AGGRESSIVE BEHAVIOR OF CHICKENS: SOME EFFECTS OF SOCIAL AND PHYSICAL ENVIRONMENTS*

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Poultry management experts think in terms of tens or hundreds of thousands of birds. They usually prefer systems which require a skilled mechanic as much as a poultry caretaker. As a result, chickens are often seen as some sort of odd little machine that has feathers, squawks, and struggles if caught. This loss of contact between the caretaker and his charges is often associated with lack of recognition of behavioral and other problems. Breeders and managers know that chickens function well or poorly depending on both genetic constitution and quality of environment. We also know that most widely-used housing environments for laying-type chickens impose some stress, particularly those involving crowded multiple-hen or "colony" cages. We found genotype by housing-environment interactions in each of 3 studies where genetic strains and housing environments varied over a wide range (5,8,12). There appears to be a need to adapt strains of egg-type chickens to specific housing environments. Such adaptation is likely to include behavioral changes or reductions in responsiveness to stimuli that would otherwise cause behavioral stress.

A recent comparison suggests that present-day commercial strain cross hens perform relatively better than an unselected control population when compared in multiple-hen cages than when compared in a floor-pen environment (20). How can that be explained? Have breeders tested potential commercial combinations in multiple-hen cages and kept those that do better? Or are they simply benefitting from the well-known ability of hybrids to withstand stress better than genetic stocks having lesser genetic heterozygosity?

How important are genetic influences on behavior and the behavioral environment? Inbreeding and selection can alter social dominance ability (13,19). Commercial strains differ in frequency and severity of aggressive acts (5,10) and in tendency to hysterical behavior when kept in groups of 20 to 40 in colony cages (29). Selection has also produced differences in the imprinting response (21) and in sex drive of the male (45). The well-known "peck order", once established, is quite stable among hens, even when potential social dominance changes for genetic reasons (48).

Management practices influence the behavioral and social environment. Social disruptions, availability of feeding and living space,

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group size, presence or absence of males, alteration of appearance or ability to recognize others, debeaking, and toe nail removal are among the conditions imposed by man which may drastically alter the life-style, well-being, and productivity of chickens. My aim here is to focus attention briefly on some recent behavioral studies carried out at our institution and to mention the results of relevant studies done elsewhere.

Social Disruption

Adverse effects of social disruptions were documented in the classic study of Guhl and Allee (27) who found that small flocks receiving a strange hen daily or on alternate days had higher pecking frequencies, lower feed intake, and reduced egg production when compared with undisturbed flocks. Studies at Virginia Polytechnic Institute and the Southeast Poultry Research Laboratory indicate that moving birds from group to group, where they are in the minority and are repeatedly attacked by residents, causes physiological symptoms of stress (42,44). In several experiments, socially stressed birds were exposed to disease organisms; short term, but intensive stress (up to 3 weeks), reduced resistance to viral diseases, but increased resistance to bacterial ones (22,43).

We produced social disruptions by randomly redistributing pullets among flocks on a weekly basis, from 18 to 30 weeks of age, thereby increasing agonistic activity (18), but without adverse effects on age at sexual maturity or egg production (17). Results of the Guhl and Allee study are contrasted with ours in Table 1. We believe the social disruptions in our study were less stressful because all pullets were interacting with strangers whereas Guhl and Allee's introduced hens were attacked by a relatively organized group. We also hypothesized (17) that weekly redistribution may have benefitted those individuals that would otherwise have remained at the bottom of a stable peck order. Under a system of changing group membership, low-status individuals have an opportunity to rise in the hierarchy whenever a new group is formed.

Chickens appear capable of withstanding temporary increases in frequencies of aggressive and submissive acts without overt indications of stress or loss of productivity. Thus, assembling egg-strain pullets in flocks at 6 weeks of age (before peck orders form) conferred no advantage in productivity over flocks in which strange pullets were assembled when 19 weeks old, though the latter flocks had elevated frequencies of agonistic acts for several weeks following (9). Similarly, flocks of 8 and 16 pullets in colony cages receiving replacements for real and simulated mortalities were not detected as having lower productivity as compared to flocks without replacements (1).

High Density

What happens when the same number of individuals are placed in pens or cages of different size? We know there is concern for the welfare of domestic animals in high-density environments (24) and some countries specify minimum requirements (34). Regulations arrived at by intuition rather than experimental methods have been imposed in some instances.

Although the evidence is indirect, we have an indication that less space may be better than more, when cockerels are kept together. Thus, when pairs of cockerels were kept in roomy, solid-floored cages (1910 cm^2 per male) from 12 until 20 weeks of age, they could be classified easily into dominant and subordinate categories by 20 weeks because the subordinates showed clear signs of physical abuse and submissive posture (23) and were delayed in attainment of sexual maturity, Table 2. In a later study pairs of cockerels were kept in wire-floored, layer-type cages (575 cm^2 per male) from 15-17 to 38-42 weeks. Those males had essentially equal weight gains, survival, and subsequent fertility as compared to singly-caged males with twice as much space (16), Table 3. Cockerels kept as pairs (or trios) in the second study showed no signs of physical abuse inflicted by one individual on the other.

We have looked at frequency and severity of agonistic activity in flocks kept in colony cages and in floor pens. Beginning with a relatively generous space allowance, social interaction rates increase as area per bird decreases until a critical level is reached, then agonistic activity falls off drastically with further decreases in space (4,39) (see Table 4). Though aggressive activity is depressed with very high density, it is clear that chickens are stressed as indicated by physiological changes (41) and decreases in productivity (2).

Hughes and Wood-Gush have recently confirmed our finding that hens in high-density cages have reduced aggressive behavior as compared with those in lower-density floor pens (31). Their observations of hens in floor pens suggest that normal threat displays require minimal amounts of space exceeding the dimensions of most cages. Indeed, the frequency of threats is clearly reduced in cages (7), but the reduction of aggressive head pecking found in high-density environments must be explained otherwise. They postulate that with extreme crowding subordinate hens may not trigger pecking by a dominant bird, if they are already within the dominant's sphere of influence; only entry into an individual's "personal space" is postulated as causing such behavior.

We suggested (18), several years ago, that crowding could reduce agonistic activity because a particular individual may fail to behave aggressively towards a subordinate in the near presence of one of its dominant penmates.

Third-party Effects

Male Presence. When males are present in small flocks of hens, agonistic activity is reduced among the females (7,14). The more males present, the greater the reduction, as shown in Table 5. Male presence effects occur though there is a general absence of overt aggressive behavior (26,40,50). We found that male presence, over a 30-week period, may decrease body weight gains and egg weights (7).

Recently we recorded the frequency of agonistic acts between pairs of hungry hens during feeding as influenced by the absence or proximity of a male (Ylander and Craig, unpublished). The results were dramatic (see Table 6); with the male in their immediate presence hens had only 5 peck-avoidances in 24 10-minute trials, when the cock was at 1 m distance there were 21, and when he was removed there were 74. Threat-avoidances followed the same general pattern, but the effects were less pronounced. Cocks were not observed pecking hens in their immediate presence and threats were rare (only 3 were seen), but they occasionally interposed themselves between hens after one had pecked or threatened the other.

We had wondered whether the reduction in hens' agonistic activity, when a male was resident in a flock, might be associated with physiological or hormonal changes because such male presence effects are well documented in some avian and mammalian species. That explanation appears unlikely in view of the increased agonistic activity between pairs of hens with temporary removal of the cock from the pen.

Dominant Hen Presence. Repetition of the same experiment, but substituting the hen at the top of each peck order in place of the male, produced roughly comparable results, as shown in Table 7. However, the inhibitory effect on peck-avoidances appeared to be present only in the dominant hen's close presence; peck-avoidances of the subordinate pair were about as frequent at 1 m distance from the top-status hen as when she was totally removed from the pen.

In contrast to the cock's behavior, the dominant hen was observed to threaten 17 times (in 30 10-minute trials) and members of the subordinate pair avoided her on 34 occasions when they were feeding in her presence. No threats by the dominant hen were recorded when the subordinate pair was 1 m distance from her.

General. The results support our hypothesis that the frequency of agonistic acts under high-density conditions is generally reduced between pairs of individuals in the near presence of an individual socially dominant to both. Both mature cocks and high-status hens exert such an influence, though the cock's influence does not require overt aggressive behavior whereas the dominant hen often behaves aggressively.

Group Size

Wild and feral chickens form relatively small groups and show home range and territorial behavior (11,38). Because groups under natural conditions usually include no more than 10 to 20 individuals and because chickens have such poor memory of other individuals, we wonder how they cope behaviorally in large flocks. Two experiments suggest that they have home ranges, i.e. they restrict their movements to particular areas (15,37). If this is correct, then they would have no need to recognize a large number of individuals. One study suggests that pullets of a nonaggressive strain, kept under very dim lights did not show home range behavior (32); it was suggested that they may move freely under such conditions because they can not be recognized as strangers.

What are the limits of recognition in the chicken and how can we recognize those limits? In a study involving flocks of size 6, 12 and 24, peck orders were found to be stable over months, though the number of "peck order violations" increased sharply with increases in group size (6). Increases in frequency of aggressive behavior occur when hens' combs are removed (46) and with debeaking (28). Dubbing may make recognition more difficult, especially in larger flocks, and debeaking presumably increases pecking frequency because dominant individuals must reinforce their status more frequently (pecks delivered are less aversive).

We have looked closely at agonistic behavior in multiple-hen cages. The frequency of aggressive acts per hen increased as group size increased from 4 to 28. Most aggressive acts in colony cages are pecks rather than threats and most occur while the birds are feeding or near the feeder (4).

In a second study involving cages with flocks of size 4, 8 and 14, we observed higher levels of aggression in the larger flocks during the first 8 weeks, but agonistic activity was much reduced for all flocks when they were observed again, 26 weeks after assembly (5)(see Table 8). Increasing group size from 4 to 8 or 14 pullets decreased egg production and increased mortality. No associations were found between frequencies of agonistic acts within flocks and their egg production or between social status of individuals and duration of time feeding. Those results are contrary to earlier results obtained in floor pens (25,48,49). The multiple-hen colony cage imposes a very different social environment upon chickens than exists in floor pens and relationships of agonistic behavior to productivity appear to be eliminated, or at least drastically reduced (5). Though the commercial strains that we used differed considerably in aggressiveness soon after flock assembly, we could not relate agonistic activity levels to productivity (as indicated above). Nevertheless, those strains differed in ability to withstand the stress of increased group size, as shown by effects on egg production.

We developed a pictorial score card which shows feather damage and injury to the back and wings which is typical of many flocks kept for prolonged periods in colony cages; "feather condition scores" at 40 weeks of age indicated that flocks of 22 had greater feather damage and showed more injuries than flocks of 11. The larger flocks also were more fearful and laid fewer eggs (3).

In addition to the common practice of severe debeaking, toe nail removal reduces injuries and is beneficial in terms of productivity for hens kept in larger groups in cages (29,36).

It appears that behavioral stress imposed by high-density colony cage environments may be largely associated with trauma caused by nervousness or hysteria. We found (5) that frequency of aggressive behavior was not correlated with productivity; perhaps the low frequency of agonistic activity in high-density colony cages reduces the importance of aggressive and submissive behavior as compared with the floor-pen situation.

Genetic Adaptation to Colony Cages

What can be done to reduce behavioral stress in multiple-hen cages? Hansen's studies (29) indicate that genetic influences may be responsible for large differences in nervousness and hysteria of pullets in colony cages. Because nervous, fearful, or hysterical behavior may seriously reduce performance in multiple-hen cages, it might be useful to include measures of such traits among those used in selecting strains which are to be kept in colony cages. A family selection scheme is implied, as those traits are probably best measured as group phenomena. An alternative approach is to keep families in separate multiple-bird units, but to select on productivity alone under the assumption that those families which perform best will, on the average, have whatever behavior is appropriate. We are currently carrying out a selection study using the latter alternative. Selected and control strains are being compared in single-hen, multiple-hen, and floor-pen environments to determine whether specific adaptation to the colony-cage environment occurs and what behavioral changes may accompany such adaptation.

Cage Shape and Feeder Space

We compared the behavior of pullets kept 14 per cage in nearly square (80 cm wide x 70 cm deep) and in shallow cages (160 cm wide x 35 cm deep); those in shallow cages had fewer agonistic acts but were frightened by the slightest movement of the observer or caretaker so that they would run to one end of the cage and "pile up" (10). Pullets in cages of different shape were observed to feed at about the same average rate.

Several recent studies have compared effects of cage shape on performance characteristics. Most have shown an advantage for "shallow" cages (33,35,47); we suspect that less or no advantage would be shown if the cages had a width comparable to ours (10). Not all studies show an advantage for the shallow cage and it appears that a genotype by cage shape interaction may be important; for example, some genetic strains may overeat when placed in shallow cages with increased access to feed (30).

Summary

Crowding chickens into high-density, multiple-bird cages and repeated exposure of individuals to organized groups of strangers causes physiological symptoms of stress, reduces weight gains and reproductive performance, and alters disease resistance. Nevertheless, hens of some genetic strains withstand adverse social environments better than others and, in some cases, cockerels may benefit from being kept together in less space.

Close examination of behavior under very high-density conditions reveals a reduced frequency of agonistic acts. Threat displays may be prevented by extreme density and close proximity to dominant individuals inhibits interactions between subordinates. Increasing group size in multiple-hen cages is associated with increased aggression initially, but agonistic activity drops to low levels later. Trauma associated with nervous and hysterical behavior appears as a more likely cause of poor performance in colony cages than does agonistic behavior.

A growing body of evidence suggests that genetic adaptation to high-density environments is possible and that genotype by housing environment interactions are important for productivity traits. Successful adaptation to high-density environments is likely to include behavioral changes or reduction in responsiveness to stimuli causing social stress.

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Table 1. Effects of adding strangers to organized flocks and random weekly redistributions of flock members

Guhl and Allee (1945)		Craig et al. (1969) and Craig and Toth (1969)	
Added 1 strange hen to flock of 7 on alternate days (longest-term resident removed)		Pullets randomly redistributed among flocks of 18 weekly, from 18 to 30 wks. old	
	$\frac{\text{Disrupted}}{\text{Organized}} \times 100$		
Aggressive acts, frequency	157%**	Aggressive acts, frequency	174%***
Feed consumed per hen	74%***	Age at first egg	99%(NS)
Eggs per hen	79%*	Rate of lay	96%(NS)

* = P<.05, ** = P<.01, *** = P<.005.

Table 2. Influence of social status on age at maturity in cockerels

	Social Status[1/]		Difference
Criterion	Alpha	Beta	Beta-Alpha
1st sperm, wk.	15.3	16.9	1.6*
10^8 sperm, wk.	18.2	19.4	1.2*
1st mating, wk.	25.4	28.6	3.2*

[1/] Means for 24 Alphas and 24 Betas.

* P<.10

Table 3. Effects of crowding cockerels in cages before 42 weeks of age

No./Cage[1/]	Weight Gain, Gm.	Survival %	Single-Sire Pen Fertility, %	
			10 days	20 days
1	1008	100	63	81
2	983	97	72	84
3	805	93	68	84

[1/] Seventy-two were weighed and twenty-four tested for fertility from each treatment.

Table 4. Density effects on frequency of agonistic acts among pullets kept 4 per cage

Area		Agonistic Acts/ Pullet/Hour[1/]	Egg Production %
cm^2	(in^2)		
412	(64)	6.1^a	70.7
824	(128)	15.2^c	71.6
1442	(224)	11.6^b	72.1
2884	(448)	8.4^a	75.4

[1/] First 8 weeks after flocks were assembled.

$P<.05$ for means with different superscripts.

Table 5. Frequency of agonistic acts among pullets as influenced by cockerel presence in floor pens

	Acts per female per hour[1/]		
Males/Flock	Peck-avoidances	Threat-avoidances	Total
0	6.5	6.8	13.3
1	3.9	4.4	8.4
2	3.4	3.2	6.6
4	2.2	2.3	4.5

[1/] Mean frequencies for observations 1 to 4 and 9 to 12 weeks after flocks were assembled.

Table 6. Male effect on frequency of agonistic acts between hens

	Distance (or absence) of male from feeding hens			
Agonistic Acts	0 m	1 m	absent	P
Peck-avoidances	5[1/]	21	74	<.01
Threat-avoidances	55	82	94	<.05
Avoidances	123	144	155	ns

[1/] Total acts for 24 10-min. trials.

Table 7. Dominant hen effect on frequency of peck-avoidances between lower-status hens

	Distance (or absence) of dominant hen from feeding pair			
Flock	0 m	1 m	absent	P
1	0[1/]	17	5	<.01
2	0	3	12	<.01
3	7	17	25	<.05

[1/] Total acts for 10 10-minute trials.

Note: Similar effects were found (P<.01) for threat-avoidances and avoidances.

Table 8. Group-size effects on agonistic activity, egg production, and mortality

Group Size	Acts/hen/hr. Wks. after flock assembly 0 - 8	Acts/hen/hr. Wks. after flock assembly 26-28	Hen housed rate of lay %	Mortality %
4	9	2	67	6
8	15	2	64	8
14	13	3	57	12
Prob.	<.05	ns	<.005	<.05

DR. J. V. CRAIG - Aggressive Behavior of Chickens: Some Effects of Social and Physical Environments

WALTER A. BECKER: Haven't pullets heard of female liberation? Why do they allow male chauvinistic cockerels to dominate them?

CRAIG: Our hens don't seem to be liberated. But life isn't so bad for them. The cock rarely pecks or threatens, and they live more peacefully together when a male is present than otherwise.

R. P. REDDY: Can you suggest the application of the results on male crowding as a means of weight management, lowering the mortality and still maintain optimum fertility in broiler type males?

CRAIG: I can't say anything specifically about broiler-type males. Most of our work has been with egg-type chickens. It does appear, however, that less space may be more beneficial than more, at least within limits. Besides keeping 1, 2, or 3 males in single 10 x 18 inch laying-hen type cages, we have also kept 10 Leghorn males per 28 x 36 inch cage for fairly long periods with good success. They were not tested for fertility, but appeared to be in excellent health when removed. There were few signs of the kind of physical abuse that we often see when adult males are kept together in roomy floor pens.

DR. T. KASHYAP: What was the effect on fertility when the number of males was increased in the group of 16 females?

CRAIG: We didn't test for fertility in the pens of 16 when there were 1, 2, or 4 males present. Our interest was in the effect on frequency of female-to-female agonistic acts.

GRADY MARTIN: What was the light intensity in the shallow vs deep cage comparison?

CRAIG: After checking with Dr. Adams, I learned that there were light-meter readings of 2 1/2 to 3 foot candles at the food-trough level. In human terms that is a moderate level of artificial lighting.

(NO NAME): What is the effect of feather consumption and denuding of hens?

CRAIG: I believe that most of the feather loss that we saw resulted from wear against the wire and from trampling by other birds. It is very interesting to us that adjacent cages can vary greatly in feather loss and in level of flightiness. I believe that hysteria in a colony cage is probably caused by one or two excessively irritable individuals initially. Perhaps the hens are conditioned to flightiness; it must be punishing to be on the bottom of the pile. Feather loss would require greater feed intake during cold periods to offset losses of body heat.

R. N. SHOFFNER: Increase in density or presence of a third party female reduces the number of observed agonistic encounters, yet egg numbers decreased, mortality increased, etc. ...What is the explanation?

CRAIG: I believe the adverse effects that are commonly seen in large-size, high-density, colony cages are largely caused by physical injuries and punishment associated with flighty behavior, that is, from the birds piling-up and injuring themselves by moving about so violently.