

# **Domestication effects on the social behaviour of chicken**

**(*Gallus gallus*)**

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## **Abstract**

The domestication process has altered the behaviour of the chicken in different ways. It is mainly the thresholds that have been affected more than the actual behaviour repertoire. The selection pressure in captivity can be either active or passive depending on the environment and the interference by human. An active selection on fear of human seems to change the behaviour according to the domesticated phenotype and it is therefore reasonable to believe that fear of human is a crucial trait in the process of domestication. The change the animal will go through is not only focusing on the appearance but also the behaviour, both in the relation towards humans as well as conspecifics. This thesis focuses on the difference between the domesticated chicken that ancestor the Red Junglefowl. The social behaviour has probably been affected by domestication in different ways, in which all of them are more or less leading to resource allocation since the domesticated chicken spend more energy on many and large eggs than their ancestor the red Red Junglefowl. In other species the domesticated variant are in general more tolerant to a higher density of conspecific as well as they are more sociable.

## **Domestication**

### **Why, when?**

Bökönyi in (Ducos, 1989) defined the essence of domestication as “The capture and taming by man of animals of a species with particular behavioral characteristics, their removal from their natural living area and breeding community and their maintenance under controlled breeding conditions for

mutual benefits”. He also states that a satisfactory definition of domestication should also mention that the behaviour of man has also been changed during domestication, not only the animals. Another definition, done by Price (Price, 1984) is “Domestication is that process by which a population of animals becomes adapted to man and to captive environment by genetic changes

occurring over generations and environmentally induced developmental events reoccurring during each generation. Domestication can be seen as an accelerated evolution and as a result of conscious breeding on characteristics; it has also resulted in both morphological and behavioral changes (Price, 1999). Even though many scientists have defined domestication, it is difficult to do that such as it presents all the output it has had on both man and the species. It concerns adaptation, usually to a captive environment and to a surrounding world steered by humans. Most domesticated species are used for food production and companion such as the chicken, cattle and the dog (Price 1984). Domestication as a phenomenon is fairly old, the process of the domestication of the wolf for instance started for about 15 000 years ago (Savolainen et al., 2002) and was probably the first species that became domesticated (Serpell, 1995).

Domestication is affected by genetic changes influenced by inbreeding, genetic drift, artificial selection and natural selection in captivity. The domesticated phenotype refers to the

ability the animals have to adapt to the captive environment. Hence the domesticated animals are less sensitive to changes in their environment (Price 1999). Behaviour of the species is very important in case of domestication and many species that has undergone domestication have some characteristics in common. In Keeling and Gonyou (2001) there is a table of favourable characteristics in domestication, mentioned there, among others, are large social groups, hierarchical group structure, promiscuous mating, precocial young, short flight distance to humans, not easily disturbed by humans or sudden changes in environment and omnivorous (Keeling and Gonyou, 2001). It is not difficult to imagine that animals that possess these characteristics are easy to hold in captivity as well as they have a high reproduction rate due to their group structure and promiscuous mating. The fact that they have a hierarchy reduces the aggressiveness when several individuals are kept at the same place. In case of birds it is in favor that the species is precocial since the chickens can bond to humans just as easy as to their mother (Appleby et al., 2004).

### **Selection pressure and domestication**

It is difficult to determine how the domestication of animals started in the origin. One fairly good theory is that animals that stayed close to the settlement of the humans to benefit from the orbit of the humans. These animals were later either caught or allowed to stay in the surroundings and were then eventually bred upon and their offspring would probably be less fearful for humans and so on. It is therefore likely that one trait that was important and perhaps even crucial was the level of fear for humans in every individual (Belyaev et al., 1985). With this theory as background there have been several selection projects on different species such as silver fox (Belyaev et al., 1985), quail (Jones et al., 2002), rats (Albert et al., 2008) and mink (Malmkvist and Hansen, 2002). The most famous and long going project is probably the farm-fox experiment started by Dmitry K. Belyaev in Siberia. He selected the foxes strictly on a fear for human test, carefully described in (Belyaev et al., 1985), conducted in the same manner for every generation during more than 50

years. He wanted to show that many of the morphological and behavioural differences between domesticated animals and their wild ancestor could origin from only one behaviour trait, fear for human. After a few generations they could see some characteristics of the domesticated phenotype in the selected foxes, such as floppy ears, piebald marks, short tail, curly tail, etc all similar to the domestic dog. They also differed physically such as the selected foxes show the first fear response after 9 weeks compared to the wild type that showed it after 6 weeks. This delay in development could be due to the raise of levels of corticosteroid hormone in the plasma was delayed in the selected foxes. So, only by selecting on one trait the animal changed their physical appearance (Belyaev et al., 1985). In a similar selection study done on mink they also investigated the behaviour differences between the two strains. It started in Denmark 1988 where the selection test was based on the approach/avoidance theory. By putting a stick in to the cage the researchers could score if the animal approach the stick (considering as confident) or if they avoid the stick (considering fearful).

Malmqvist and Hansen (Malmqvist and Hansen, 2002) did in 1998, 10 years after the selection process started, an extensively investigation on behaviour differences between these two strains of mink. They put the minks through the stick test, Trapezov's hand test, novel object, social test, novel food test and a x-maze test. The conclusion they could draw from the results were that the strain that reacted fearful to the stick in the selection test also acted more fearful in all the test situations. This is also in line with a study done on quail where they have selected for animals that stay long (high stress) or short time (low stress) in a passive stress reaction state called tonic immobility (TI) where the animals is lying on its back in a cradle. The quails that stay longer time in TI were generally less fearful than the animals that were selected on longer duration in TI, this is based on a number of tests and studies (Jones et al., 1994; Jones et al., 1999; Satterlee and Marin, 2006; Satterlee DG, 1993). All these results strengthen the experiment done by Belyaev; selection on one specific trait will affect the overall behaviour of the individual.

### **Behaviour differences, no differences?**

Since humans offers a quite safe environment with shelter, food and protection against predators and climate, domesticated animals are less fearful and they may also have modified their food search strategies (Kohane and Parsons, 1988).

Although there are behaviour differences between the wild and the domestic animals it is mainly not in the ethogram but in the threshold for different behaviour (Price, 1999). Hens for an example, selected for high egg production perform the same behaviour as a Junglefowl does in a new group situation, but they differs on a quantitative basis (Boice, 1973; Väisänen et al., 2005) One difference between the domesticated chickens and the wild type can be seen in their foraging strategy. Where the wild type performs more contrafreeloading and is not satisfied by finding one good food source as the domesticated chicken is. Contrafreeloading is the term that is used when an animal put more energy in to the actual search

for the food than necessary; they can even have a feeding trough but continues to search for another food source. The reason for this difference can be explained in many ways but one is that the domesticated hens, selected for high egg production, have a higher growth and reproduction investment, which in turn leads to a higher need of food and energy hence the decrease in contrafreeloading (Lindqvist et al., 2002; Schütz and Jensen, 2001).

## **Poultry in general**

### **Short background of the domestic chick**

The domesticated chicken as well as the ancestors belongs to the genus *Gallus* (Junglefowl), which contains four species; there are 1) *Gallus gallus* (Red Junglefowl), 2) *Gallus sonneratii* (Grey Junglefowl), 3) *Gallus lafayetii* (Ceylon Junglefowl) and 4) *Gallus varius* (Green Junglefowl) (Al-Nasser et al., 2007). The Red Junglefowl (*G. gallus*) was believed to be the sole ancestor of the domesticated chicken (Al-Nasser et al., 2007; Collias and Collias, 1996; West and Zhou, 1988) until 2008 when (Eriksson et al., 2008) investigated the origin of the yellow skin that is abundant

among domesticated chickens. Surprisingly this trait probably originates from the Grey Junglefowl which means that the domesticated chicken probably is a hybrid between the Grey and the Red Junglefowl. The Red Junglefowl lives in India, China, Java, Malaysia, Indonesia and Philippine. They live in habitat such as field edges, groves and scrubland.

The domestication process started at around 8000 years ago (West and Zhou, 1988) in South and Southeast Asia and probably started out simultaneously in different countries in Asia (Liu et al., 2006).

### **Behaviour of the red jungle fowl**

The red jungle fowl are smaller than the White Leghorn Layer, a hen weighing about 800g (compared to the layer that weighs about 1,5 kg) (Appleby et al., 2004). There is a big sexual dimorphism with the male larger than the female and more colorful. The female is mostly brown and the male red on the neck and back and have long black (almost shimmering blue, purple and green) feathers on the tail. The red jungle fowl is not domesticated which means that

they behave unaffected by humans. When Collias and Collias (1967) went to North-Central India to study the behaviour of the wild jungle fowl they were impressed by their great wariness. In the wild it is a big advantage to be pre-cautious since there are a lot of predators in the jungle those preys on chickens. If the jungle fowls were disturbed or frightened they moved their roosts 90 meters or more the next night and they also reduced their crowing, even at dawn (Collias and Collias, 1967).

The baseline of the social composition seen by the wild red junglefowl is a harem-group with one dominant male, one or a few subdominant males and a couple of females in a ratio of 1:1-1:4 males to females (Collias and Collias, 1996). The harem appear to change structure over season, during the breeding season the females leave the male to incubate and raise their broods alone, during this time male-only groups can be formed (Collias and Collias, 1967; Sullivan, 1991). It is nevertheless not only the male that decides which individuals the flock will consist of; the female-female relationship is also of great importance for the bonding in the

flock (Sullivan, 1991). The hierarchies are sex-specific and a high-ranked male have more access to females and are more vigilant than a low-ranked male, though studies there is known that there are no differences between the undomesticated chicken compared with the domestic breed (Banks, 1956; Pizzari, 2003).

### **Welfare and conventional industry of poultry**

In the last 30 years the breeding of chickens has been targeted towards commercial breeds. There are two main types of chicken, egg-laying type and meat type. Both have been selected for high efficiency, either in growing rate or in egg laying, for as little food as possible (Appleby et al., 2004). As an example of the increase in egg laying the 300 eggs/ year that is laid by a hen bred for egg laying can be compared to the 10-15 eggs that a Red Junglefowl is produced during a year (Romanov and Weigend, 2001). In the conventional egg industry in the EU, with the free-ranging hens, it is allowed to have 9 hens per m<sup>2</sup> (C.o.t.E., 1999). In a housing system there can be thousands of chickens

together, all of the same breed, sex and age.

Even though the behaviour repertoire has not change during domestication the environment for the animal has. The environment for the domesticated animals are not always similar to the area for the wild animals, but does it has to be? Wild animals use an area depending on a lot of things such as food and water supplies; social interaction, shelter and the area can be different varied with season (Gibbons et al., 1994). It is not necessarily so that species that have large areas in the wild need the same area in captivity. All depending on why the species use a big area in the wild, if it is due to search strategies and the distribution of food abundance or if it is because of need for locomotion or activity. Animals in captivity are almost always served with food and shelter and do not usually need a large area due to that. It is important that the space area provided for the animals are behaviorally relevant for basic behaviour patterns (Price 1999). Nevertheless, even though man usually provides the domesticated animal with food and shelter it can still be a scarce resource

depending on the stocking density of animals and eg food bowls, nesting areas, dust bath area and drinking nipples that are provided for the animals.

## **Social behaviour**

### **Why is social behaviour interesting?**

Why is then social behaviour interesting?

Almost all domesticated animals are social animals, which is one trait that is common to almost every domesticated species (Keeling and Gonyou, 2001), social animals have in general a hierarchy order more than they are territorial which means that they can live in groups without fighting (Boice, 1973). During the process of domestication, especially during the last 30-40 years some characteristics has been favored over others such as egg laying, mentioned previously. When selecting for one specific trait such as egg laying, other behaviour will be affected as well. Some characteristics that are important to have in the wild is not of that big importance in captivity, when food and shelter are provided. What happens then to social behaviour when it does not have to be favorable to be scared, aggressive and curious? Domesticated animals tend to adopt a more energy conserving

behavioral strategy, as we seen previously in foraging behaviour described in Lindqvist et al (2002) and Schütz (2001) is a good example of. This can be due to that the evolution of domestication has favored those individuals that adopt a more energy conserving strategy. There is also less agonistic behaviour in domesticated animals compared to the wild type which can be explained by the simple fact that it is more difficult to handle aggressive animals and that trait has not been favorable by humans (Keeling and Gonyou, 2001). In the wild, on the other hand, aggressiveness can be necessary to have to increase the chance of surviving for instance when food supply is scarce or for reproduction success. Social behaviour has then probably been changed during domestication or at least the threshold and the frequency of social behaviour. The social environment for the chickens has also been changed drastically. Is it possible that the alteration of behaviour has been changed simultaneously?

### **Hierarchy and social recognition**

The hierarchy structure can differ depending on species, it can be formed

as a pyramid, a triangle or it can be linear. In the case of the chicken, the hierarchy has seen to be linear, with one dominant or hierarch and then the individuals follow in order down to the one at the bottom of the pecking order (Chase, 1982).

In captivity, especially among animals in de production industry, all the animals are usually of the same age and sex. This can have an impact on e.g. sexual behaviour (Price et al., 1994). It can also have an impact on dominance and hierarchy order. Under natural circumstances a group of animal usually consists of both juvenile and adult animals. An older animal is normally considered as a high-ranked animal and are dominant over juveniles and if the subordinate behaves appropriately it inhibits aggression from the dominant individuals. When the group consists of a lot of animals that are of the same age the ranking and the dominance hierarchy cannot function correctly (Keeling and Gonyou, 2001). Who becomes dominant and who becomes subdominant then? Although there is evidence for individual characteristics of poultry that makes an individual high-ranked such as hormone levels, size and aggressiveness (Collias,



1943) the hierarchy formation does not seem to be that easy. It seems that mechanisms within the group also play an important role (Bradshaw, 1992). There have been a lot of studies done considering the effect of trained winning and trained losing for an individual and the hierarchy position. In a study done by Kim and Zuk (2000) on dominance and hierarchy formation in red junglefowl females their conclusions were that social experience, age and aggression has bigger impact on social status than other attributes such as morphological traits that has been seen important in males (Kim and Zuk, 2000).

In the formation of the hierarchy within a group the individuals has to be able to recognize each other (Croney and Newberry, 2007). This requires social discrimination which is a specific type of memory that differs from other types of learning and memory (Bielsky and Young, 2004). It has been seen that domestic hens has a restricted social memory and that they will treat an individual as a stranger if it has been separated from the flock for a few weeks (Keeling and Gonyou, 2001). The ability to recognize other individuals in a flock

requires cognitive capacity and this differs between species (Bond et al 2003). Sheep for example has an ability to recognize faces of at least 50 other sheep and remember it for 2 years (Kendrick et al. 2001).

There are several studies done on species ability to recognize flock members on an individual basis by olfaction or by vision (Bielsky and Young, 2004; Boysen and Berntson, 1989; Brown and Smith, 1994; Hojesjo et al., 1998; Roeder, 1980). In Guhl and Ortman (1953) they changed the appearance of hens and introduced them in to their home pen with their flock. It was, interestingly, only when they changed the colour of the chickens that they got a difference in behaviour from the flock mates meaning that they challenged them in an aggressive way (Guhl and Ortman 1953). Later on several studies has strengthens the indication that eye sight is important in social recognition in chickens (D'Eath and Keeling, 2003; D'Eath and Stone, 1999). Dawkins (1995) find that chickens are unable to tell a familiar chicken from an unfamiliar if the distance is longer than 30 cm from the individual. For them to recognize an

individual they use their binocular vision and can only focus at a very short distance (Dawkins, 1995).

But it is difficult to be sure on what is measured in a social recognition test. Hens can be trained to recognize individuals by operant conditioning (Abeyesinghe et al., 2009) but it can be important to distinguish between what the animal has been taught to do and what they do spontaneously (Dawkins, 1995). Most studies done on social recognition in chickens are directed towards vision but respect to odor has not always been taken. It is therefore difficult to be sure that the chickens only use their vision in these studies. Hirao and Sugita (2009) proved in their study that chicken females uropygial gland acts as a social olfactory cue. So, chickens do use their olfaction as a social discriminator (Hirao et al., 2009) and odor has to be taken in respect while constructing a social recognition test.

### **Group size and social structure of the domesticated chicken**

When animals live in captivity their social environment can be very different from the wild. It is difficult to measure the optimal group size of a species,

especially since the group sizes for the wild type varies between seasons and are usually not very stable (Keeling and Gonyou, 2001). The populations densities in captivity can be far above the natural level and this have effect on the animals' behaviour. Farm animals are most likely to deal best with group sizes and structures as their wild ancestors live in, in terms of that social behaviour, communication and recognition abilities of individuals are probably designed for that (Keeling and Gonyou, 2001). Even tough domesticated animals seem to be less aggressive than their wild ancestors (Künzl and Sachser, 1999) there can still be problems with large groups. If the group is larger than the capacity for the animal to recognize individuals it can be an increased aggression in the group. This due to that the individual has problem remember previous interactions with group members (Croney and Newberry, 2007; Guhl and Ortman, 1953). On the other hand it has been hypothesized by Pagel and Dawkins (1997) that it is only beneficial for the animals to establish a hierarchy if it is likely for the animals to meet the individual twice, other wise it is to

energy demanding (Pagel and Dawkins, 1997), and that could be the case in the conventional chicken industry. It has been seen in later studies that the aggressiveness decreases linear to an increase of the group size (Estevez et al., 2003). In D'Eath and Keeling (2003) hens in large groups (120 group members) did not show more aggression towards a stimuli animal that was familiar than an unfamiliar stimuli animal, in contrary to hens that lived in small groups (10 group members) that showed more aggression towards the unknown stimuli animal. This could indicate that hens living in large groups do not have the conventional hierarchy that the jungle fowl has (D'Eath and Keeling 2003). But less aggression in a large group could also indicate that the chickens form subgroups, within the big group, that limits the space an individual is using and also the probability to meet a stranger, hence less aggression level in a big group of chickens (Grigor et al., 1995; McBride and Foenander, 1962) In a group of 12 individuals the pecking-order is very stable and the dominant individual will maintain their position only by threatening behaviour and the aggressive level is low (Guhl and

Ortman 1953). Hughes et al (1997) agree with Pagel and Dawkins (1997), mentioned before, that in a large group it could be beneficial to change strategy depending on the situation not to have the same kind of social structure as in a small group where there is an established hierarchy. To have another social structure e.g. more tolerant in a large group would lead to less agonistic interactions between individuals and instead a strategy of high social tolerance towards each other (Hughes et al., 1997). Domesticated pigs as well as chickens seems to be able to alter their behaviour according to how the actual competitive situation changes with group size (Andersen et al., 2004). Is it possible that we have, through breeding, created breeds that are flexible and “made” for this kind of husbandry?

### **Social synchronization in chickens**

Group living animals have some advantages compared to solitary animals such as protection against predators and exploitation of resources. Social facilitation is one way to optimize these advantages and therefore most group living animals are more or less social synchronistic (Clayton, 1978).

In domestic animals welfare problems such as feather pecking may partly have their origin in failure to synchronize. It has been seen that severe feather pecks are more directed to inactive individuals than active. If the animal group is synchronized properly the individuals will be active at the same time as well as inactive at the same time. Chicks that have been brooded by a hen appear to be more synchronized in their behaviour than non-brooded chicks. The chicks are motivated to follow the hen in her behaviour and she also promotes them to follow her. During feeding for instance, she calls and makes the characteristic tidbit call which encourage the chicks to eat, all at the same time. When it is time for resting she lays down and this motivates the chicks to come and lie down under her, which also helps them to keep their body temperature. Resting in the dark seem to be a crucial factor for synchronization since it has been seen that chicks that only have access to a dark brooder (not a real hen) have better synchronization than chicks that have been reared without either hen or brooder. There seems to be a long-term effect when chicks are raised and

brooded by a hen, even at 28-29 weeks of age they spend more time in the proximity of conspecifics than non-brooded chickens. This could be due to the fact that they are more synchronized than the non-brooded chickens. In the chicken industry of today the chickens regulates their temperature by a red heating lamp which ?? (Riber et al., 2007).

### **Sociality- the motivation to be with other conspecifics**

Almost all domesticated animals have one trait in common, they are all social animals. The term social can be divided into several dimensions, where sociality is one. Sociality refers to the motivation animal possess to be with or near other conspecifics. The level of the sociality differs among species and individuals but is vital in a wild living social animal. In the wild, the formation of the group is species specific and the animals underlying need for social companion is usually fulfilled. The situation is different in captivity where the animals are placed into a social environment that is not necessarily the best for the species, for example with large groups in a high density, and groups of single-sex and

single-age (Jones, 1996). The chickens in the conventional egg and meat production live in high dense population, in Sweden it is allowed to have up to 20 individuals /m<sup>2</sup> for meat production and 9 for animals in the egg production depending on the housing system used (Swedish agricultural board), which is very different from the group composition of the wild Red Junglefowl. A mismatch between the environment an animal is offered and the animal's underlying sociality could cause welfare and performance problem (Jones and Hocking, 1999). This difference in the social environment may have caused some changes in the social behaviour for the domesticated animals (Eklund and Jensen, 2010) Domesticated guinea pigs for instance have a different social pattern than their wild ancestor the Cavy. Guinea pig males are able to have small hierarchies close to each other and coexist contrary to the cavy, where males normally attempt to monopolize all the females (Künzl and Sachser, 1999).

One way of measure sociality in chickens is the social reinstatement test (Jones et al., 2002) . The bird is placed

in a corridor divided into different zones and that holds some conspecifics in one end. Interesting variables are the time it takes for the individual to reinstate with the conspecifics, the total length the chicken walks during the test and also how long duration the chicken stays in one specific zone. In general, the sociality in the domesticated chicken compared to the wild type is poorly investigated there is a few references such as (Väisänen et al., 2005).

Another dimension of social behaviour is the social tolerance. Social tolerance refers to the ability to cope with the density of the social environment and is yet one trait that seems to have been affected by domestication, mostly by unintentional selection. The animals that cope well with the social composition are less stressed by the environment and will therefore breed more successful than the affected animals. One species where the difference in social tolerance has been documented is the rat, where the wild rats are more aggressive towards each other than domesticated rats (Boice, 1981). Again, comparisons between the wild type and the domesticated chickens are scarce just as

for the sociality. Nevertheless there have been studies done where researchers have compared different social situation in the domesticated chicken. D'Eath and Keeling (2003) compared chickens that lived in large groups (120 individuals) with chickens from small groups (10 individuals) and reported that those in the large group showed less aggressive behaviours than the birds in the small groups. This can be interpreted in several ways. Perhaps the domesticated animals are able to change their social behaviour depending on the situation, or they are not able to recognize as many individuals as 120 and therefore they have difficulties in establishing a proper hierarchy (D'Eath and Keeling, 2003). It is reasonable to believe that both the sociality and the social tolerance are probably connected to recognition and hierarchy. If the animal has a strong underlying motivation to form a stable hierarchy in the group or if the individual is very dependent on the social interaction between the members of the group it may be difficult to cope with a high number of individuals. Further studies need to be done of the differences in sociality and social

tolerance between the domesticated chicken and the wild type.

The degree of the sociality and the social tolerance of an animal can also be related to fearfulness and stress (Boice, 1973; Jones et al., 2002; Marin et al., 2001) If the animal is stressed or has a low stress tolerance then it is more likely that the individual has a lower sociality than if it is in a calm state or has a high stress tolerance. An animal that copes well with the social situation, probably has a higher social tolerance, a higher sociality and produces more in the industry (Jones and Hocking, 1999). This could be desirable traits from the farmer's perspective. On quail a long-lasting study actively selected for high or low sociality using a social reinstatement test (Jones and Hocking 1999). After 26 generations there was a significant difference between the two strains. If the social disturbance is reduced through a high underlying sociality the productivity is likely to increase in terms of growth, egg laying and food consumption since the animal is better to cope with the situation in the housing system (Jones and Hocking, 1999).

To learn more about the underlying mechanism in both sociality and social behaviour further studies needs to be done. By doing studies that focus on how the domestication process has affected these traits we can be able to distinguish between social tolerance and

sociality. It is probably more energy demanding to have a high sociality than to have a high social tolerance and therefore it would be expected that the domesticated animal in general possesses a higher tolerance and reduced sociality.

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