CANNIBALISM IN EXTENSIVE POULTRY KEEPING: INTERFACING GENETICS AND WELFARE

Paul Koene

Department of Animal Sciences, Ethology Group, Wageningen Agricultural University, Marijkeweg 40, P.O. box 338, 6700 AH Wageningen, the Netherlands, paul.koene@etho.vh.wau.nl, http://www.zod.wau.nl/~www-vh/etho

SUMMARY

Cannibalism frequently occurs in free-range poultry keeping. An inventory in the Netherlands showed the severity of the problem. Also in our neighbouring countries the problem of cannibalism is found. A short literature review showed that a wealth of factors - environmental, ontogenetical and genetical - may play a role in the development of cannibalism. The most promising way to reach a solution seems to be to adapt the animal to its - free-range - environment. Heritability estimates of feather pecking and cannibalism are reasonably high. Especially the molecular genetical analysis together with ethological analysis can show the genetic background (markers or even genes) that is responsible for the cannibalism. Selection against this vice must be feasible.

Keywords: cannibalism, genetics, selection, welfare, Gallus domesticus

INTRODUCTION

The objective of this study is to determine the best way to diminish cannibalism in extensive poultry keeping (free-range hens) by adapting the bird to the free-range environment (Faure, 1980), where adapting the environment to the bird seems to have failed concerning animal welfare. Different breeding and selection strategies will be presented dependent on welfare criteria, rather than on production criteria.

Extensive poultry keeping. The goal of free-range laying hen keeping is to provide the consumer with an animal-friendly egg from hens kept under animal-friendly conditions. During the last 40 years breeding programs were directed at intensive husbandry systems and changed markedly the genotypes of the animals involved. Apart from the question whether these animals have been adapted adequately to these intensive systems the question arises in how far the potential to adapt to extensive systems was maintained. If we are going to keep animals in these extensive systems should they be selected anew or can we just go on with the strains available now? There are a priori no convincing arguments either pro or contra selection of domestic animals for extensive systems (Koene 1992). However, more and/or other abnormal pecking behaviour may appear in more extensive systems compared to intensive systems. For instance, in alternative systems for laying hens cannibalism occurs, which seems to necessitate beak trimming. However, for animal welfare reasons both cannibalism and beak trimming are not acceptable.

Cannibalism in extensive poultry keeping. In 1994 some 22.000 hens were kept under extensive conditions in the Netherlands. Part of the extensively kept hens are so-called EKO hens, the other part are BD (Biological Dynamical) hens; BD hens are kept together with roosters (1 per 40 hens). These free-range hens are managed according to strict regulations. In both housing conditions beak trimming is forbidden. In 1994 extensive cannibalism occurred in this branch. A short survey was done concerning the existing problems of the cannibalism related to the conditions of housing and management. Results are presented in a Dutch report (Van de Wouw en Koene 1995) and in Koene (1997a). In short, more cannibalism is found on large farms, in large groups, keeping Hysex breed hens, keeping hens only recently and having more floor eggs. On the question how the pecking started one farmer responded 'by extreme feather pecking', one 'by extreme pecking between cloaca and legs', and nine 'by cloaca pecking'. The inventory showed that mortality due to cannibalism is sometimes very high (range 0-30%). The problems for the 'animal friendly' egg market are thus very serious. In the years 1995, 1996 and 1997 the problem seemed to be even increased. Cannibalism in extensive poultry keeping seems to be widespread, not only in the Netherlands, but also in Denmark and Germany (Koene 1997b).

Extensive and intensive keeping. The main difference between intensive and extensive keeping is the beak trimming of birds. Beak trimming has some adverse effects, although recent research shows that it is less painful if done at a young age (Gentle 1997). Strain differences in pain perception may exist (Hughes 1990). Thus beak trimming may still be the best way to master cannibalism, depending on the strain involved. Beak trimming however, does not eradicate all cannibalism. Kuo and Craig (1991) found significant differences between mortality due to cannibalism in intact birds, 1/4 debeaked and 1/2 debeaked birds. Mortality rates were 46, 39 and 22% respectively in one breed and 27, 16 and 2% in another breed. More than 85% of the cannibalism was caused by vent pecking even in heavily (1/2) debeaked animals. Plastic anti-pecking devices are also promising for small scale commercial application but need some more research (Savory 1997). Still, especially under BD housing conditions a complete and intact hen is needed.

CANNIBALISM IN LAYING HENS

Description and history. Cannibalism is a diffusely defined term indicating severe pecking of birds on each-other causing severe wounds, eventually causing death of the pecked bird, and eating the victim. Cannibalism can take several forms, i.e. toe picking in chicks, feather pulling, head, tail or body pecking, and vent pecking in older birds. It is often assumed that feather pecking sometimes develops into cannibalistic pecking. Cannibalism appears often during the laying period (Preston 1984) as vent pecking (Kuo *et al.* 1991; Allen and Perry 1975). Although cannibalism is in some animals normal behaviour (Elgar and Crespi 1992), it is probably abnormal pecking behaviour in chicken (Ferguson 1968, emphasising social stress as the main cause). It is not described or studied in the ancestor of our chicken, the red junglefowl *Gallus bankiva*.

Cannibalism and feather pecking. Cannibalism is often seen as a severe form of feather pecking (Bessei 1983). Literature on feather pecking will be presented in addition to literature on cannibalism. However, Duncan and Hughes (1972) showed that no significant differences were found in amount of feather pecking in groups significantly differing in cannibalism (vent pecking). Allen and Perry (1975) found no worse plumage condition in hens dead due to vent pecking and non-cannibalised hens. On the basis of this information the relation between feather pecking and vent pecking seems to be at least indirect.

Internal factors. The causes of cannibalism are not well understood, but the onset of cannibalism has been attributed to a number of causes which are outlined below. The main theories of causation concentrate on an early phase during ontogeny of pecking behaviour. Blokhuis (1986) proposed the theory that feather pecking was redirected ground pecking and thus a part of the feeding behaviour system. Recently the relationship between dustbathing and feather pecking is explored and partly substantiated (Vestergaard 1996). Vestergaard *et al.* (1993) show that the results concerning dustbathing are not in contradiction with Blokhuis theory. Feather pecking is redirected pecking but according to Vestergaard as part of the dustbathing behaviour system. Vent pecking often starts after the start of laying and is an indication that cannibalism is influenced by the hormonal system (Hughes 1973). Hughes and Duncan (1972) showed that fear is related to feather pecking (correlation of +0.48). Vestergaard *et al.* (1993) found that fearful hens - shown in the tonic immobility-test (TI) - showed more feather pecking. Also Blokhuis and Beutler (1992) found that a high feather pecking line shows a longer TI response than a low feather pecking line. On the other hand Keeling (1994) and Jones *et al.* (1995) did not found a significant relation between fear and feather pecking or cannibalism.

External factors. The art of feeding chicken has changed significantly the last 40 years. The composition of the feed has large consequences for production and health, and has been a central issue in cannibalism research. Sodium deficiency increased pecking to objects in the environment (Wood-Gush and Hughes 1973) and conspecifics (Hughes and Whitehead 1979). Much more research showed relations between feed composition and cannibalism. However, no effect was ever replicated and convincing. High densities of birds are generally associated with high feather pecking (Allen and Perry 1975; Hansen and Braastad 1993; Simonsen *et al.* 1980), although sometimes no relation is found (Hughes and Duncan 1972). Despite this, generally stocking density of birds is seen as of lesser importance. The group size is seen as more important. Cannibalism is mainly found in large poultry flocks (more than 250 birds in a group). In larger flocks more feather damage is found (Hughes and Duncan 1972; Keeling 1994), and also more cannibalism (Allen and Perry 1975; Hughes and Black 1976). Hughes and Duncan (1972) and Allen and Perry (1975) found an increase in peck damage under high light intensities. Schumaier *et al.* (1968) even found a relation between wavelength of the light and the occurrence of cannibalism. In red light, cannibalism was completely absent.

Epidemiology. How cannibalism develops and spreads in a group is not very well investigated. Primary cannibals cause other hens to practice cannibalistic behaviour (Siren 1963). Allen and Perry (1975) found a significant trend of finding a second cannibalised hen after finding the first one in a cage. Keeling (1994) found in one of the six groups extreme cannibalism in which group 9% of the animals was doing 50% of the vent pecking. Keeling and Jensen (1994) selected the cannibals (hens pecking much to the cloaca of other hens) and found no significant difference with other hens on fear, pecking behaviour, exploration and social behaviour. The development of cannibalism remains unclear (see also Savory and Mann 1997). The motivational and learning components need more attention in future research.

GENETICS OF CANNIBALISM

Line differences. Craig and Lee (1990) investigated the pecking behaviour of three white leghorn breeds (Babcock B300, Hy-line W-36 and H and N Nick Chicks commercial stocks). After 36 weeks significant differences between the pecking behaviour and between the mortality due to cannibalism (up to 34.6%) of the lines was found. There was surprisingly no relation between the pecking and the cannibalism. In floor housing no differences were found. In cages breed differences in pecking behaviour appeared to be related to differences in light intensity, stocking density, diet and group size. Hughes and Duncan (1972) found comparable interactions between breeds and housing conditions in the same leghorn lines concerning pecking and cannibalism.

Heritability. In 1954 Richter published the first article about genetics of feather pecking and emphasised a genetic component in the behaviour. Bessei (1995) gives a review on the genetics of feather pecking Estimates of the heritability of feather pecking range from .04 (Dickerson *et al.* 1961) to 0.10 (Cuthberson 1980). Omission of families, that show no feather pecking, increased the heritability to 0.56, suggesting a strong genetic component. Being pecked was less heritable and was assumed to have a negative correlation with feather pecking it self. Bessei (1995) showed in a first experiment heritabilities for pecking between 0.00 and 0.10 and being pecked from 0.00 to 0.11. In a second experiment pecking of birds on a bundle of feathers was automatically recorded. Heritabilities for pecking ranged between 0.18 and 0.20 and being pecked from 0.25. Realised heritabilities of feather pecking are between 0.09 and 1.04 . Kjaer and Sørensen (in press) found heritabilities of feather pecking between 0.05 and 0.38 of white leghorns of ages 6, 38 and 69 weeks. Most heritabilities of being pecked were not significantly different from zero. Genetic correlations between feather pecking and plumage cover and body weight have been found. Keeling and Wilhelmson (1997) found severe feather pecks to be heritable and associated with behavioural activity, but not related to gentle feather pecking and aggressive pecking. This was supported by Savory and Griffiths (1997). High receivers avoided novel objects more and pecked less at a caged group mate. The only reported heritability, directly related to cannibalism is obtained by selection on beak inflicted injuries in laying hens, showing a high realised heritability of 0.65 (Craig and Muir 1993).

INTERFACING GENETICS AND WELFARE

Genetics. Nielsen and Vestergaard (1994) found a genotype-environment interaction concerning feather pecking dependent on experience with feathers as a substrate during rearing. Often large differences in feather pecking and cannibalism are found between breeds, and even flocks of the same breeds, may show large differences under different management conditions. The data of Kjaer and Sørensen (in press) and Bessei (1995) show that selection of birds with low tendency to feather peck should be feasible. The development of a feather pecking device to measure feather pecking is of crucial importance to reduce observation time (Bessei 1997). Still, the often found positive correlation between egg production and feather pecking (Bessei 1995) is problematic; selection for the production trait opposes the welfare trait. Molecular genetical techniques and behaviour research (Newman 1994) allow for genetic identification of cannibals. With a set of high polymorphic microsatellite markers a 'total genome scan' procedure can be done. Segregation for behavioural parameters may reveal chromosomal regions that are basic to cannibalism or related traits by identification through 'linkage analysis'. Such markers are guides for characterising the responsible genes (Crooijmans *et al.* 1996). From a genetic point of view cannibalism is not very predictable, but seems to be often associated with feather pecking that is more predictable. Feather pecking and cannibalism appear to have reasonable heritabilities, making selection against these traits feasible. Molecular genetic techniques can probably identify gene-complexes responsible for feather pecking and cannibalism.

Welfare. Cannibalism in free-range poultry indicates a welfare problem; certainly for the cannibalised birds, and maybe also for the cannibals themselves, dependent on what caused their behaviour. Different causes are mentioned earlier, but most probably lines of chicken can have a predisposition of intense pecking behaviour that can express itself in feather pecking and/or cannibalism. When cannibalism occurs some actions can be taken, as reducing light intensity, red light, providing more distraction and so on. However, data show that despite such steps the problems still are not solved. As it appears now the chicken lines used in free-range poultry keeping are not suited, and must be better adapted to the environment, especially to a social environment with non-beak trimmed conspecifics. Animals - when challenged by changes in the environment - show at first behavioural reactions or adaptations (McBride 1980). Such first reactions can be described as acute stress reactions or emotional expressions (Wiepkema *et al.* 1992). Vocalisations are often such emotional expressions (Koene 1991). For instance, birds receiving severe aggressive pecks often vocalise. Thus sound could be a welfare parameter related to the occurrence of a welfare problem (e.g. unstable rank-order). In search for welfare parameters associated with feather pecking or cannibalism, no specific candidate is found up till now. Fear - measured in the tonic immobility test - seemed to be a good candidate; high feather peckers showed longer TI durations. Also sometimes a high activity was found in high feather peckers. Better welfare parameters associated with the abnormal pecking behaviour are needed for starting a selection programme. The feather peck device of Bessei (1997) could be of great help as a direct measure of the abnormal pecking behaviour.

Interface: a selection model. Heritabilities indicate that selection against feather pecking and/or cannibalism in laying hens may be successful. A flow-chart model or strategy for selection for behavioural traits in animal husbandry is given elsewhere (Koene 1992; cf. Newman 1994). The strategy for breeding for welfare traits is dependent on the 'Type of husbandry' which is the starting point of the model that determines the environment in which the selection has to take place. Such a selection strategy can be done in the following 7 steps: 1. define the welfare parameter, for instance tonic immobility duration, activity or pecks at feather pecking device (Bessei 1997), 2. establish the heritability of the welfare parameter, in relation to the environmental factors, 3. search for a marker, associated with the welfare parameter, 4. search for traits associated with the welfare parameter, 5. estimate genetic correlations between the welfare parameter and associated traits, 6. search for possible antagonisms between genetic demands and production and welfare demands, and 7. select until sustainability of the type of husbandry in the chosen environment is achieved, and then stop.

Discussion. As outlined in the introduction the aim was to find a solution for severe cannibalism with special emphasis on a genetic solution. Genetic and environmental factors were presented. None of these presented an immediate solution. The conclusion is that cannibalism is a multifactorial problem in which genotype-environment interaction plays an important role. Possible future strategies to solve the cannibalism problem in free-range laying hens could be:

0. Keep beak trimming hens. However, this is not allowed in EKO and BD hens in the Netherlands.
1. Use regular commercial strains and keep trying to adapt the environment to animal.
2. Use regular commercial strains and wait until breeders deliver animals according to welfare standards enforced by legislation.
3. Choose a commercial breed composed of non-pecking parent lines and accept the correlated lower egg production.
4. Breed and select your own animals. Biological or ecological farming has special attention for welfare and a biological approach. A Darwinian approach in which the fitness of an individual can be determined by its reproduction and survival is really biological! Roosters and a brooder (or broody hens) are essential. Such a strategy is possible in BD systems in the Netherlands.

5a. Select the animals that are the best under practical conditions and determine their genetic make-up by molecular genetic techniques. In this way breeders may compose the hybrid with the best traits for free-range keeping.

5b. Select the animals that are the cannibals under practical conditions and determine their genetic make-up by molecular genetic techniques. In this way breeders may select against cannibalism.

6. Use the above mentioned selection model and try to balance welfare and production traits in making a new free-range chicken strain ('Freehen' or 'Biohen').

Although it is commercially probably the most attractive to sit and wait for the perfect hen, it is better for the welfare of the hen to start asking for a new type of laying hen without the vice of cannibalism. In the Netherlands and Germany there is a market for a 'biokip' or 'Biohuhn'. The best strategy seems to select for a specific cannibalism-free breed. The search for such breeds has started already. In England the Colombian Blacktail is claimed to show no cannibalism. In the Netherlands the brown Hysex hens showed more cannibalism than ISA hybrids (Koene 1997). Hysex birds are not used anymore in ecological, biological or extensive poultry farming. White (LSL) breeds are preferred in Germany for showing less cannibalism (Koene 1997)! For health and welfare reasons, composition of new races of laying hens with a large adaptation ability for changing environments is preferred above using animals of current battery cage breeds. Information of individual animals about health, welfare and production must define the features and traits for selection in future. Natural selection should determine the genetical basis of the future production animal in extensive animal husbandry. Animal variation in health, welfare and production must identify the optimal combination of genetic characteristics in relation to environmental characteristics. Thus leading to identification of the necessary characteristics of future animal friendly, natural, ecological, biological housing systems. The limits of selection are still difficult to determine if we adapt the animal to its environment. The example of blind hens (Ali and Cheng 1985) that produce better, show no feather pecking and have probably less stress is a challenging subject for an ethical discussion concerning welfare.

Conclusion. A multi-disciplinary approach and effort - ecology, environmental physiology, epidemiology, molecular genetics and ethology - may solve the problem of cannibalism in free-range chicken. The molecular genetic approach in combination with behaviour research seems to be the most promising. If successful, and beak trimming is no longer necessary, also billions of intensively kept chicken may benefit from such an effort.

ACKNOWLEDGEMENTS

The author thanks Sjoerd van de Wouw for field work on cannibalism in poultry.

REFERENCES

Ali, A. and Cheng, K. M. (1985) Poult. Sci. 64:789-794.

Allen, J. and Perry, G. C. (1975) Brit. Poult. Sci. 16:441-451.

Bessei, W, Reiter, K. and Schwarzenberg, A. (1997) In “Proc. Fifth Eur. Symp. on Poultry Welfare 1997”, pp. 74-76, Editors P. Koene and H. J. Blokhuis, Wageningen, the Netherlands.

Bessei, W. (1983) Deutsche Geflügelwirtschaft und Schweineproduktion 24:656-665.

Bessei, W. (1995) In “2nd European poultry breeders roundtable”, Editor P. Sørensen, Foulum, Denmark, 9-21.

Blokhuis, H.J. (1986). Appl. Anim. Behavior Sci., 16:63-67.

Blokhuis, H.J. and Beutler, A. (1992). J. Anim. Sci. 70 Suppl. 1: 170.

Craig, J.V. and Lee, H.Y. (1990) Appl. Anim. Behavior Sci. 25:107-123.

Craig, J.V. and Muir, W.M. (1993) Poult. Sci. 72:411-420.

Crooijmans, R.P.M.A., Van Oers, P.A.M., Strijk, J.A., Van der Poel, J.J. and Groenen, M.A.M. (1996) Poult. Sci. 75:746-754.

Cuthbertson, G. J. (1980) Brit. Poult. Sci. 21:447-450.

Dickerson, G., Kashyap, T. and Lamoreux, W.T. (1961) Poult. Sci. 40:1394-1395.

Duncan, I.J.H. and Hughes, B.O. (1972) Brit. Poult. Sci. 13:525-547.

Elgar, M.A. and Crespi, B.J. (1992) “Cannibalism: ecology and evolution among diverse taxa” Oxford: Oxford University Press.

Faure, J.M. (1980) In “The laying hen and its environment”. pp 19-42, editor R. Moss, ECSC, EEC, EAEC, Brussels-Luxembourg.

Ferguson, W. (1968) In “Abnormal behavior in animals”. pp. 188-207, Editor M.W. Fox, W.B. Saunders company, Philadelphia.

Gentle, M.J. (1997)) In “Proc. Fifth Eur. Symp. on Poultry Welfare 1997”, pp. 5-12, Editors P. Koene and H. J. Blokhuis, Wageningen, the Netherlands.

Hansen, I. and Braastad, B.O. (1993) In “Proc. Fourth Eur. Symp. on Poultry Welfare”. Herts, Federation for Animal Welfare: 264-265.

Hughes, B.O. (1973) Brit. Poult. Sci. 14:341-348.

Hughes, B.O. (1973) Brit. Poult. Sci. 14:341-348.

Hughes, B.O. (1982) In “Disturbed behaviour in farm animals”, pp 138-147, Editor W. Bessei, Stuttgart, Verlag Eugen Ulmer.

Hughes, B.O. and Black, J. (1976) Brit. Poult. Sci. 17:327-336.

Hughes, B.O. and Duncan, I.J.H. (1972) Brit. Poult. Sci. 13:525-547.

Hughes, B.O. and Whitehead, C.C. (1979) Appl. Anim. Eth. 5:255-266.

Hughes, R.A. (1990) Behav. Neurosci. 104:619-624.
Jones, R.B., Blokhuis, H.J. and Beuving, G. (1995) Brit. Poult. Sci. 36:525-530.
Keeling, J. and Jensen, P. (1994) In "28th Int. Cong. ISAE", p. 105, Research centre Foulum, Denmark.
Keeling, L. and Wilhelmson, M. (1997) In "Proc. Fifth Eur. Symp. on Poultry Welfare 1997", pp. 77-79, Editors P. Koene and H. J. Blokhuis, Wageningen, the Netherlands.
Keeling, L.J. (1994) In "Proc. 9th Eur. Poultry Conf.", pp. 288-289, Walker and Connell ltd, Glasgow.
Kjaer, J.B. and Sørensen, P.S. (in press) Brit. Poult. Sci.
Koene, P. & Wiepkema, P.R. (1991) In "Alternatives in animal husbandry", pp. 95-103, Editors E. Boehncke and V. Molkenthin, Witzenhausen: AgrarKultur Verlag.
Koene, P. (1992). In "Animal genetic resources for adaptation to more extensive production systems", Editor M. Hagelsø, Foulum, Denmark: Proceedings from CEC workshop.
Koene, P. (1997a) In "Proc. Fifth Eur. Symp. on Poultry Welfare 1997", pp. 147-148, Editors P. Koene and H. J. Blokhuis, Wageningen, the Netherlands.
Koene, P. (1997b). In "Neue Entwicklungen in der ökologischen Geflügelhaltung", Editors U. Schumacher and R. Holle (Bioland-BV und Ökoring Schleswig-Holstein), Schleswig, Germany.
Kuo, F.L., Craig, J.V. and Muir, W.M. (1991) Poult. Sci. 70:1057-1068.
McBride, G. (1980) In "Behaviour in relation to reproduction, management and welfare of farm animals", pp. 195-198, Editors M. Wodzicka-Tomaszewska, T. N. Edey, & J. J. Lynch (Reviews in Rural Science Number IV). University of New England, Armidale, N.S.W., Australia.
Newman, S. (1994) J. Anim. Sci. 72:1641-1653.
Nielsen, P.F. and Vestergaard, K. (1994) In "28th Int. Cong. ISAE", p. 115, Research centre Foulum, Denmark.
Preston, A.P. (1984) In "Proc 17th Worlds Poultry Congress", pp. 433-435, Helsinki, Finland.
Richter, F. (1954) In "10th World's poultry congress", pp. 258-262, Edinburgh, UK.
Savory, C.J. and Griffiths, J.D. (1997)) In "Proc. Fifth Eur. Symp. on Poultry Welfare 1997", pp. 109-110, Editors P. Koene and H. J. Blokhuis, Wageningen, the Netherlands.
Savory, C.J. and Hetherington, J.D. (1997) Brit. Poult. Sci. 38:125-131.
Savory, C.J. and Mann, J.S. (1997) Brit. Poult. Sci. 38:38-47.
Schumaier, G. Harrison, P.C. and McGinnis, J. (1968) Poult. Sci. 47:1599-1602.
Simm, G., Conington, J., Bishop, S.C., Dwyer, C.M. and Pattinson, S. (1996) Appl. Anim. Behav. Sci. 49:47-59.
Simonsen, H.B., Vestergaard, K. and Willeberg, P. (1980) Poult. Sci. 59:2202-2206.
Siren, M.J. (1963). Acta Veterinaria Scandinavia, Vol. 4. (Suppl. 1):1-48.
Vestergaard, K. S. (1994). Department of animal science and animal health, The royal veterinary and agricultural University, Copenhagen.
Vestergaard, K.S., Kruijt, J.P. and Hogan, J.A. (1993). Anim. Behav. 45(6):1127-1140.
Wiepkema, P.R., Schouten, W.G.P. and Koene, P. (1992) J. Agr. Environm. Ethics, In Press
Wood-Gush, D.M.G. and Hughes, B.O., (1973). Anim. Behav. 21:10-17.
Wouw, S. van de, en Koene, P. (1995). LUW. Rapport Wetenschapswinkel, nr. 109.