

Linköping Studies in Science and Technology, Thesis No. 1439
LiU-Tek-Lic-2010:10, Linköping 2010

Maternal behaviour, infanticide and welfare in enclosed European wild boars (*Sus scrofa*)

A licentiate thesis by
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Foto: Åke Hjelm



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Andersson, A. 2010. Maternal behaviour, infanticide and welfare in enclosed European wild boars (*Sus scrofa*). IFM Biology, Division of Zoology, Linköping University, Linköping, Sweden.

ISSN 0280-7971

ISBN 978-91-7393-376-6

LiU-Tek-Lic-2010:10

Thesis No. 1439

Linköping Studies in Science and Technology

Front cover:

Wild boar sow (*Sus scrofa*)

Photo by Annelie Andersson

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Printed by LiU-Tryck

Linköping Sweden 2010

To my daughter My

ABSTRACT

European wild boars (*Sus scrofa*) are kept in Swedish enclosures for hunting and meat production purposes. The sows are known to undergo behavioural changes in connection with farrowing and their natural behaviours may be compromised by the limited area of the enclosure. The general aim of this thesis was to provide detailed quantitative data on wild boar sows when farrowing in captivity and to report whether possible needs can be compromised by the limitations of an enclosure. Specifically, it was aimed to provide a quantitative and functional account of the occurrence of infanticide, and its possible relations to welfare of confined wild boars.

A field study was carried out in a hunting enclosure, where 1200 hours of behavioural recordings and data from 22 farrowings were collected. The farrowing period could be divided into three phases: pre-farrowing, isolation and sociality phases (in relation to farrowing: day -14 to -1, day 1 to 8, day 9 to 14 respectively). The activity decreased during isolation and increased in the sociality phase. The average distance to other individuals increased during isolation and decreased in the sociality phase. Habitat use changed towards more protective habitats after farrowing (*Paper I*).

Non-maternal infanticide was documented in 14 out of 22 litters. Infanticide, typically performed by an older and larger sow than the mother, caused the deaths of all neonates in all but one affected litters. We found no effect of relatedness. A questionnaire sent to 112 owners of enclosures in Sweden and Finland resulted in 62 responses. Although the owners were often not able to provide exact figures on reproduction and mortality, non-maternal infanticide was reported to be the most common cause of piglet mortality. The occurrence of infanticide was unrelated to size of enclosure and to variations in husbandry routines. All together results may suggest that non-maternal infanticide is part of the normal behavioural repertoire in wild boars (*Paper II*).

The studies of this thesis reveals the farrowing period as the most dynamic and perhaps most challenging for wild boar sows in enclosures. There are serious welfare concerns in the husbandry of wild boars in Swedish enclosures. The most obvious welfare problem is non-maternal infanticide, where both sows and piglets are assumed to suffer, and where the outcome from the action must be considered unacceptable. If wild boar husbandry shall be equated with other animal husbandry in our society, it needs to be regulated to overcome many of the presented potential welfare problems in this thesis.

Europeiskt vildsvin (*Sus scrofa*) hålls i svenska hägn för jakt och köttproduktion. I samband med grisning genomgår suggan beteendeförändringar och där kan suggans naturliga beteenden tänkas hindras av de begränsningar som hägnet utgör. Det övergripande syftet med den här avhandlingen var att redovisa detaljerade kvantitativa uppgifter om vildsvinsuggors grisning i ett jakthägn, samt att rapportera om möjliga behov hos suggan äventyras på grund av begränsningarna av ett hägn. Särskilt syftar avhandlingen till att ge en kvantitativ och funktionell beskrivning av förekomsten av infanticid (kultingdödlighet orsakad av artfrände) och dess eventuella påverkan på hägnade vildsvins välfärd.

En fältstudie genomfördes i ett jakthägn, där 1200 timmar beteendebeskrivningar och data från 22 grisningar samlades in. Grisningsperioden kunde delas in i tre faser: grisnings-, isolerings- och sociala fasen (i relation till grisningsdagen: dag -14 till -1, dag 1 till 8, respektive dag 9 till 14). Aktiviteten minskade under isoleringsfasen och ökade i sociala fasen. Det genomsnittliga avståndet till andra individer ökade under isoleringsfasen och minskade i sociala fasen. Habitatutnyttjandet förändrades mot mer skyddande habitat efter grisningen (*Paper I*).

I 14 av 22 kullar observerades icke-maternell infanticid. Infanticiden utfördes vanligtvis av en äldre och större sugga än modern, och var orsaken till att alla kultingar dog i alla utom en av berörda kullar. Det fanns ingen släktskapseffekt på infanticiden. En enkät som skickades till 112 hägnägare i Sverige och Finland resulterade i 62 svar. Trots att ägarna ofta inte kunde ge exakta siffror på reproduktion och dödlighet så rapporterades icke-maternell infanticid som den vanligaste orsaken till kultingdödlighet. Förekomsten av infanticid saknade samband med storlek på hägn och variationer i rutiner för djurhållningen. Resultaten tyder på att icke-maternell infanticid är en del av den normala beteenderepertoaren hos vildsvin (*Paper II*).

Studierna i denna avhandling visar att grisningsperioden kan vara den mest dynamiska och kanske svåraste för vildsvinsuggor i hägn. Det finns allvarliga djurskyddsproblem i djurhållningen av vildsvin i svenska hägn. Det mest uppenbara välfärdspöblemet är icke-maternell infanticid, där både suggor och kultingar antas lida, och där resultatet av beteendet måste anses oacceptabelt. Om vildsvinshållning skall likställas med annan djurhållning i vårt samhälle, behöver den regleras för att övervinna många av de potentiella djurskyddsproblem som påvisas i denna avhandling.

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Photo: A. Andersson

*I: Behaviour of European wild boars (*Sus scrofa*) in connection with farrowing in an enclosure. Annelie Andersson, Riikka Äänismaa, Jenni Huusko and Per Jensen. Submitted.*

*II: Extensive infanticide in enclosed European wild boars (*Sus scrofa*). Annelie Andersson, Anna Valros, Johan Rombin and Per Jensen. Submitted.*

Annelie Andersson contributed equally with co-authors in shaping ideas, formulating questions and collecting data for both papers. AA organised field studies and contributed equally with Per Jensen in choice of methods in both papers. AA made the analyses and writing of both papers, all under supervision of Per Jensen.

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Regulated animal husbandry

The Nordic countries have a long tradition to care for animals, and today the animal husbandry is far more regulated than in many other parts of the world. Long ago, the Nordic climate with its long and cold winters made man dependent on animals and what they produced to survive. Life space and roofs had to be shared with the animals and this grounded the view on animals as creatures with needs and the view that man has an obligation to minimise suffering for animals in human care.

In Sweden of today, animal husbandry is strictly regulated for pets, farmed animals and laboratory animals. Cage sizes, group compositions, food regimes and bedding materials are some examples of areas which are regulated to ensure the welfare of the animals. Apart from those animal husbandries, wildlife animals are kept in enclosures. However, the detailed regulations which is needed to secure animal welfare also for wildlife animals is lacking for many of the species, as is the case for captive wild boars (*Sus scrofa*).

Poorly regulated wild boar husbandry

Today there are about 100 wild boar enclosures in Sweden. With a rough estimate these enclosures inhabit about 2000 individuals which mainly are kept for hunting and slaughter purposes. The husbandry of the enclosed wild boars is poorly regulated, at least regarding their welfare. To keep wild boars, as well as other wildlife animals in enclosures, permission from The Swedish County Administration Board is needed. The board controls that enclosures and animal husbandry follow the Swedish laws and regulations: the “Environmental Code” (SFS 1998:808, chapter 12, §11), the “Environmental Protection Agency's Regulations and General Advice on Wildlife Enclosures” (NFS 2002:20) and the “Animal Welfare Act” (SFS 1988:534). The “Environmental Code” rules out that the need of protection of outdoor life and environment of the nature shall be taken into consideration in the granting of permission for enclosures. The “Environmental Protection Agency's Regulations and General Advice on

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Wildlife Enclosures” give detailed regulations on how the enclosure shall be designed regarding fence net and fence posts. The basic principles are that the enclosed animals shall not be able to escape and that dogs and wild specimens shall not be able to enter the enclosure. The “Animal Welfare Act” rules out fundamental regulations on keeping and managing of domestic and/or confined animals. Paragraph 4 (4 §) of the “Animal Welfare Act” is especially important for this thesis. Paragraph 4 says that ”animals shall be kept and managed in a good animal environment and in a way that it promotes their health and bring them opportunities to behave naturally”. The government or an authority decided by the government can draw up further regulations on conditions for, or prohibitions against, certain animal keeping to provide that the “Animal Welfare Act” is followed (SFS 2007:362) and that e.g. 4 § is implemented. Such regulations are missing for wild boars living in Swedish enclosures today.

The absence of regulations for wild boars in enclosures is partly due to poor knowledge of the species and its needs in the captive environment. The about 100 wild boar enclosures in Sweden have strikingly varied designs. Sizes range from less than a hectare to several hundreds hectares, the habitats in the enclosures differ from homogenous fields or forests to heterogeneous landscapes consisting of many different habitats, and in some enclosures the wild boars are the only inhabitants while in others there are also other species such as e.g. mouflon (*Ovis aries musimon*) or fallow deer (*Dama dama*) (Andersson and Jensen, unpublished data). It is not investigated how the different types of enclosure design affect the welfare of confined wild boars and whether the design do hinder the animals to behave naturally. To examine and evaluate the behaviour of wild boars in captivity it is important to have basic understanding of their natural behaviours, why a literature overview of wild boar biology is provided.

Biology of the wild boar (*Sus scrofa*)

Home range

The annual home range of the wild boar is highly variable and has been found to be for example 3-24 km² (Boitani et al, 1994) and 40-150 km² (Janeau and Spitz, 1984), depending on habitat conditions such as food resources (Janeau and Spitz, 1984; Boitani et al, 1994; Mauget, 1981). The

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daily home ranges (which can be e.g. 60-75 hectares) vary depending on season (Janeau and Spitz, 1984), and can be linked to variations in food availability (Singer et al, 1981).

Habitat use

Food availability does not only affect daily home area, but also the habitat choice of wild boars (Dardaillon, 1987). When a habitat's main food supplies decrease it is left for other richer habitat types (Dardaillon, 1986; Massei and Genov, 1995). Habitat selection is also influenced by the availability of protective elements and soil moisture, where the protective element is preferred and soil moisture is avoided (Dardaillon, 1986).



Photo: A. Andersson

Wild boars are primarily forest living.

Wild boars are found in many different habitats such as open and dense forests, swamps and fields (Abaigar et al., 1994; Boitani et al., 1994; Spitz and Janeau, 1995) but are primarily forest living (Boitani et al., 1994) and commonly found in mixed forests, often with elements of pine. If the terrain is hilly or not, is of no significance for their use of the area (Abaigar et al., 1994).

Activity

Wild boars seem to prefer different habitats for different activities (Massei and Genov, 1995), which also is shown in confinement (Blasetti et al., 1988). In confinement the wild boars are inactive more than half the time and

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the rest of the time is mostly spent on feeding and locomotion (Blasetti et al., 1988) which is consistent with results from free living wild boars (Mauget, 1980a). Their activity pattern has been demonstrated to be diurnal in enclosures (Gundlach, 1968) and nocturnal in the wild (Mauget, 1980b), a dissimilarity explained as the wild animals adjusting to human hunting pressure (Stegeman, 1938; Briedermann, 1971a).

Social organisation

The social organisation of wild boars is highly dynamic and varies between seasons, with the basic unit consisting of related sows of several generations and their latest offspring (Gundlach, 1968; Dardaillon, 1988; Kaminski et al., 2005). As other social animals wild boars form a hierarchy, which is maintained by nose contacts and agonistic behaviours (Beuerle, 1975; Dardaillon and Teillaud, 1987).



Photo: A. Andersson

*Hierarchy is maintained by nose contacts and agonistic behaviours.
Defensive to the left, threatening to the right.*

Synchronised reproduction

Wild boars are seasonal breeders (Sáez-Royuela and Tellería, 1987). July to September is a seasonal anoestrous, depending on long day length, high average temperatures and relatively low access to food before the harvest

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ripens (Mauget, 1982). Within a group, the sows' reproduction is synchronised (Delcroix et al., 1990) and external cues such as e.g. increased food availability initiate the common oestrus (Mauget, 1982; Fernández-Llario and Carranza, 2000; Santos et al., 2006). There are indications that the higher food availability during the summer, the earlier the sows come into oestrus in the autumn (Pépin et al., 1987). Coherently, inadequate food supply may cause the sows to not come into oestrus at all (Matschke, 1964). The solitary male joins the sows during the autumn when they come into oestrus (Briedermann, 1971b; Dardaillon, 1988) which lasts for about two days. A normal oestrus cycle is 21 to 23 days (Henry, 1968), i.e. a sow that does not become fertilised will be in oestrus again after about three weeks. Gestation usually lasts 114-118 days (Henry, 1968) and results in a farrowing season during the spring when the sows within a family group give birth to the piglets within about one week (Delcroix et al., 1990). If the onset of oestrus starts early in the autumn, the sows will farrow and wean piglets early enough in spring time to have post-weaning oestrus before the anoestrous period begins. Thereby sows can have another litter in that year (Mauget, 1982).

Behavioural changes in connection with farrowing

It is reported that before farrowing aggression increases in captivity and in the wild (Gundlach, 1968; Martys, 1982; Hirotsu and Nakatani, 1987), and activity increases in confinement (Eguchi et al., 1998). The increased activity is consistent with that described for domestic pigs in semi-natural conditions, where sows left the group and walked 2.5-6.5 km to find a place to nest (Jensen, 1986). Also in confined (Gundlach, 1968; Martys, 1982) and free-living wild boars (Dardaillon, 1988), sows are reported to isolate from the group a couple of days before farrowing to find a place where to build a nest and give birth to piglets. The isolation is suggested to prevent the piglets trampled down by other adults, to facilitate the formation of bonds between the sow and her piglets and to reduce the risk of milk competition between the litters before the sow's udder have adapted to the current litter size (Jensen, 1986; Jensen et al., 1987; Fernández-Llario, 2004). It is shown in domestic pigs that if separated they do not perform the nest seeking phase, i.e. the seeking is not a behavioural need, but the isolation from group members seems to be (Jensen, 1993).

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Nesting

Sows decrease their home range areas to about 1-4 hectares during farrowing (Janeau and Spitz, 1984; Boitani et al, 1994). According to Spitz (1992) and Boitani et al. (1994), the farrowing sows nest within the home range, and an average distance of about 315 meters between empty farrowing nests is reported (Fernández-Llario, 2004). However, it is not clear how far from group members sows actually farrow. The closest neighbouring nest to a farrowing sow's nest might already have been abandoned. Farrowing nests are found in relatively protective habitats as e.g. edges to marsh land (Dardaillon, 1986) or dense forests and often in slopes facing the south, south west and east (Janeau and Spitz, 1984).

When nest building, the sow roots up a shallow pit, collects nest material at a radius of about 50 m around the nest and arranges the material in a nest up to a height of one meter, under which she crawl under (Steinbacher, 1949; Gundlach, 1968). The nest varies in size and structure depending on the sow's age and size, and the surrounding habitat. The main purpose of the nest is to provide protection against climatic factors (Mayer et al., 2002) and in domestic pigs in semi-natural conditions, it is demonstrated that the amount of nesting material depends on season of the year and how well the nest is protected vertically (Jensen, 1989).



Photo: A. Andersson

Sow collecting nest material.

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Birth

Studies in confinement show that sows give birth at any time of the day (Gundlach, 1968) and that they are very quiet during the birth which takes about three hours on average (Martys, 1982). The litter size increases with increasing age (Mauget, 1972; Stubbe and Stubbe, 1977), body size and weight of the sow (Fernández-Llario and Mateos-Quesada, 1998) and is on average 4 to 6 piglets /litter (Mauget, 1972; Stubbe and Stubbe, 1977).



Photo: A. Andersson

Newborn piglet resting by the udder.

Maternal behaviour

In contrast to other ungulates the wild boar young are well developed (Gundlach, 1968). The piglets can see and crawl at birth and directly start to search for the teats, causing umbilical cord and foetal membranes to rupture (Gundlach, 1968). The sow eats the placenta (Martys, 1982). As in the more investigated domestic pig, the suckling in wild boars is developed and performed through a complex signalling system between the sow and her piglets. The sow varies her grunt frequency and the piglets varies their massage of the udder during a bout (Gundlach, 1968; Whittemore and Fraser, 1974; Fraser, 1980; Horrell, 1997). Already in the first days of life, the piglets start to eat what is available (Gundlach, 1968) and it is shown in domestic pigs in semi-natural conditions that weaning is a gradual process, that for piglets ends between 15 and 22 weeks of age (Jensen and Stangel,

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1992). The sow and her piglets have directly after birth a high frequency of nose contacts which decreases when the piglets grow older (Gundlach, 1968).

The first days after birth is spent with the piglets in the nest. Subsequently the time spent in the nest decreases, and after up to two weeks it is left completely.



Photo: A. Andersson

Sow in nest with three-day-old piglets.

The sows join in the family group again, in which the young are reared communally in nursing groups consisting of two or more sows with piglets of about the same age (Gundlach, 1968; Delcroix et al., 1985; Teillaud, 1986; Dardaillon, 1988). The sows take turns to guard the piglets and a loudly screaming piglet is very much alarming for all sows in the group that immediately comes to rescue (Andersson and Jensen, unpublished observations). The sows in a nursing group do coordinate the suckling (Horrell, 1997), i.e. if one sow start to suckle her piglets, the other /-s will follow.

After farrowing there is a decrease in agonistic behaviours (Teillaud, 1986), and avoidance and crying are now the typical responses to aggression (Beuerle, 1975; Dardaillon and Teillaud, 1987). Wild boar sows with young

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piglets have low activity (Cousse and Janeau, 1992) and tend to prefer protective and dense habitats (Spitz and Janeau, 1995; Fernández-Llario et al., 1996). When other wild boars use open habitats if they are rich in nutrition, the sows with piglets seem to prefer a poorer habitat if it is more protected (Spitz and Janeau, 1995).

At maturity

According to Mauget and Pepin (1991), a young female has a minimum weight of about 30 kg (by about seven months of age) when reaching maturity. If the body weight is reached in the normal anoestrous period (summer and autumn) the puberty will be delayed and can at the earliest be attained in the coming oestrous period (winter and spring). Young males reach maturity independent of season, and at a body weight of 30-35 kg (by about 10 months of age) (Mauget and Pepin, 1991). The young females can, dependent on group size, stay in the family group at maturation or form new family groups with siblings, while the young males leave the family group and form bachelor groups, from which they later on become solitary (Kaminski et al, 2005; Hirotsani and Nakatani, 1987).



Photo: A. Andersson

Young females can stay in the family group or form new groups at maturation.

Non-maternal infanticide

Non-maternal infanticide is observed a few times in captive wild boars, a behaviour which function and background is unknown. It has been mentioned both in popular science (Morgan, 2004) and in daily press (Hudon and Gauthier, 2000), but also in the scientific literature (Gundlach, 1968). None of these reports offer any details. However, the behaviour could potentially be of significance for the welfare of wild boars kept in enclosures.

Infanticide

Infanticide is the killing of an infant by a conspecific. This behaviour has been reported from a wide variety of taxonomic groups (e.g. insects, birds and mammals) as reviewed by Hausfater and Hrdy (1984).

It has been suggested that infanticide can sometimes be caused by social pathology, where killing of an infant may in fact decrease both individual and inclusive fitness of the infanticidal animal. But, there are also mainly four different suggestions for how an infanticidal animal may gain fitness from the action (Hrdy, 1979): 1) *Exploitation* where an infant is used as a food resource or other exploitations leading to infant death; 2) *Resource competition* where the death of an infant gives the perpetrator and its descendants increased access to resources, e.g. nest sites or food; 3) *Parental manipulation* where the death of an infant can improve fitness of the mother or the father by improving survival possibilities of other offspring; 4) *Sexual selection* where the killing of offspring increases the opportunities to mate for the infanticidal animal (usually a male) and reduces the reproductive success of the same-sex competitor.

Regardless if there is an ultimate explanation to the behaviour or not, infanticide must be considered a welfare problem for the individual eaten and for the mother losing her offspring. Also the perpetrator's welfare can be questioned since the behaviour may perhaps be a manifestation of stress.

Welfare of animals in general...

The prevailing view of today is that the way we treat our domestic and captive animals reflects the ethical standard of our society. Society has an obligation and a will to ensure welfare of our animals, as intended through for example the “Animal Welfare Act” (SFS 1988:534). The welfare of an animal can be defined as an individual’s state as regards its attempts to cope with its environment (Broom, 1986; Broom and Johnson, 1993). To cope, an animal uses different physiological and behavioural strategies, which are more or less costly. If an animal cope with less costly strategies, then the welfare is satisfactory. But, if instead the strategies are successful but very costly, the welfare is considered as poor. If an individual fail to cope with the environment its welfare is obviously poor and may e.g. increase offspring mortality or reduce growth rate (Broom, 1986). All welfare indicators, such as behaviour, physiology, health and reproduction, should be taken into consideration when the welfare of an animal is assessed (Broom, 1986; 1998).

...and welfare of captive wild boars in particular

Wild boars in confinement can meet several challenges in the limitations given by the environment in which they have to live. These challenges can be compromising for the animals and their welfare. Unlike in homes, farms or other institutions where animals are kept, wild boars in enclosures can be managed in many different ways, very much depending on each and every owner, his/her knowledge, interest and possibilities to meet the needs of the animals. Wild boars can live their own life in the enclosure, as the wild animals they are under circumstances that at a glance can seem to be very good and natural, but at a closer look would be defined as poor animal husbandry. There might be food or water shortage, diseased or injured animals, animals that get stuck in fences without possibilities to come loose, animals that fight and would leave the area if they could, animals that live in unnatural group constellations, animals that hurt and/or eat each other and enclosure sizes and habitat structures that do not meet possible needs of the animals.

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As seen in the literature overview (paragraph *Biology of the wild boar*), the wild boar is an animal with complex social behavioural changes during the course of a year. The farrowing period of wild boar sows may well be a period where the needs and requirements of the animals can not be met by the limitations given by the confinement. For example the restricted area of an enclosure is likely to limit the ability of sows to isolate during farrowing. As seen in the literature overview, isolation is a natural behaviour (Dardaillon, 1988) that is likely to be a need (Jensen, 1993) which may influence piglet survival as shown in domestic pigs by Jensen (1989). Also, the observed infanticide reported before in captive wild boars (Gundlach, 1968; Hudon and Gauthier, 2000; Morgan, 2004) may possibly be a manifestation of stress and a welfare problem.



Photo: A. Andersson

*Female walking back and forth in an enclosure, as searching for a nesting place.
12 hours later she gave birth to nine piglets.*

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Detailed studies of reproduction and care of young in free-living wild boars are by natural causes limited since the wild sow is difficult to get close to. In contrast, detailed studies of reproduction in domestic pigs are available (e.g. Jensen, 1986, -88, -89) and those results can in some ways be applied on the wild boar, since the wild boar is the ancestor of all domestic pigs (Giuffra et al., 2000). Systematic and detailed behaviour data, based on long-term recordings of individual sows during farrowing were before start of this study scarce, but data are crucial in order to understand the details of the environmental requirements of farrowing wild boars in enclosures.

General aim

The general aim of this thesis was to provide detailed quantitative data on wild boar sows when farrowing in captivity and to report whether possible needs can be compromised by the limitations of an enclosure. Specifically, we aimed to provide a quantitative and functional account of the occurrence of infanticide, and its possible relations to welfare of confined wild boars.

Paper I

Aim

The aim of *Paper I* was to quantitatively describe the behaviour of wild boar sows in connection with farrowing in an enclosure.

Methods

Activities, habitat use, social behaviour, social isolation and farrowing nest characteristics were collected in a group of 6-10 animals. The study was performed in the same enclosure during three consecutive seasons and data from a total of 1200 hours and 22 farrowing nests were collected.

Results

In this paper, we present for the first time integrative quantitative and systematic data demonstrating significant changes in wild boar behaviour in connection with farrowing. The farrowing process could be divided into three phases: the pre-farrowing, isolation and sociality phases. Each phase was characterised by specific profiles in general activity and social behaviour. Distance to other adults increased but sows were not fully isolated during parturition and isolation phase. After farrowing the activity decreased, the distances to other adults increased, and habitat use changed towards more protective habitats. The maternal activities (social contact with piglets and nursing) gradually decreased after farrowing, indicating a gradual loosening of mother-offspring bonds.

Paper II

Aim

The aim of *Paper II* was to report on infanticide events in wild boars, where neonatal piglets were killed and eaten by other sows than the mother. We also aimed to examine the extent of infanticidal behaviour in enclosed wild boars, and to provide a quantified description of its occurrence. Furthermore, we aimed to provide an initial analysis of the individual traits associated with both performers and victims of the behaviour, in order to suggest a hypothetical functional explanation to infanticide in this species.

Methods

Data were collected through extensive field studies over three reproductive seasons covering 22 farrowings in one confined group of animals, and by a questionnaire study covering in total 116 wild boar enclosures in Sweden and Finland.

Results

In this paper, we present for the first time data on extensive non-maternal infanticidal behaviour in captive wild boars. Infanticidal behaviour was the single most common cause of piglet mortality both in field observations and as reported in the questionnaire study. The sows most likely to be exposed to infanticide were younger and smaller than the perpetrators. Relatedness between the sows was of no statistical significance. In the questionnaire, the behaviour was unrelated to size of enclosure and to variation in husbandry routines. All together the results may suggest that the behaviour is part of the normal behavioural repertoire in European wild boars, and may have evolved in the wild populations.

Discussion

There were significant changes in behaviour of wild boar sows when farrowing in an enclosure. The farrowing period was very dynamic and could be divided into three phases, each characterised by specific profiles in activity, sociality and habitat use. The possibilities to isolate when farrowing were reduced because of the limitations given by the confinement (*Paper I*), and this had consequences on piglet survival. Non-maternal infanticide in wild boars was not described before, but was the single most common cause of piglet mortality both in the field study and in questionnaire studies. Non-maternal infanticide seems to be part of the normal behavioural repertoire in European wild boars, and may have evolved in the wild populations (*Paper II*). Altogether, the results in *Paper I* and *Paper II* raise serious welfare concerns in the husbandry of wild boars in enclosures.

Today we do not have any regulations for how wild boars in enclosures shall be managed or how the enclosures shall be designed to meet specific needs of the species. The more general Animal Welfare Act (SFS 1988:534) regulates the basic husbandry of all animals in areas such as food, water, freedom to behave naturally etc., but then it is very much up to the animal keeper to interpret and implement the paragraphs. This might of course turn out well in many cases; most people really care for their animals. But, it may well result in poor animal welfare due to absence of knowledge and understanding of the needs of the species. The Swedish board of agriculture may want to regulate wild boar husbandry in the future and this thesis point out some of the areas that need to be considered.

Farrowing sows may have certain needs which can be compromised by confinement (e.g. Gundlach, 1968; Jensen, 1993; Massei and Genov, 1995) which is why they have been the subject of this thesis. The field studies showed as expected, that the farrowing period of wild boar sows were very dynamic, with sows that tried to isolate before farrowing and changed their sociality, activity and preferences for habitats in connection with farrowing (*Paper I*). These behavioural changes could be manifestations of behavioural and environmental needs of the species, possibly affecting their welfare negatively if not met.

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A serious welfare problem was found for the wild boar sows when farrowing in the studied field enclosure; sows had limited possibilities to isolate. This raised major concerns for their welfare. Firstly, isolation during farrowing is most likely a need for wild boar sows, as shown in domestic sows (Jensen 1993), and without which a sow might experience stress compromising the welfare. Secondly, our studies revealed that due to lack of isolation other sows were able to come up to farrowing nests and perform non-maternal infanticide on new born piglets (*Paper II*). The mother sows might have experienced severe stress in that situation since at first they failed to be isolated, then were unable to fend off the intruders and at last heard the piglets scream loudly when being taken from the nest. Thirdly, the piglets that were taken from the nest and were killed and eaten (and at some occasions partially eaten before killed) obviously experienced low welfare.



Picture from video recorded by A. Andersson

Another sow than the mother have just taken and killed a newborn piglet and runs off with it to eat.

Non-maternal infanticide was not only observed in the field study, but was also reported as the most common cause of piglet mortality in the questionnaire study (*Paper II*). The behaviour might be pathological (Hrdy, 1979) and expressed as a response to e.g. stress due to circumstances given by the confinement. However, based on the results in the field study, non-

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maternal infanticide in wild boars appears to be a natural behaviour with a functional background of exploitation and resource competition (Hrdy, 1979). This is supported by the fact that only adult females were perpetrators, and they clearly benefitted from the behaviour in terms of food (all piglets were eaten) and increased reproduction, sometimes mediated by adoption of their own piglets by exposed sows (*Paper II*). If this interpretation of the studies is correct, the perpetrators can not be said to have had a lower welfare, i.e. they did not perform infanticide as a manifestation of experienced stress (as mentioned in paragraph *Infanticide*).

Non-maternal infanticide may have been a significant aspect in the evolution of maternal behaviour of the species. Synchronised farrowing and isolation when farrowing in wild boar sows may have evolved as counter-strategies against infanticide (Poikonen et al., 2008; *Paper II*). This implies that non-maternal infanticidal behaviour in wild boars can not be “treated”, i.e. it is a behaviour performed when circumstances and possibilities are given.

Even if the focus of this thesis has been on maternal behaviour, there are of course other potential areas of welfare problems in enclosed wild boars. Based on discussions with initiated people, on questionnaire studies and on observations during field studies, some areas, which have not been subject for the present studies, need to be highlighted.

Control on animals: Large enclosures with non-tame animals make control of and attendance to the animals almost impossible. One enclosure which was visited (size about 4 ha) was according to the owner inhabited by 30 wild boars. Not a single animal was spotted during the 2 hours of walk by foot in the enclosure and the only sign of live animals was one single grunt. Naturally, the welfare and status of those animals are almost unknown to the keeper. Also, it must be hard only to spot how many animals there are in a large enclosure, which also was confirmed in the questionnaire study where only a few of the keepers knew how many animals they had in their enclosure (*Paper II*).

Capturing, handling and transportation of live animals: Animals are sometimes captured and transported to other enclosures. Some enclosures do not seem to have well functioning fenced off areas for capturing of the

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animals. Such an area can be important to minimise the stress for the animal captured.

Unnatural group constellations: Wild boar females live in family groups with males in bachelor groups or as satellites in the periphery. The exchange of animals between enclosures can lead to a female being introduced to a home area of already settled females. If the enclosure is not large enough, the settled females will try to fight and chase away the “intruder”. Because of the fence, the newly introduced animal has no escape possibilities. The same goes for males, where especially two males of the same age and/or size can come into severe fights, and where the “looser” have no other option but to stay in the area.

Culling: The culling of the animals is usually done with a rifle. The animals are shot at a close distance or at a long distance as in naturalistic hunts. There is a risk of injuring during shooting and that the wrong animals are culled due to misidentification.

Water: Some enclosures only have natural water sources. When those are frozen during winters of little snow, water shortage can be a problem. Also, the water quality in natural water sources may be poor, which especially can affect health of piglets.

Food supply: Since there are no regulations on feeding of wild boars, the food regime may lead to malnutrition and/or hunger.

Fencing: It is well known that fences do not always keep the animals in. Furthermore, fencing is not always working to keep other animals out. Especially wild boar males are said and observed to come into enclosures during female oestrus. This can give fights with the inhabiting boar, leading to injuries and stress. Also, the fence is a potential trap for piglets. Piglets can go out and in through the fence when they are small, but can get stuck the day they are too large. Furthermore, the gate of the enclosure can be an Achilles heel to fencing out other animals. Hunting dogs have been observed to crawl under and at one occasion to chase farrowing sows.

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Hunting dogs: In some of the enclosures, hunting dogs are tested and trained on the wild boars. This can be potentially stressful for the wild boars, especially if done in farrowing periods.

Some of the problems mentioned above may stem from an, as it seems, quite wide-spread opinion that wild boars in enclosures are wild animals that live under natural circumstances. This view can lead to unrealistic expectations on the animals' abilities to solve their situation themselves whether it comes to e.g. handle social difficulties, getting food or water, or healing from injuries. Authorities who can regulate the wild boar husbandry have an important question to consider: shall wild boar husbandry be equated with e.g. domestic pig husbandry where the keeper have advanced responsibilities to e.g. know the number of animals, ensure health, ensure freedom from hunger and pain and where culling must follow certain standards or, can wild boars in enclosures be allowed to experience the same kind of suffering as they actually may meet in wild conditions?

In my view we have an obligation to ensure that animals in our care do not suffer more than necessary, and my hope is that this thesis with its results can make a contribution in the progress of wild boar husbandry.



Photo: A. Andersson

Shall wild boar husbandry be equated with domestic animal husbandry?

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Conclusion and future perspective

The farrowing period of enclosed wild boars was very dynamic and consisted of three phases, each characterised by specific profiles in activity, sociality and habitat use. The possibilities to isolate when farrowing were reduced because of the limitations given by the confinement, and poor isolation had a negative influence on piglet survival. Non-maternal infanticide in wild boars was described and quantified for the first time, and was the single most common cause of piglet mortality both in the field study and in questionnaire studies. Non-maternal infanticide seems to be part of the normal behavioural repertoire in European wild boars, and may have evolved in the wild populations.

The studies of this thesis reveals the farrowing period as the most dynamic and perhaps most challenging for wild boar sows in enclosures. Also, there are other potential problem areas that have not been subject for these studies. There are serious welfare concerns in the husbandry of wild boars in Swedish enclosures. If wild boar husbandry shall be equated with other animal husbandry in our society, it needs to be regulated to overcome many of the presented potential welfare problems in this thesis. The most obvious welfare problem is non-maternal infanticide, where both sows and piglets are assumed to suffer, and where the outcome from the action must be considered unacceptable. This welfare problem might have its solution in a food regime which initiates a common oestrus in the autumn, increasing synchronisation of farrowings, and/or in a husbandry where sows during farrowing are offered possibilities to isolate in secluded parts of their home enclosure. This would need further investigations. Moreover, it would be interesting to look deeper into the preferences shown by the wild boar sows in our studies. Are they needs that are necessary to be met to ensure the welfare of the animals or is it just that - preferences?

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Acknowledgements

Many thanks to my supervisor professor **Per Jensen** for giving me the opportunity to this experience, from our very first meeting with wild boars (two hours of search - one single grunt from behind some bushes ☺) to the finishing of this thesis. Thanks for giving me guidance and inspiration to develop my skills in science and writing, for giving me support to finish this thesis and for showing so much patience when I really needed it.

Thanks to **Göte Olsson** and **Ingvar Larsson** for giving full access to the enclosure and its animals, and to all **owners of enclosures** who responded to the questionnaire. This thesis had not been written without your participation!

Thanks to former students **Edwin Jousmaa** and **Nadine Smits**, **Jenni Huusko** and **Riikka Äänismaa**, and **Johan Rombin**, for collecting behavioural data. We shared many fun and hard moments in the enclosure. Special thanks to **Edwin** and **Nadine** for fun and friendship and because you by necessity got me to start speak English.

Thanks to professor **Anna Valros**, Finland, for friendliness, inspirational discussions, input and help with data collection in the questionnaire study.

Thanks to my colleague **Lars Westerberg** for learning me about Excel when I was totally desperate.

Thanks to my colleagues at **IFM Biology**, for just being there, no one mentioned or forgotten. I have not been very social the last few years, but I really appreciate the positive atmosphere you all create at the department.

Thanks to all **members of the ApE group** for inspirational and interesting discussions on science and science fiction and everything in between. And thanks for sharing my joy over my first submitted manuscript ☺.

Thanks to my colleague and friend **Frida Lögdberg** for fika, friendship and wonderful illustrations for our children's book!

Thanks to my colleague and friend **Linda Lindell** for being who you are!

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Thanks to my former colleagues and, since then, wonderful friends in good times and in bad: **Jennie Westander**, **Christina Lindqvist** and **Anna Eklöf**. We have shared so many tears, laughs and fika and now you all have left Linköping...miss you!

Thanks to **all my friends** from “the outside”, no one mentioned, no one forgotten. Thanks for tears and laughs, for making this world a better place!

Thanks to **Gisela Wisung** for showing me the way when I had lost it. You made difference and I will always be thankful!

Thanks to the best bonus-family ever: **Ingegerd** and **Inge, Jan** and **Anita, Ing-Marie** and **Karl-Oskar**, and **Håkan**. I really appreciate all your help and lovingly support!

Thanks to my beloved sisters **Helena** and **Bozena** and beloved brother-in-law **Sam**, for always being there – good to know I can always count on you! I am so thankful for **Vincent** and **Tristan**, and **Helena** – I can not understand how *you* got a dog before *me* ???!

Thanks to mum and dad, **Monika** and **Bo-Inge**, for always being supportive, helpful, loving and caring, and for sharing bad times and good times. You are the best, I love you! Or, all-all-oo as **My** would say ☺!

Stefan, thank you for being in my life since 15 years, in good times and in bad times. Thank you for giving me My! Today is the first day of the rest of our lives. I love you!

My, my defiant, clever, brave, strong, happy, wonderful little girl. I love you more than words can tell. Once again I will give you the words of Lisa Rinnevou: “Sweet baby girl stay forever pure and simple. You can fly by wish if you only believe. Remember love is always the right answer. You are perfect the way you are. Love you.”

The work presented in this thesis was financed by the Swedish Board of Agriculture and by the Swedish Animal Welfare Agency.