Animal housing systems, behaviour and welfare

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1. A historical overview of developments in opinions about animal behaviour

The term behaviour refers to the way of behaving whereas the term behaviourism refers to the direction taken by the psychological research initiated by J. Watson and introduced to science in the 20th century. Behaviourism research involves studying people and animal behaviour as a set of reactions to external stimuli. Already in ancient times many philosophers were interested in the basic issues of behaviour for which there is, however, no univocal definition. Stoic philosophers, particularly Chrysippus, created the term animal instinct. They described the advisability of animal actions and attributed it to the cosmic mind at work in them. Animals pursue pleasant things and avoid difficult and harmful experiences. According to the Stoics, birds, for instance, build nests without any understanding of the activity itself, and bees make wax honeycombs and spiders make webs because they are guided by the part of the cosmic mind within them.

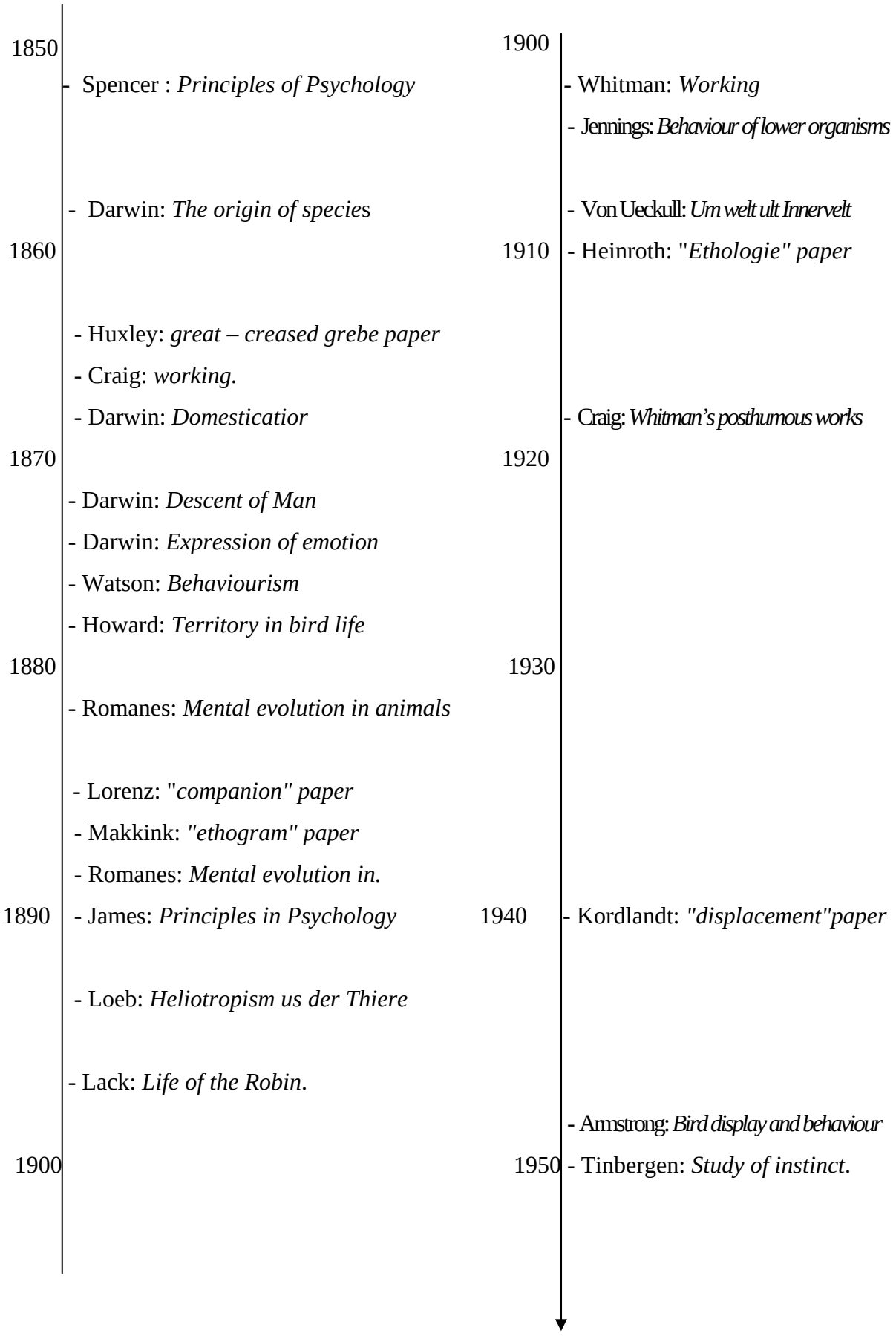
According to Saint Thomas Aquinas, animal instincts lie behind their natural behaviour and are signs of divine activity taking place within them. It is undeniable that animals feel and remember although they lack reason, and this is why they rank lower than humans in the hierarchy of organisms. According to theological philosophy, as a thinking creature a human being was created to rule animals but in such a way that everything exists in harmony with nature.

An essential step in the development of views on animal behaviour was taken by Darwin (*The Origin of Species*). He supported the existence of animal instinct as a compulsory impulse determining behaviour. Darwin undertook the difficult task of providing a natural explanation of the propriety of animal instinct. According to his theory, all animal behaviour in some way depends on the structure of the nervous system and sense organs, which means that any improvement changes their behaviour. Natural selection, which eliminates defects and retains only the most useful changes, determines the propriety of changes and their harmony with living conditions. This rule was defined by Darwin as the "selection rule" and it appears to be a decisive factor in the formation of animal behaviour.

In the 20th century, Watson (1930), mentioned above, stated that the outside environment has the greatest influence on animal behaviour. This theory discounts the role of genetics in shaping

overall animal behaviour. Skinner (1958) was of a similar opinion when he wrote that all cases of behaviour can be explained by stimulating the responses of animals living in different environments. In their descriptions in the 1960s, Brelands and Brelands (1961) stated that animals' natural instincts play a significant role in their behaviour. They therefore consequently confirmed the thesis put forward by the Stoic philosophers. More important developments in the creation of behaviourism theory are presented in Fig. 1.

Fig. 1. Developments in the study of animal behaviour from 1850-1950



1.1. Animal behaviour in the natural environment

Technological and structural changes in the agricultural economy, such as mechanisation, chemisation and multigrain fields, and also changes in the forest economy, led to the disappearance (*Lepus timidus*, bustard, grouse) or the decrease (bears, wolves, lynxes, otters, European minks, chamois, etc.) of many animal species. The characteristic feature of many species living at large is separateness as well as considerable behavioural polymorphism, which is dependent on species, lifestyle, environment and other features that are defined by the term natural behaviour.

A wild boar, as the equivalent of a pig, has a strict hierarchy ladder. This scheme is derived from two essential, yet seemingly contradictory, behavioural features of wild boars, namely low mutual tolerance of individuals and pack (flock) organisation at the subpopulation level. A clear scheme of mutual interpersonal relationships must be developed for these two above-mentioned features — which have a strong integrating effect within the population — to prevail.

Determining mutual relationships among individuals to define an individual's place in the population depends on factors such as gender, age, body weight and reproductive status in the case of mature females. It can be assumed that individuals that fight eagerly and frequently occupy higher hierarchical positions in their social category than passive animals, poorly trained to fight. The population's high level of intelligence brings about incredible stability within the herd structure. It is formed annually in early spring, i.e. after farrowing and the short lair period when the sows begin to lead the young to the feeding grounds. The herd structure formed in this period remains unaltered (regardless of changes resulting from mortality) until the beginning of March the following year, when the pregnant sows get separated from the pack to raise the young in the places of their choice. Wild boars quickly find and recognise the resources needed for sustenance, especially food. They also show a noticeable attachment to the chosen feeding grounds and therefore, during the period when the food appears in particular places, the herd or a solitary individual constantly return to them. In addition, potential feeding grounds are chosen on a particular scale: from the most valuable to the least valuable places for feeding.

Another indication of animals' natural instincts is the behaviour of wild ruminants (Lambert, 1998). The example given here is a roe deer recognised as a typical forest species. However, on account of changes in the natural environment, it has become accustomed to life in the open rural environment. The new habitat has required drastic changes in terms of space usage and the social organisation of the species population. Large groups of roe deer can be spotted in rural environments thanks to the possibility of maintaining eye contact and the openness of the surrounding area. In the field environment, deer are strongly attached to places where trees and

bushes grow. Territoriality developed as a strategy for choosing partners in low-density forest populations and this is the difficulty for populations living in high density or open areas. Despite the fact that it forms large groups, the roe deer population is organised into family units. This fact, as well as the relatively high level of intolerance among male deer, hampers the roe deer's development of social structures typical of herd animals living in open spaces.

Examples of behaviour of small ruminants living at large, that find their equivalent in reared animals, are sheep, goats and chamois. Like horses or cattle, sheep and goats have a strongly developed herd instinct. This instinct is characterised by the aspiration to gather in a herd in situations of danger, and submission of individuals to the behaviour of the herd as a whole. As members of a herd, animals react in different ways depending on herd composition. The flock of adult mothers reacts differently to adult males or young members. The reaction is different in herds with animals of different genders and ages, e.g. mothers with their young or flocks roaming free, where animals of all ages of the particular species can be found. The results of observations made are that a social hierarchy has existed for a few generations in flocks of sheep and goats staying in a specific environment. It generally depends on the age of individuals. The flock is usually led by the oldest ewes together with their lambs. Female offspring from previous lambings follow the ewe, very often with their own young. The social hierarchy created in this way may be disrupted in a situation where ewes brought up outside the flock enter another flock. Contention and fighting, which lead to a new hierarchy, are very common.

Chamois live in flocks led by the oldest female and become part of larger flocks with their young. Older male goats lead a solitary lifestyle, approaching the flock only at mating time when they fight for females. Sheep, as well as goats and chamois, belong to animal species which are easy to tame. This natural herd behaviour was the reason why they were chosen for breeding and it influenced the creation of particular farming and rearing systems.

The behaviour of horses is an example of typical changes in natural behaviour originating from the evolution of environmental conditions in which the animals live. Despite a vast number of observations made regarding horses, scientists still know little about their true nature, psyche and natural behaviour of horses. The essential rule on which most cases of horse behaviour are based is escape. Surviving on steppes with no trees or places to hide became possible thanks to the structure of the horse's body and its well-developed senses. The horse's psyche also orders it to react to strength with strength. This means that the resistance it meets in a moment of fear will be counteracted using force. The greater the resistance, the stronger a horse's reaction will be, and this can lead to an animal injuring itself in moments of great fear.

Horses have a remarkable sense of hearing owing to the shape of their ears which they can move in any direction. When a horse senses an obstacle it cannot yet see it begins to snort, and the echo

reveals the position and approximate distance of the obstacle. Some horses test unknown areas or deep puddles in this way when they are not able to assess these obstacles with their sight. A horse can see two pictures at the same time. Its sight organ is designed in such a way that it is able to analyse and evaluate two separate pictures coming from different eyes or receive one picture stereoscopically while looking ahead. Moreover, a horse's sight is so developed that it can see every movement, even the slightest or fastest one, which is invisible to the human eye. A horse sees it as if at a slower pace. These elements also affect the shaping of natural impulses in an animal. Another characteristic feature of horses is a very well-developed sense of smell and touch. A horse feels warmth, cold, pain and the slightest touch through its skin. There are single long hairs (vibrissae) situated around the eyes and nostrils, that are extremely important parts of the horse's touch organ.

Horse hooves play an essential role in forming their behaviour. Thanks to their specific build (the bottom part is quite sensitive) horses recognise soil types and find a suitable path to walk along. Horses are naturally gentle but timid animals and 90% of changes in their behaviour are due to the influence of human activity. Horse behaviour, just like that of cattle, sheep and goats, is characterised by their typical herd instinct. One example is a mare's behaviour around the delivery period. Just before parturition, a female animal withdraws from the herd a little to give birth to her offspring at night or in the early hours of the morning. This kind of behaviour is deliberate as a herd moves towards different places to search for food during the day. Giving birth at night and adapting the young to standing up quickly and following their mothers protects females and offspring from any danger from predators as they stay with the herd. The females of the above-mentioned species protect their young against individuals from their own herd by avoiding direct contact and staying apart from the herd for the first few days after parturition.

Another animal group with specific natural behaviour is birds. The types of environment in which they live in Europe can be divided up as follows: forests, fields, meadows, rocks and human sites. With the development of civilisation and rapid landscape changes, artificial and fairly dry steppe-like areas have emerged from the former forests. Species which depended on forest and mud habitats are endangered and failure to adapt to new living conditions in time has led to migration and death. This group of animals consists mainly of large birds, such as eagles, eagle owls, storks, herons, cranes, geese and wood grouse. However, comfortable living conditions have been found by birds in steppe regions or park environments. Birds are becoming increasingly common and appear in places where they were hitherto unseen. Most birds living in natural environments have the ability to fly and this differentiates this group of animals from mammals and accounts for its different behaviourism. Some species fly away in certain seasons of the year for their survival (hibernation). Migration connected with food-seeking shapes birds' natural behaviour. A typical

example of birds' adaptation to flying is building nests on tree tops, rocks and telegraph poles, etc. Development of civilization and climate changes in different climate zones have led to significant behavioural changes in birds migrating before winter. Many give up flying away and spend winter in the same place, often making use of food prepared by humans. Some examples of such behaviour can be seen in geese, swans and some storks.

An interesting example of birds' natural behaviour is maternal behaviour. In some species, the female hatches the eggs and feeds the nestlings and the male's role is restricted to building the nest and protecting the female. However, in the case of many other species, both males and females take part in the nest-building, egg-hatching and nestling-feeding processes. The vast majority of bird groups raise their young together, as opposed to mammals where this task falls to the female.

1.2. Understanding natural behaviour in animals

Ethology is the scientific study of behaviour in individuals or specific social groups (from Greek *ethos* — habit, character and *logos* — word, thought). Determining and examining regularities in complex forms of organism reactions to environmental stimuli, among others, fall within the scope of ethology. The acts of animal behaviour observed are caused either by unconditional reflexes (swallowing, copulation, nest building, egg hatching, defecation), or by conditional reflexes acquired during and beyond foetal life, as a result of experience, training or learning (seeking food, returning from pasture at a set time, getting into stalls or in line to be milked). Although the first type of behaviour is hereditary, behaviour connected with conditional reflexes is not handed down from generation to generation because it is not genetically conditioned (Lorenz, 1975; Lorenz, 1981).

When analysing both types of behaviour, one problem involves defining which acts observed in separate animal species should be qualified as normal and characteristic and which should be counted as abnormal and pathological. One 20^{th}-century behaviour research study (Hafez, 1969) distinguished nine basic animal behaviour forms.

1. Ingestive behaviour. This is characteristic of specific animal species. All individuals take food but different animals prefer different types of food and take it in different ways. Carnivores eat meat whereas herbivores only eat plant food. Among herbivores there is also a substantial difference in the choice of specific grass or plants. Without the specific plant type in the given area, there is no possibility of a specific animal emerging in that ecosystem. A similar situation can be observed among carnivores that choose some types of meat and are forced to hunt for other types if their preferred type is lacking.

2. Elimination behaviour. This concerns the frequency and amount of urine and faeces excreted by an animal, for instance. It is also related to the behaviour of many species that causes them to mark their territory (dogs, cats, wild animals). Essential species differences can also be seen in the way urine and faeces are excreted. Animals take characteristic postures (male dogs lift their leg, females crouch, etc.) and show characteristic acts of behaviour (looking for secluded places, burying faeces, etc.). When urinating, camels wave their tails to spread urine over themselves in order to make their smell stronger. White rhinoceros walk through their own faeces to spread their smell with every step. For all other animals, a characteristic personal smell is one of life's joys, a source of reassurance and comfort, and a way of consolidating a relationship among closely related individuals. It is used to find the way home, to mark territory and leave information for other herd members. Smell is also closely linked to animal reproduction.
3. Sexual behaviour. This is observed in all species and manifested in different ways. Animals choose specific postures; some species attract their females with a mating call and birds' feathers become brighter. There are also differences in sexual activity as well as in the length of male copulation. Polygamy can be observed in some species of birds and mammals. Differences in the mating and gestation period and the number of young in one litter influence the specific development of behaviour connected with sexual activity.
4. Care-giving behaviour — also referred to as maternal behaviour or maternal instinct. This describes the way a mother or both parents behave towards their offspring and differs between animal species. A lack of maternal behaviour points to disturbances in a female's behaviour, which is largely affected by the outside environment. The physiological conditions of newborns differ significantly from the needs observed in mature animals. Suckling, during the first 48 hours of their lives, organises their natural behaviour around finding their mother and food. Any object can be regarded as a mother when it emits warmth, is soft and provides food. According to many behaviourists, specific conditions can be created for newborns to maintain artificial breeding processes on large-herd farms, without any large-scale death being observed.
5. Care-soliciting behaviour is hierarchy-related and concerns species of animals living in herds. It has been observed that there are dominant and subordinate individuals, and this has an important effect on the characteristic behaviour of particular social groups in a herd.
6. Agonistic behaviour is often used to refer to the behaviour resulting from hierarchical attitudes. It concerns animals ranking higher on the hierarchical ladder in a herd in relation to individuals from lower groups and those who have recently entered the herd. This behaviour type is characteristic of herd animal species.

7. Allomimetic behaviour involves passing on behaviour from adult animals to their young. Nestlings, when observing their mother searching for food, try to copy her behaviour and so learn how to find food. A similar type of behaviour was also described by Lorenz (1981) and Tinbergen (1948) in water birds that jump into the water with their mother immediately after hatching and drying. Another example of this behaviour in mammals is the passing on of the hunting instinct which is mainly characteristic of carnivores.
8. Shelter-seeking behaviour. The characteristic feature of this behaviour is active defence against an enemy attack or escape in a situation when an individual has difficulty protecting itself. The self-preservation instinct also involves looking for shelter and unintentional self-injury in the face of danger. According to Lorenz (1981), the behaviour known as egg-rolling should also be counted as a self-preservation instinct which is particularly seen in water fowl. When hatching eggs, geese periodically turn them to maintain stable humidity in the various egg layers. Another example of the self-preservation instinct is the food-collecting behaviour characteristic of young as well as mature animals. Sucklings attempt to get food immediately after their birth as the small reserves gathered during foetal life are quickly depleted. Mature animals, however, get food to avoid the feeling of starvation (Grandin and Deesing, 1998). In a herd hierarchy, there are two types of social food-collecting activity: imitative and cooperative. In the first case, an animal heads towards the same place as the group and eats the same food as the others (shoals of fish, flocks of birds). Cooperative food seeking involves hunting together and cooperation in food collecting which would be impossible for a lone individual. This type of food seeking is mainly observed in mammals living in herds, e.g. lions and wolves (Wilson, 2000).
9. Investigatory behaviour. The characteristic feature of this behaviour is seen when animals approach unknown objects, show careful behaviour in new places and mistrust of new situations. This kind of behaviour, described by Lorenz (1965; 1975; 1981), is very often observed in newly bought animals. In herd communities it is observed in animals ranking lower on the hierarchy ladder. However, it is clearly expressed among wild animals living in the natural environment.

Understanding natural behaviour and its changes has led to the creation of numerous scientific descriptions, known as ethograms, which feature examples of specific behaviour, that is characteristic of particular animal species. The most famous and well-known are the papers by Lorenz (1965; 1981) and Tinbergen (1948; 1951) that include a complete list of behavioural acts observed in animals in the natural environment. The description of particular behavioural types was subordinate not only to the influence of the external environment but also to the species, age

and gender of animals. One example is the behavioural forms observed by Bokkers and Koene (2001) in calves after feeding.

Table 1
Ethogram used for time budget measurements and behaviour after feeding (based on de Wilt (1985))[a]

Behaviour	Description	Category
Standing	Standing without doing anything else	Standing
Lying	Lying without doing anything else	Lying
Manipulating object	Biting, sucking, licking at objects in its surrounding	Oral behaviour
Manipulating calf	Biting, sucking, licking at other calves excluding preputium	Oral behaviour
Manipulating preputium	Biting, sucking, licking at preputium of other calves or of its own	Oral behaviour
Sham chewing/ruminating	Irregular, repetitive biting without having food in the mouth	Oral behaviour
Tongue playing	Rolling movements with tongue which is inside or outside the mouth	Oral behaviour
Self licking	Movements with tongue over body surface	Self-grooming behaviour
Scratching	Scratching itself by its leg	Self-grooming behaviour
Rubbing	Moving body against walls or partitions	Self-grooming behaviour
Other	All other behaviours	Rest

[a] Behavioural elements are grouped in five categories.

2. Animal housing within production systems

In the age of intensive industrial development, characterised by intensive farming in which the amount of animals in the basic herd ranges from several hundred to several thousand heads, essential changes in animal production system development can be observed (Halverson, 1991). These systems seldom have any rules concerning welfare because they do not allow the basic needs of the animals living in them to be met, i.e.:

- Readily accessible food and water to maintain health and vigour,
- Freedom of movement to stand, stretch and lie down,
- Light during the daylight hours,
- Visual and social contact with other animals,
- Accommodation which provides protection from the weather and which neither harms nor causes distress,
- Freedom to exhibit natural behaviour,
- Rapid identification and treatment of vice, injury and disease.

Humans, as creators of the breeding environment over which they have control, are fully responsible for any changes taking place as regards the care of animals living in this environment.

Many production systems, which take animals' natural behaviour into account according to species, have emerged. One such behavioural type is the ability to live in a herd, which is seen in all farm animals. On this basis, different animal production systems have emerged for dairy cattle as part of the large-herd rearing process (Stookey, 1994). These systems are extensive and intensive. Within them, litter cowsheds (with free or tied stalls) and litterless cow–sheds — considered more economical to run and commonly used in the 1960s — were differentiated. Long or short stalls are used for dairy cows in the tied systems, and the free stall housing system (whether litter-based or litterless) is used for heifers and castrated bulls. In addition, a rearing system in a free-stall cowshed with an umbrella roof has been introduced for heifers. In temperate climates, it has been noted that bull fattening in this type of maintenance system in the autumn-winter period does not meet the basic animal welfare criteria because it leads to a considerable reduction in daily body weight growth and also intensifies the urge to jump in individual animals (defined as stereotypy). A determining factor in the specific rearing system's influence on the production and welfare of dairy cows and calves was the percentage of fertility and morbidity (Empel *et al.*, 1999) and the ability to express natural behaviour (Fraser, 1990). On account of their high injury rate (limb and udder injuries) and the curbing of animals' natural instincts (e.g. digging in the litter), litterless rearing systems have a very low welfare indicator and this is why they have been replaced by the litter system. A comparison of the effect of the maintenance system (tied or free stall and straw yard systems) on the incidence of lameness in dairy cows as a welfare indicator has led to the following conclusions:

- a link has been established between the tied system and an increase in disease with symptoms of lameness,
- the straw yard system has been shown to have a highly beneficial effect on dairy cows' welfare (Winckler and Willen, 2001).

Layered battery breeding systems have also been used for pigs in the large-herd management system, where many animals of similar weight are reared in a confined space. The conditions make movement difficult and the microclimate in this type of pig house has had an unfavourable effect on their health, leading to cases of disease and death, and consequently lower the production results. A similarly disadvantageous maintenance system with a very low welfare indicator is represented by the batch system. Excessive humidity, reaching 90% with a high animal density in a small space and restricted light access, severely impaired immunological status, and led to an increase in morbidity and mortality as well as a substantial reduction in the growth weight of porkers. We compared the effect of the maintenance system, according to the amount of livestock (extensive, intensive breeding) and the system of providing fodder, on pregnant sows' welfare

(Barbi *et al.*, 2001) in order to draw differentiated conclusions. It is suggested that pregnant sows kept in smaller groups have better behaviour, thus indicating higher welfare criteria in a given environment. In the case of fodder provision, animals receive more attention, and this improves the welfare level in a given environment. Two chosen maintenance systems, namely intensive and extensive, were also compared (Bea *et al.*, 2001) as indicators of two levels of welfare on behaviour and the physiological state of porkers. It was revealed that in a system characterised by a fully slatted floor and forced ventilation, in comparison with a system with a partly littered floor and separate lairs for animals (known as kennels) and natural ventilation, animals are much less social and this is negatively correlated with weight gain. The type of ventilation system used is also significant as it produces a specific housing micro-climate. The micro-climate in the room is one of the basic factors for creating the breeding environment. It has a direct effect on the organisms of the animals staying in it. Too high an animal density in a small area requires mechanical ventilation, one negative effect of which is excessive noise, that causes stress reactions.

One particular example of an alternative maintenance system in extensive breeding practice is tent- or sheltered outdoor breeding in which sows are kept outside the building, and a shelter (roofed coops or sheds) is available for each sow to protect them against unfavourable environmental conditions.

In poultry production, the following breeding systems can be distinguished, depending on the flock size, bird-keeping conditions and related cost restraints:

- Extensive system, mainly managed in the form of a stockyard, whose conditions are most similar to natural ones.
- Semi-intensive system, containing from one hundred to several hundred birds kept in special, separate rooms. The birds make use of the limited fowl runs, and feeding is based on special premixes prepared in the farming system with considerable use of industrial ingredients.
- Intensive system, designed for flocks consisting of several hundred to several thousand birds of one species kept in rooms. These are usually buildings without windows where lighting programmes are used. On such farms, mechanised feeding, water serving and ventilation are used. Feeding is based mainly, and in some species only, on fully proportioned mixtures.

On intensive poultry-breeding farms, two principal floor systems can be found:

1. Floors wholly or partly covered with litter, scaffolding or netting:

- the litter system is used for production of broilers, starter chicken flocks, laying hens, turkeys and water poultry. The breeding conditions are similar to natural ones.

- the rearing process on scaffolding or net floors is another form of bird-keeping in the floor system. It enables larger numbers of birds to be kept, isolates them from litter, makes it easier to clean and disinfect floors and buildings, enables multiple use of grates or nets and accommodates the brood without any additional waste. A variant of laying hen breeding on net floors is the Bressler system where a sloping net is used. The laid eggs roll down the slope and therefore avoid getting dirty. The disadvantage of this system is that it leads to stressful behaviour in flocks.

2. Cages and batteries; observations of birds in cage systems have revealed that hens are less active and more stressed (Duncan, 1992). Before laying eggs, they are more aggressive and restless than hens in a poultry house with deep bedding and nests. Criticism of cage breeding due to the birds' poor living conditions resulted in legislation prohibiting this bird-keeping system (Council Directive 99/74/EC of 19 July 1999).

The preferred alternative systems for laying hen breeding, which provide the most favourable welfare conditions in poultry production systems, are those with the following characteristics:

- roofed straw fowl runs,
- deep bedding,
- net floors,
- a building where birds perch on multi-layered platforms connected by ladders,
- hen roosts,
- multi-storey buildings.

Alternative breeding systems should provide birds with greater living comfort, movement ability, contact with surroundings, the possibility of clawing litter or using the fowl run, resting on hen-roosts and laying eggs in nests. Thanks to improvements in birds' living conditions, the eggs produced are heavier (by 2-6%) and thicker, with tougher shells. The negative effect of these systems is the higher production cost, which exceeds traditional hen production systems by 30% in terms of outlay. In a free fowl-run, breeding hens have free access to a grass-covered fowl-run during the day. According to EU regulations, 1,000 hens should be kept on 1 hectare, which amounts to $10m^2$ per hen. A fowl run covered with grass, bushes and short trees provides shelter against predatory birds and adverse weather conditions. Hens with access to the fowl run have intensely-coloured comb, beaks and legs, better feathers and a healthier liver, and are leaner.

Another type of alternative maintenance system is the aviary system. The maximum stocking density is 25 laying hens for a $1m^2$ area in a poultry house. This system covers several levels (platforms) in a building on which hens are kept (the maximum number of platforms being four).

Animal production systems aim for maximum use of animals. This concerns both meat animals (broilers, cutters, fowl) and reproductive ones. Hormonal manipulation of female productive cycles to increase litter size (sows, cows) does not have a positive effect on the physiological condition of these animals. For instance, respecting a cow's dry period enables full regeneration of the udder tissue. The intensive feeding system causes irreversible changes to the structure as well as the functions of the animal's alimentary tract. Too high an animal density in a small area limits movement and can lead to degeneracy in the osseous joint structures. The disadvantageous results of such high and intensive animal production are visible in production cycle diseases, or technopathies. The most common technopathies in animal production systems are given in Table 2.

The specific housing system environment is observed during transportation of animals over different distances (Van de Water *et al.*, 2003). There are many groups of stress-inducing factors, which are expressed by physiological and behavioural changes, for example:

- psychological stress
    - novelty, noise,
    - handling and mixing of animals during transport.
- environmental stress
    - transport duration and type of transport,
    - stocking density and ventilation.
- physical stress
    - fasting, fatigue, injury, thermal extremes, vibration.

These groups of stressors result in stress reaction which is observed in:

- changes in behaviour (balking, reversal, abundant defecation and urination, increase in aggression),
- increase in physiological stress and physical activity (increased muscle glycogen, pH, plasma cortisol, heart rate, rectal temperature),
- increased morbidity and mortality.

The intensity of stress reaction depends on the intensity of the stress factor(s) and general genetic differences.

Table 2. Common technopathies and their main causes in intensive production systems.

Kind of technopathy	Technological factors
1. Limbs and wings injuries, 2. Damages, wounds, impressions, abscesses of body surface, udders and teats.	• Litterless floors, restriction or lack of hoofs, • Bitings, tethers, high density, hen–coops with no ergonomy.
3. Disturbances in reproduction.	• Lack of movement, light, thermal stress, feeding errors.
4. Vagina, uterus and anus falling out.	• Tethering breeding systems, high stand inclination, • Fattening, multiple difficult parturitions,
5. Difficult/ or prolongated parturitions, 6. Retained placenta, 7. Metritis.	• Lack of movement during pregnancy, • Multiple pregnances, numerous, high lactation, • Insufficient sanitary care.
8.Metabolic disturbances: Investigation of feed, acidosis and alcalosis, fat cow syndrome, ketosis.	• Wrong feeding, too high exploatation.
9. Mastitis.	• Numerous lactations, wrong milking,
10. Lameness	• Metabolic disfunctions (acidosis), • Litterless floors, restriction, lack of hoofs correction.
11. Deficiency diseases: Hypocalcemia, hypomagnesemia	• Feeding errors, excersive exploatation.
12. Stereotypies.	• Wrong breeding environment, low welfare level, stress.

2.1. The effect of housing production systems on changes in animal behaviour

In natural conditions, animals are able to express their natural instincts, which include hunting, calling during the mating season and fighting to dominate a group. With major changes in the natural environment and constant human interference in development in the 21st century, profound

changes are being observed in the natural behaviour of animals — even those living at large. The processes of the intensive forest economy are, in some respects, contrary to animals' basic needs. The gradual rejuvenation of forests and their conversion to single tree species forests have changed the feeding conditions of herbivorous animals such as roe-deer. In addition, the number of these animals is now considerably higher than in the past. The effect of this is, of course, greater damage caused by animals which, because of a lack of natural food, are forced to eat agriculturally cultivated plants. This is one example of how animals living at large have been forced to change their behaviour in the natural environment.

The behaviour of domestic animals differs from that of their wild ancestors. This is also the result of deliberate genetic selection by farmers. Nevertheless, the presence of many behavioural features, characteristic of wild ancestors, can be observed in farm animals reared in groups or on pasture land. The herd, creation of hierarchy within a herd, acceptance of a particular type of behaviour, e.g. during the mating period, male domination over females or the possibility of adapting to new surroundings, should be mentioned here. A gradual deterioration of other characteristic behaviour, i.e., being watchful over the herd, aggressiveness towards same species members or humans, feeding (food-seeking connected with wandering), and also reproduction during particular periods, is unfortunately being observed.

Other examples of natural instinct disappearance in farm animals are the deterioration of nest building by birds, the lack of seasonal duck and goose wandering, a decrease in the clawing instinct and maternal behaviour minimisation (Duncan, 1998).

With regard to the self-preservation instinct, sexual behaviour has also undergone major changes. In comparison with the natural behaviour of animals living in the wild, this instinct has been seen to decrease in animals kept in intensive breeding systems. It is a somewhat unfavourable phenomenon on account of the limitation of reproduction possibilities and, consequently, the fall in animal production (Jensen, 1986).

The social behaviour of pigs kept in a breeding system similar to a natural one is very close to the behaviour observed in wild boars (Jensen, 1989).

During the gestation period for instance, the sow has characteristic behaviour, which includes:

- isolation from the group and nest site seeking,
- nest building,
- farrowing,
- nest occupation,
- nest abandonment followed by social integration of the piglets into the larger group of pigs,
- weaning.

This behaviour is also defined as being caused by a high motivation to perform and is conditioned by the physiological state of the female (Van Putten, 2001). Intensive production of pigs, based mainly on a reduction in the area available to one animal, has largely restricted the possibilities of expressing this and other natural instincts. Sows in intensive breeding systems live as long as four years and are kept in coops of 1.5m^2. During the lactation process, sows are also kept tethered to prevent piglet crushing. This system fully eliminates any possibility of freely expressing the above-mentioned behaviour. As a result of limiting the area available to piglets, social behaviour is non-existent, as manifested in the complete disappearance of play fighting or gathering instincts. This is the situation in intensive production systems where weaning pigs have an area of 30-40cm^2 per animal in a building. Weaning pigs gain weight in a few days and the boxes become too tight, after which they are moved to the fattening building where they have 60-70cm^2 of available space. These conditions do not allow social, food-seeking and other such instincts to develop.

2.2. Animal selection and genetic changes conditioning the production of animals with the required features for a given production system

The intensification of animal production has substantially contributed to a selection process aimed at producing individuals with the features most required for a specific breeding system. The development of the egg industry and growth in demand for laying hens have resulted in the creation of an artificial non-clucking hen breed (Leghorn). Hens of this breed lay eggs throughout the entire production cycle with no break for hatching. This has improved egg production efficiency on poultry farms.

Another meat production system, which makes use of domestic birds, has contributed to the creation of meat breeds, such as Sussex and Cornish breeds with a 4.5kg weight gain and Bramaputras and Kochinchi breeds with 5kg weight gain.

An example of mammalian genetic selection is the will to produce cows with a characteristic udder shape and teats of a suitable length and similar milking time. This involves interbreeding cow offspring with these phenotypical features. The introduction of artificial insemination quickly produced individuals with the necessary phenotypical features but also led to the elimination of animals with the undesired phenotype.

Pig genetic selection produced animals with a specific fat and muscle tissue structure and also pedigree animals with a particular litter size.

Another example of genetic selection is creating male breeding animals to produce the high quality sperm required for artificial insemination purposes. This has greatly improved the fertilization rate while increasing production at the same time.

Another aim is to produce animals with a particular number of offspring in a litter in intensive production conditions (multiple parturitions). To achieve this, related pairs from litters with the required amount of offspring are mated.

Intensive economic growth related to intensive consumption has also contributed to meat breeds, with fast-growing, high muscle mass animals. Numerous experiments have led to several cattle breeds of a particular type:

- beef cattle (Aberdeen Angus, Charolais, Hereford),
- dairy cattle (Holstein-Friesian, Jersey, Ayrshire),
- dual-purpose dairy/beef crossbreeds (Dutch Black and White, Black and White and Red and White; both bred in Poland),
- dairy/beef cattle (Normandy, Groningen, Polish Red, Pinzgauer),
- versatile, useful cattle (Simmental, Czech Gaudy, Watussi),
- other breeds (Romagnola, Hungarian grey steppe).

Genetic selection in sheep has largely influenced the creation of wool breeds (Merynos, Cheviot, Leicester, Booroola) and meat breeds (Texel).

It should be remembered, however, that although genetic selection produces animals with higher breeding value, the resulting breeds have higher sensitivity to external environment factors, a lower degree of resistance and lower adaptation factor in relation to changes in the farming environment. As a result, increased susceptibility to stress is observed in such animals. This finally leads to infections caused by conditionally pathogenic bacteria.

2.3. Abnormal behaviour as a result of decreasing welfare criteria in production systems

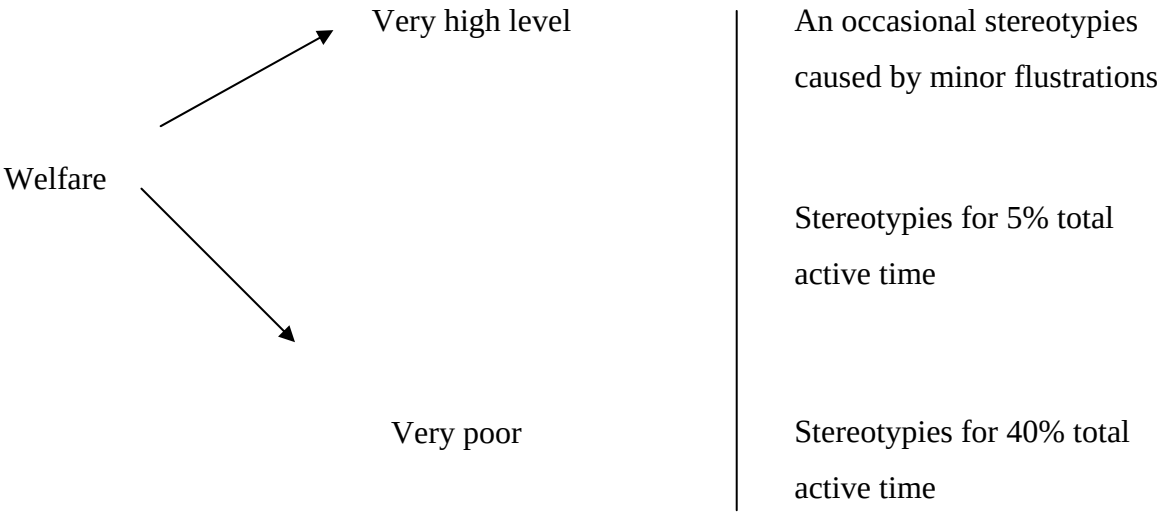
The breeding environment created by humans is far from perfect, as testified by numerous instances of unnatural behaviour observed in animals living in differentiated breeding systems. It can be assumed that certain groups of factors reducing the welfare rate are present in such environments and result in stereotypies. Environmental welfare-reducing factors include:

- feeding,
- microclimate,
- social and socio-living conditions,
- specimen properties.

The extent of abnormal animal behaviour observed depends on the species and the intensity of the effect of separate factor groups. Different reactions occur in single individuals in relation to those observed in other herd animals. These kinds of behaviour are defined by the concept of

stereotypies, and their existence proves the negative effect of the farm environment on the animal organism (Fraser, 1990). In the Fraser and Weary (1997) paper, the authors introduced a scale representing the link between welfare degree and the intensity of stereotypies in a herd (Fig. 2). The authors suggested that abnormal animal behaviour (stereotypies) is akin to animal dependence on endorphins, the opioids, produced by the organism during such behaviour cases.

Fig. 2. A scale presenting the frequency of stereotypies in relation to welfare (Broom, 1983)



Stereotypy types also depend on species and animal age. For instance, among pig herds, especially among young animals, cannibalism is a common stereotypy symptom. It can be observed in various different forms: animals bite off their tails, ear tops or even genitals. Among sows kept in the same pen, intense aggression can be observed which eventually leads to stress reaction symptoms (Arey and Edwards, 1998). Another example of stereotypies observed in pregnant sows living in too small a pen is tongue rolling, wall and floor licking, vacuum chewing and sucking and bar biting, which have been observed in 80% of cases (Vieuille-Thomas *et al.*, 1995).

Calves taken from their mothers too early lick one another's auricles, scrotums or foreskin (bulls). Another form of stereotypy is aimless wandering and also what is referred to as simulated life. In the case of adult cows, a frequently observed stereotypy is mutual suckling of teats whereas bulls have a tendency to sexual deviation (homosexualism, masturbation).

The most frequent stereotypy in horses is windsucking — a habit not entirely explained that involves biting the edge of the crib or some other object and swallowing the air. Other untypical

behaviour patterns observed in horses is crib-biting, weaving involving rhythmical oscillatory head movements, and also bolting, i.e., failing to respond to commands to stop. Another abnormality is masturbation in stallions, or homosexualism (Baker, 1986).

Untypical behaviour observed in poultry was most evident in hens which peck each others' feathers, starting with the tail and extending to the whole body.

Another example is pecking wattles and combs (or caruncles in the case of turkeys), and also eating their own eggs. This is a sign of one form of cannibalism and is generally proof of certain shortages in fodder composition (Calnek, 1997).

Pathological behaviour forms can be observed in all animal species which express pain reactions in their own characteristic way. Every animal responds to pain, whether external or internal. Pain usually increases aggression towards humans and other animals. This is seen in the way a sick animal attempts to avoid being touched on a painful body part. Many animals make specific noises, such as bleating (cattle) or neighing (horses) or show restless behaviour and stare at the pain source.

3. Human-animal interactions versus animal behaviour and physiology

Animals appeared on the Earth many millions of years ago. Since that time, and as a result of the changes that have taken place on our planet, species and animals' living conditions have adapted to the environment. Right from the moment when human beings first appeared in the environment, they began interfering by hunting animals for food. As time went on, people began to tame some species and started domestic breeding, and this led to changes in the natural behaviour of animals.

Ruminants, namely sheep, goats and cattle, quickly became acclimatised to domestic breeding. The beginnings of wild horse domestication are also connected with the emergence of trade. Horses were used for transportation purposes and as a source of meat and milk, and were also the means of communication for horseback guides leading sheep flocks. Many centuries passed before our ancestors realised they had a friend in this beautiful animal and stopped treating horses exclusively as prey to be hunted. However, in the nations that settled and lived off agriculture, horses were slow to find their application as all their existing roles were performed by donkeys and oxen. As warfare developed, horses that had been domesticated by nomads were incorporated into military units, and then into agriculture and transportation. Horses were a source of food and raw material to make clothes for primitive man. Horse domestication was a true turning point in human history. Horses were entirely subjected to human will and made fast travel possible, which turned out to be useful in warfare and conquering new territories. In times of peace, they were

essential in industry and agriculture. Developments in civilization have restricted their function. In recent years, there has been a growing interest in horse-keeping, and horses are now kept for sport and recreation, and considered as human pets.

The situation was entirely different in species that were not domesticated. This concerned carnivores which were unable to be tamed and bred. This is why humans gave up breeding them. The only animal whose domestication was successful and which has remained a companion for humans is the dog. Of all the omnivorous animals, pigs were tamed for consumption purposes (Fraser and Weary, 1997).

Interactions between humans and production animals remain an open issue among animal behaviour researchers. In the observations collected by a group of scientists under the leadership of Prof. Fraser, it has been suggested that human behaviour towards animals greatly influences both their efficiency and production indicators. Animals kept in large-herd systems are exposed to constant fear due to their contact with humans and this, depending on its intensity, may even lead to the appearance of panic fear. As a result, pathological changes in animal behaviour, existence of stereotypies, reproduction disturbances, unwillingness to feed and also increased aggressiveness in a herd can be observed. The result of research conducted on Australian pig farms is that in the reproduction industry, human-animal interaction has more serious consequences than in other production industries. According to assessments, the effect of fear resulting from this contact on sow reproduction indicators is 20%. Chronic stress connected with the negative relationship between humans and animals consequently leads to lower response rates and immunosuppression (Fraser and Weary, 1997). Moreover, it has been proven that people employed in animal breeding and having direct contact with animals should show kindness as a result of their convictions, so that animals accept humans as a part of their habitat (Hemsworth and Barnett, 1987). In the case of workers' intolerance to poultry, a decrease in egg laying in a laying hen flock was observed together with a decrease in broiler body weight (Hemsworth and Gonyou, 1997). There is also suggestion that animals kept in large-group systems experience chronic fear due to their contact with the people looking after them and even periodically experience acute fear.

Animals subconsciously sense human attitudes towards them and never fail to recognise danger. They can also recognise the friendly and warm feelings humans have for them. In his papers, Lorenz (1981) underlines the fact that animals can recognise extreme human feelings such as joy and sorrow. Animals are also recognised as being capable of showing human moods out of empathy with humans (dogs, gaggle geese). Such behaviour is conditioned by the link existing between animals and human beings. Lorenz (1975) gives an interesting example in his description of the behaviour of a jackdaw raised in a family as soon as it hatched. When it reached sexual maturity, the bird began to treat one of the family members as its partner and attempted to force

him to live in a nest it had built. Another example is abandoned dogs hankering after their owners who have died or left. The opposite case is the behaviour expressed by animals mistreated by humans. Distrust and fear are clearly visible and rapid movements in a human have been seen to result in immediate aggression to protect themselves against an attack. Through their behaviour, way of speaking, attitude to animals and also appearance, humans can produce many positive and negative reactions in animals.

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