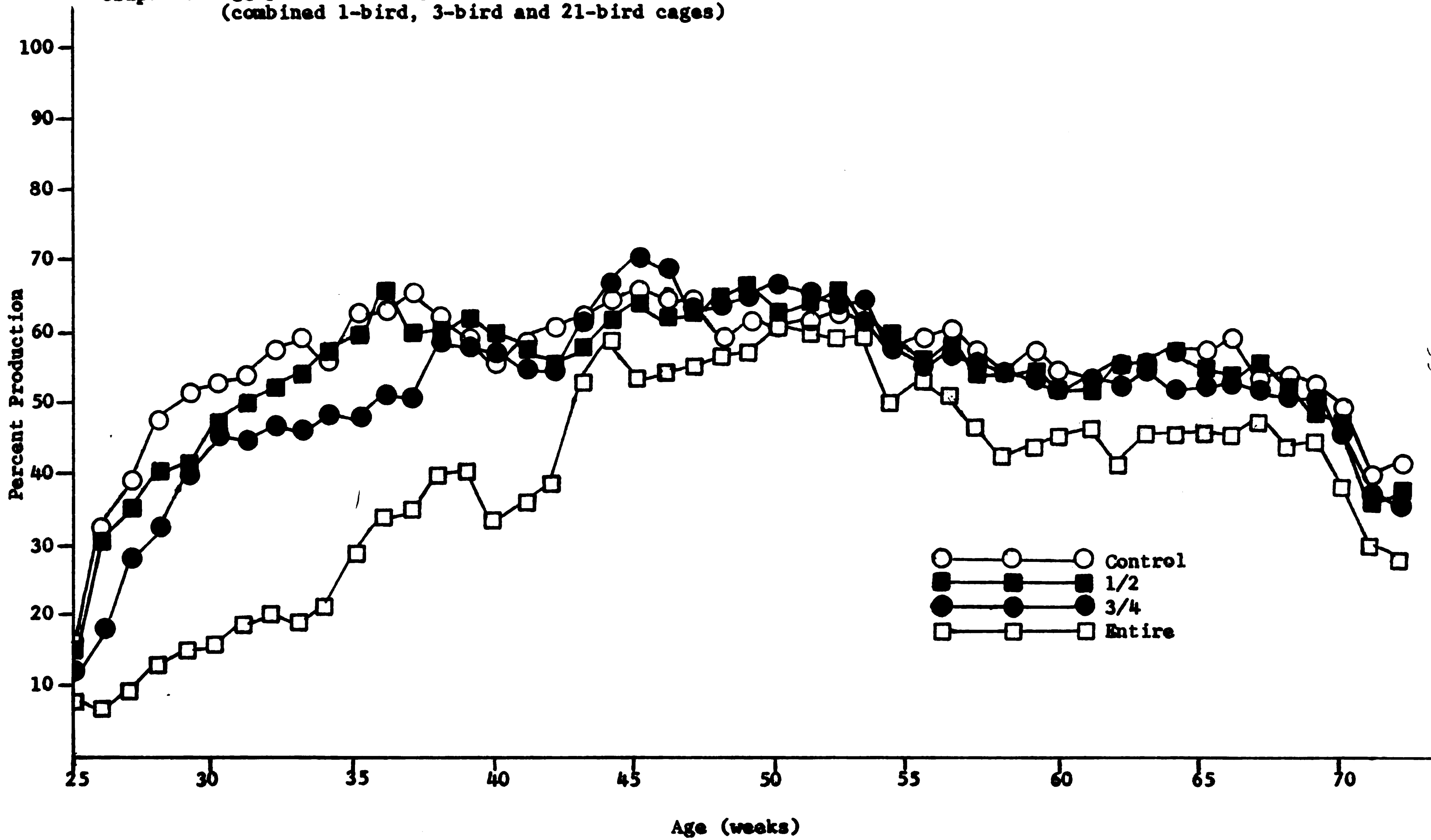
Table 20. Mortality (%) 25 weeks to 500 days of age

	C [1]	1/2	3/4	E [2]
1-bird	8.3	8.3	12.5	16.6
2-bird	33.3	30.6	27.8	27.8
3-bird	13.9	25.0	25.0	27.8
21-bird	9.5	19.0	19.0	9.5

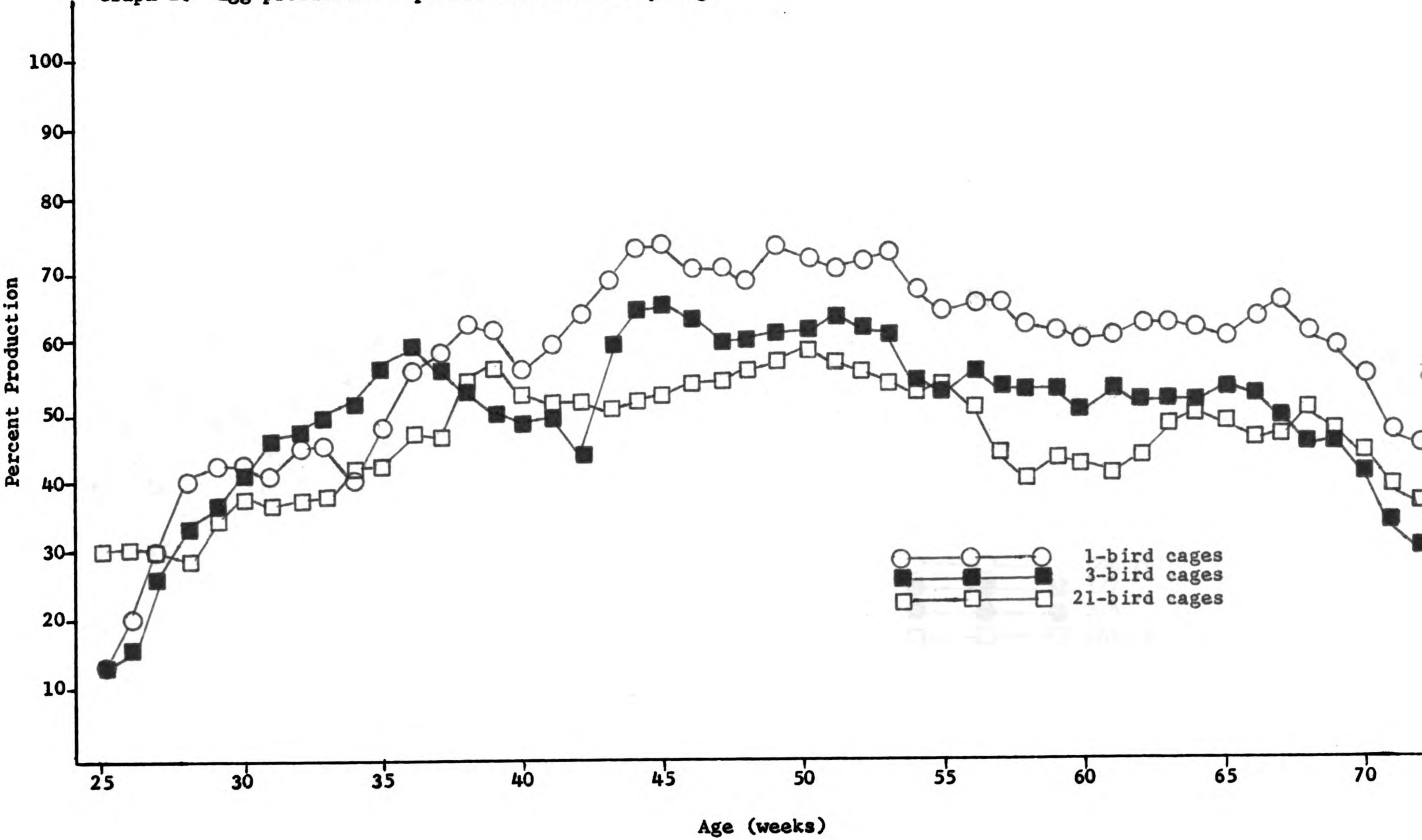
[1] C = control

[2] E = entire

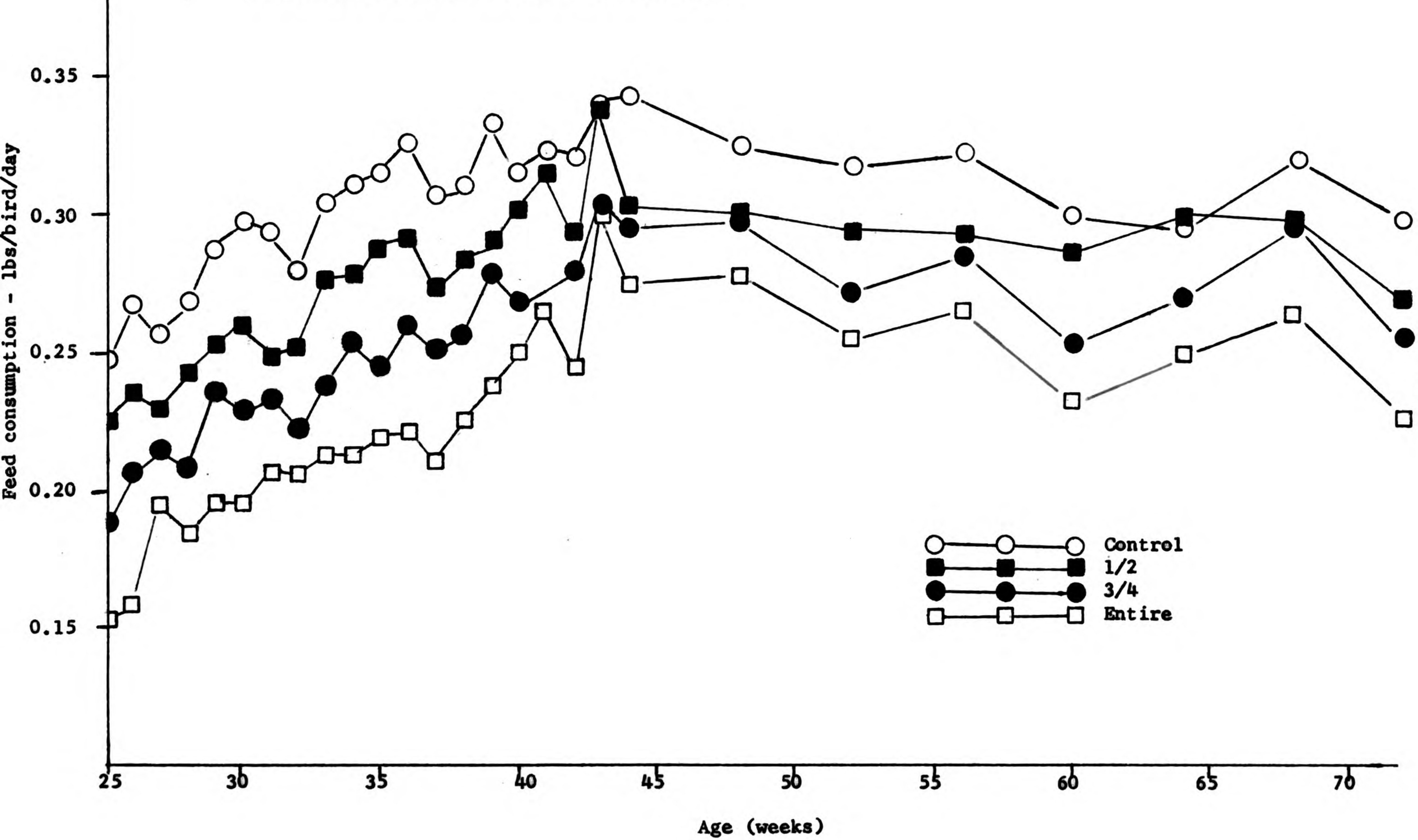
Graph 1. Egg production - percent hen-housed
(combined 1-bird, 3-bird and 21-bird cages)



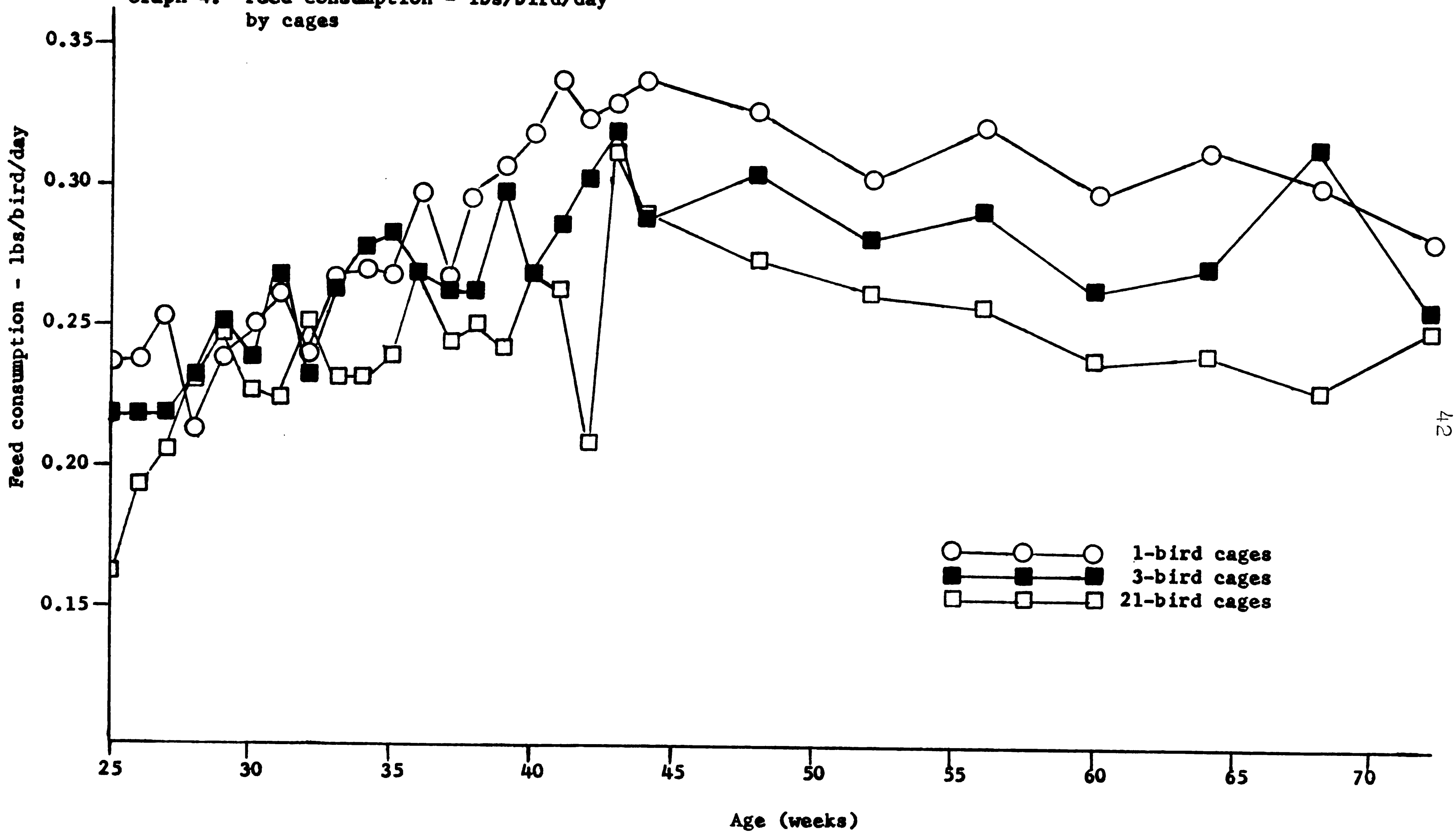
Graph 2. Egg production - percent hen-housed by cages



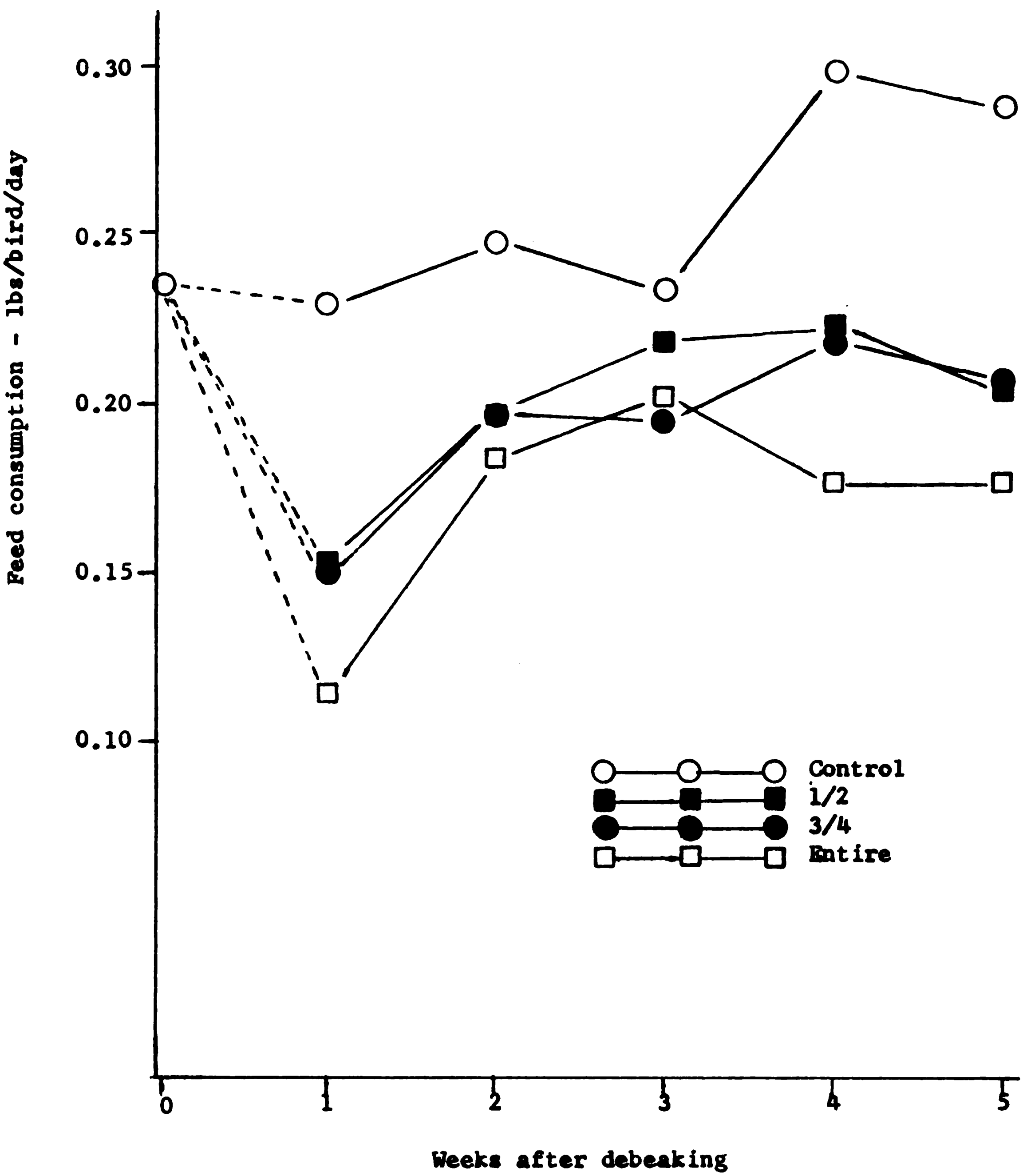
Graph 3. Feed consumption - lbs/bird/day
(combined 1-bird, 3-bird and 21-bird cages)



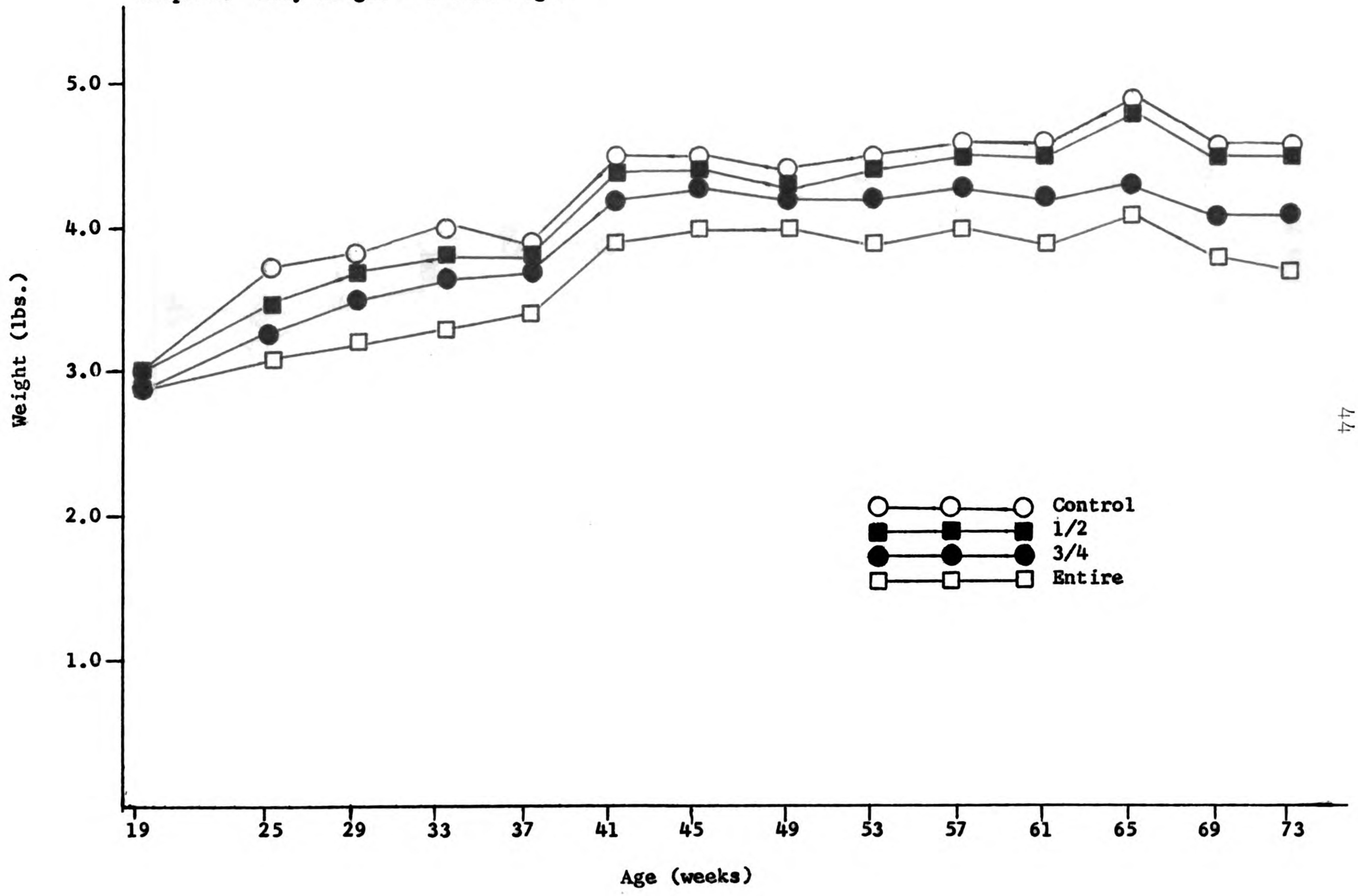
Graph 4. Feed consumption - lbs/bird/day by cages



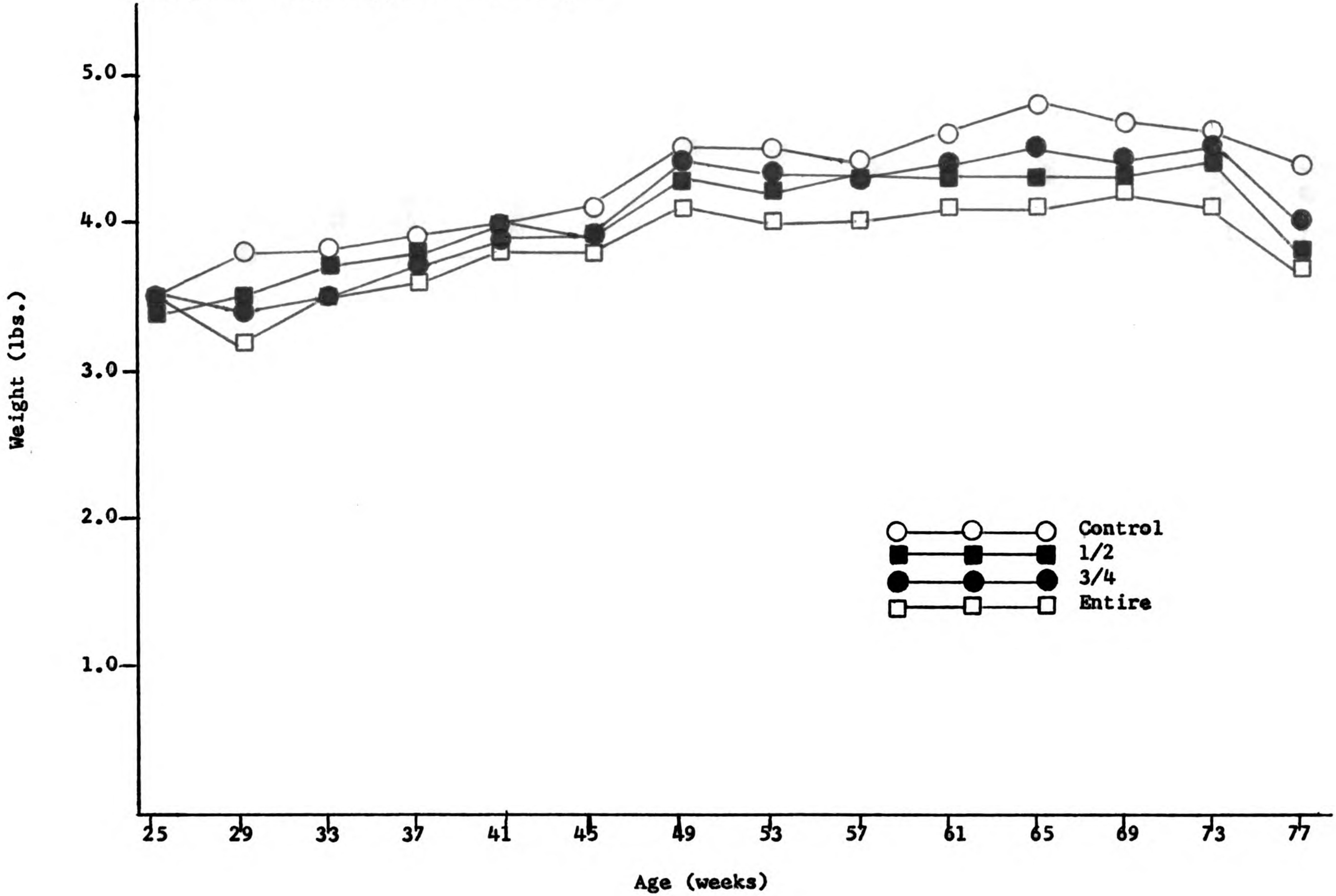
Graph 5. Feed consumption - immediate effects of debeaking in 1-bird cages (initial consumption extrapolated as average of first 3 weeks' consumption by controls)



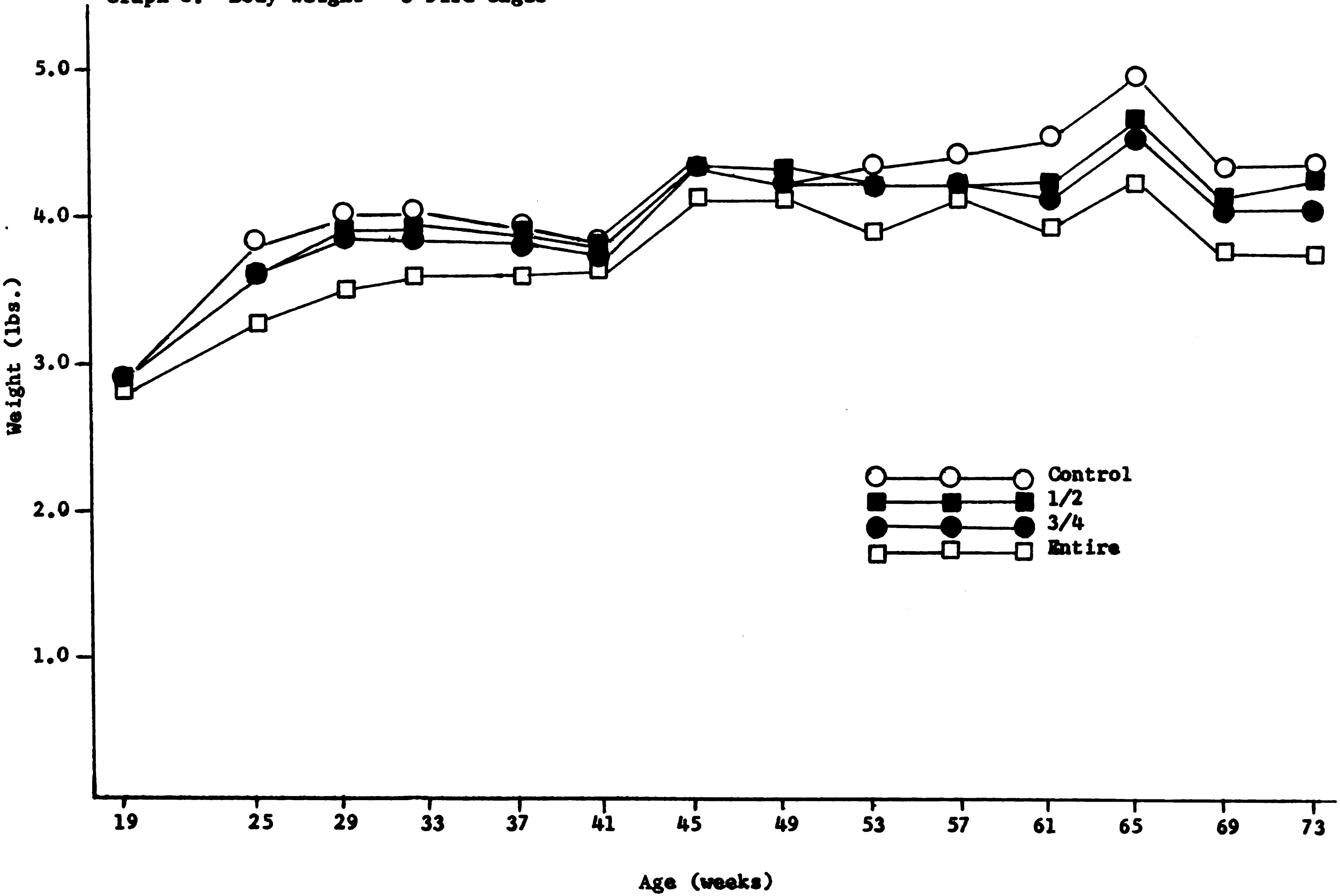
Graph 6. Body weight - 1-bird cages



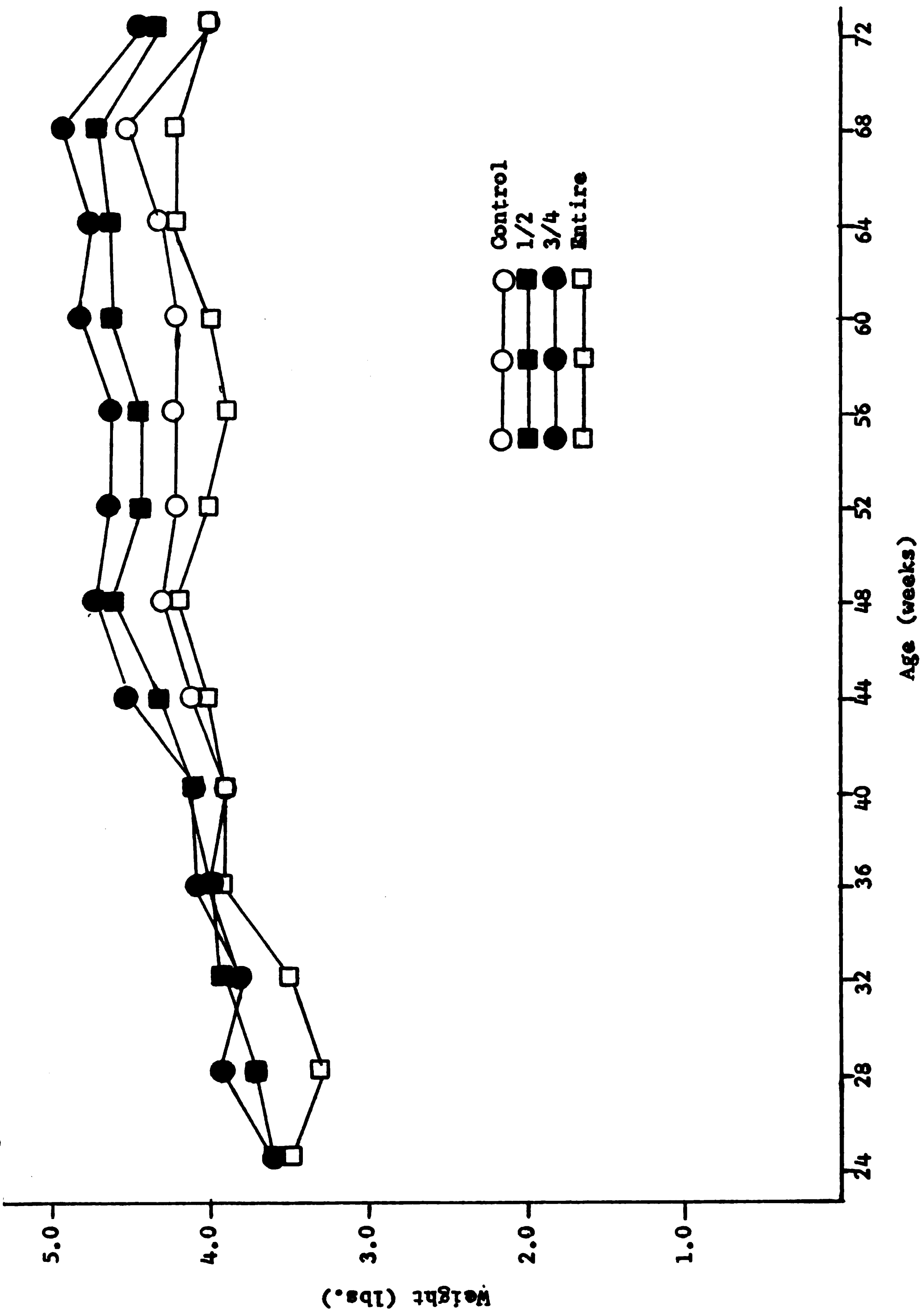
Graph 7. Body weight - 2-bird cages



Graph 8. Body weight - 3-bird cages



Graph 9. Body weight - 21-bird cages



Graph 10. Beak lengths, 1-bird cages

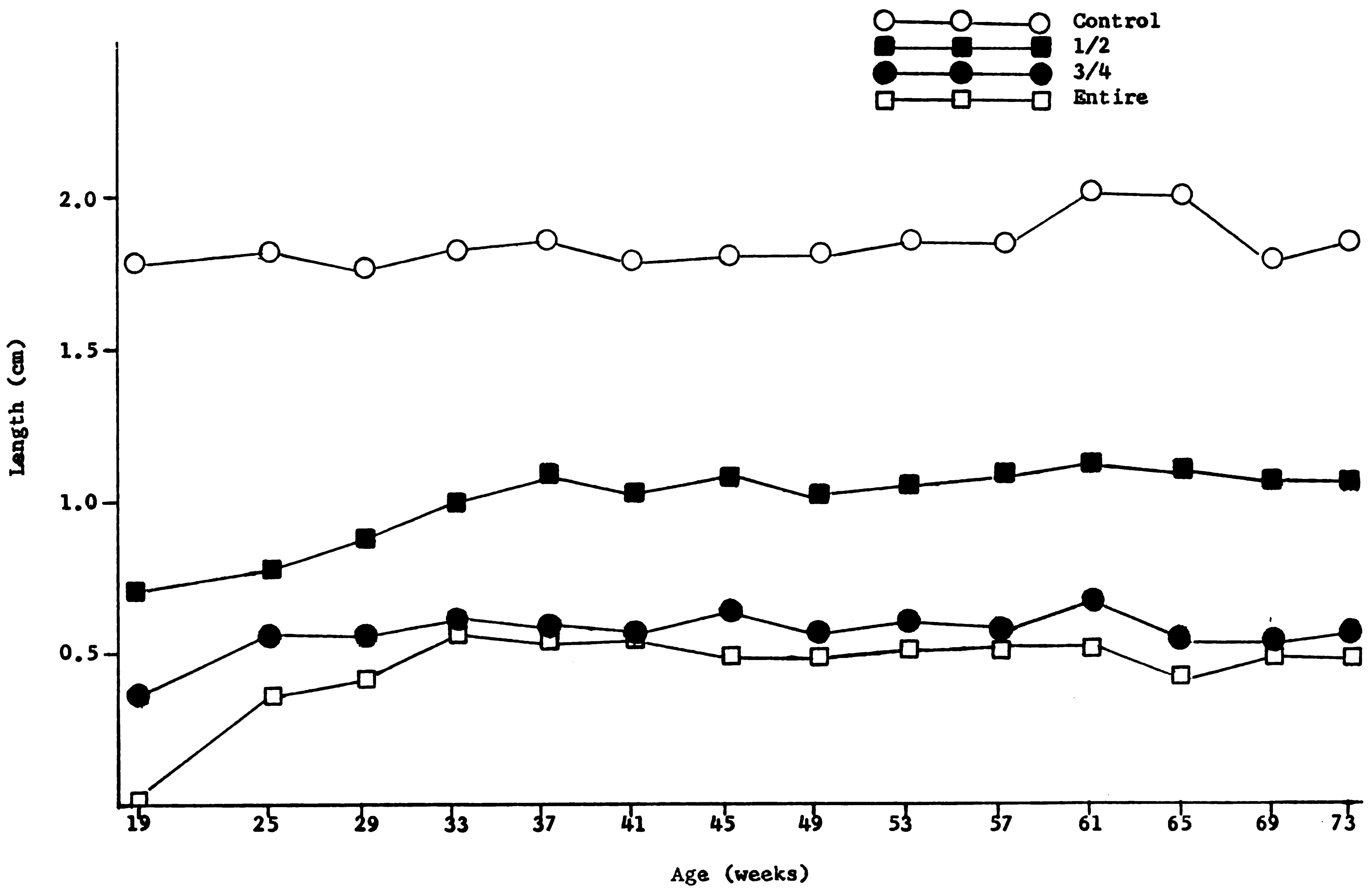


Plate I. Six weeks after debeaking

Figure 1. Control

Figure 2. Debeaked 1/2

Figure 3. Debeaked 3/4

Figure 4. Entirely debeaked

Plate II. Twenty weeks after debeaking

Figure 5. Control

Figure 6. Debeaked 1/2

Figure 7. Debeaked 3/4

Figure 8. Entirely debeaked

Figure 9. Entirely debeaked, showing variation

Plate III. Five hundred days of age

Figure 10. Control

Figure 11. Debeaked 1/2

Figure 12. Debeaked 3/4

Figure 13. Entirely debeaked

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