



# Play behaviour and maternal relationship between ewe and lambs in Urial sheep (*Ovis vignei bochariensis*)

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*Lekbeteende och relation mellan tackor och lamm hos Tadzjikiska ståppfår (Ovis vignei bochariensis)*



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Independent project • 30 hp  
Swedish University of Agricultural Sciences, SLU  
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Agriculture Programme - Animal Science  
Uppsala 2022



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## Abstract

Ex situ conservation is done to alleviate the risk of threatened species going extinct and one major conservation aim is increasing the population size. One place working with ex situ conservation is the zoo Nordens Ark in Sweden, and one of their target species is Urials (*Ovis vignei bochariensis*). The aim of this study was to investigate play- and maternal behaviour in Urials. The play behaviours performed by Urials could be an indicator of welfare and furthermore; to better understand the needs of Urials to preserve them, their welfare is important. Maternal behaviour is of course crucial for lamb survival and hence conservation of the species. As Urials only exist in four different parks in Europe and they have reproduction problems in captivity cooperation with Nordens Ark and their conservation program made it possible to study Urials. Nordens Ark was the only park in Europe in year 2021 where Urial lambs were born.

The method used was video recording, using wildlife camera traps during summer after the lambs were born in 2021. Five cameras, set up to take one-minute video clips, were put up in the enclosure. To gain basic information on the Urials' behaviours, this study registered behaviours performed during daylight hours when the park was open and daylight hours when the park was closed. The result showed that the Urials perform more play-, maternal and locomotor behaviour during park closed hours. The play behaviour performed the most during park open hours was "jumping on to object" performed 50 times. During park closed hours the play behaviour performed the most was "jump", performed 174 times. "Vocalisation" was also performed almost 300 times during park closed hours, while during open hours only just over 40 times.

When using only play behaviours as a parameter of welfare the conclusion is that the Urials have a better welfare during park closed hours since they play more, Urials could be disturbed by the visitors. However, an alternative explanation could be a difference in circadian rhythm. The information about Urials diurnal behavioural pattern is lacking and hence no conclusions can be drawn about the cause of the differences. The maternal behaviours performed by Urial was primarily suckling, also observed at a higher frequency during park closed hours.

*Keywords:* Urial sheep, play behaviour, social play, locomotor play, maternal behaviour, locomotor behaviour & welfare.

## Populärvetenskaplig sammanfattning

För att bevara hotade djurarter hålls de ibland i djurparker och hägn. Syftet är att de ska kunna reproducera sig och leva väl i fångenskap tills det finns habitat där de kan återintroduceras. En djurpark som fokuserar på bevarande av hotade arter är Nordens Ark. Där hålls många spektakulära rovdjur men även mindre kända och hemlighetsfulla bytesdjur. En av dessa arter är de Tadzjikiska stäppfåren eller urialerna. De är små, bruna vildfår som naturligt lever i Mellanöstern. Det är oerhört viktigt att dessa får, tillsammans med andra bytesdjur bevaras, bland annat eftersom de är bytesdjur för rovdjur och har stor betydelse för ekologin i de här områdena av världen. På djurparker har man dock problem med att vildfåren inte får tillräckligt med lamm och ibland att de inte tar hand om lammerna. Därför är det viktigt att studera detaljer i deras modersbeteende och även deras lekbeteende eftersom lek är ett viktigt tecken på att djuren mår bra. Vad jag vet finns ingen tidigare forskning om urialer och deras lek- och modersbeteende. Eftersom urialer bara finns på fyra olika parker i Europa var samarbetet med Nordens Ark och deras bevarandeprogram det som möjliggjorde att

studera urialerna på nära håll. Nordens Ark var den enda parken i Europa år 2021 som fick uriallamm.

Metoden jag använde för att studera de här skygga vildfåren var att videofilma dem med åtelkameror. För att se om besökarna på Nordens Ark hade någon inverkan på beteendet, jämförde jag fårens beteende (i dagsljus) när parken var öppen med beteendena när parken var stängd. Resultatet visade att urialerna utför mer lek-, moder- och rörelsebeteende under parkens stängda timmar. Det lekbeteende som uppvisades mest under parkens öppna timmar var att "hoppa på ett föremål", oftast en sten eller stock. Under parkens stängda timmar var lekbeteendet som uppvisades mest "hopp", när lammen helt enkelt skuttar rakt upp eller gör en liten piruett när de hoppar. Jag registrerade också väldigt många bråkanden när parken var stängd.

Att vildfåren lekte mer när parken var stängd kan betyda att de hade en bättre välfärd när det inte fanns några besökare där. Men det kan också betyda att de helt enkelt leker mer på morgon och kväll, när det blivit ljust men kanske inte så varmt. Vi vet inte när lammen leker i det vilda.

Jag såg också att diande var vanligare på parken var stängd, men vet heller inte om det är en effekt av besökare eller av dygnsrytmen. Vi behöver fortsätta att studera urialerna så att vi kan bevara dem på allra bästa sätt tills de kan planteras ut i sin naturliga miljö.

Nyckelord: Urial, lekbeteende, social lek, rörelselek, modersbeteende, rörelsebeteende & välfärd.

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# Abbreviations

IUCN            International Union for Conservation of Nature

# 1. Introduction

The world is inhabited by species more or less well known, and some are not even discovered yet. Still, species goes extinct and people and organisations around the world are working hard to avoid that. We know so little about what the world will need in the future and some species may be more valuable than we realise now. Diversity makes us less vulnerable to future events we cannot foresee, like diseases or extinction of other causes. According to the International Union for Conservation of Nature (IUCN) over 38,500 species are threatened with extinction (IUCN 2021). Mammals constitute 26% of them. The origin of our domesticated animal species has for some been known for a very long time, but for other, the question is not resolved. For some species the evolutionary background is still unknown, as is their behaviour in their natural habitats. And do we know how to care for these animals if kept in captivity?

Many conservation projects are carried out with animals in semi-natural captive environment, where we can monitor and protect them more closely than in the wild. Conservation of animals is only possible if we know how to care for the animals we preserve. Their well-being and reproduction are crucial for conservation and the survival of the species. If we do not care for the animals in the right way, they will not reproduce (Roger 2012). So, how do we find out that the animals need and how to take care of them? By studying them. In this study the focus animal is Urial sheep (*Ovis vignei bochariensis*). They are one species of wild sheep that are presumed to be part of the origin of domesticated sheep (Chessa et al. 2009; Alberto et al. 2018).

## 1.1. Background

Urial sheep are listed as vulnerable on the IUCN red list (IUCN 2020) and this includes the subspecies studied *Ovis vignei bochariensis*. All Urials are an important part of the ecology in the near and far East of Asia (IUCN 2020). Due to conflicts in these areas the sheep cannot be studied in the wild. Hence basic information about their behaviour is unknown and needs to be studied in the zoo environment. Furthermore, reproduction in the Urials does not work well in the ex-

situ environment. In fact, for year 2021 Nordens Ark was the only zoo in Europe with Urials that had lambs (personal communication J. Loberg 2021). As reproduction is the foundation of ex situ conservation, more basic information is needed about maternal behaviour, to meet the needs of these animals. Research about mating and other aspects of reproduction in Urial sheep is also needed but will not be studied in this paper. However, another important aspect of welfare will be studied, namely play. One theory on the function of play behaviour is to prepare young animals for adulthood (Held & Špinka 2011).

Play behaviour can be an indicator of good welfare, just like e.g. health, and hence play behaviour is of particular interest (Held & Špinka 2011). However, to say play always means good welfare is stretching it too far (Webber & Lee 2020). Play behaviour can be a coping mechanism or the effect of longer confinement (Held & Špinka 2011). It can also be one of many behaviours showed when animals are offered bigger enclosures (Anderson et al. 2015). At least in young animals, it may be more correct to apply that play behaviour showed is an indicator for the absence of poor welfare rather than an indicator of good welfare (Held & Špinka 2011).

Functional maternal behaviour is of course crucial for survival. Until lambs can survive on grass, they depend on their mother's milk for nutrition, but also for protection from predators- and to adapt to the social context of the group. Conservation of animals must be set up to safeguard the welfare of the individual animal, as well as the survival and thriving of the species, and maternal relationship between ewe and lamb is a very important subject of study.

Vocalisation that is an interactive behaviour and a way for mother and lamb to establish a bond (Sebe et al. 2010). Ewes may call for their lamb when it is time to suckle or if they cannot see each other and want to locate each other. Vocalisation could be an indicator of maternal behaviour and maternal relationship between ewe and lamb (Dwyer et al. 1997).

Urials (*Ovis v. bochariensis*) in the wild live in the barren mountains in Tajikistan, Uzbekistan and Turkmenistan as high up as 2200 meter above sea level (IUCN 2020). Both male and female have horns, but the females' are smaller. The reason for these sheep being endangered is mainly poaching. During the civil war in Tajikistan 1992-1997 the hunting was not regulated. Also, hard winters, drought and lambs being taken as pets affect the number of live and free animals, how much this affects is not yet established (IUCN 2020). Only an estimate of the total number of animals living in the wild has been done. As IUCN (2020) writes, "The total population is believed to be substantially less than 800 individuals (less than 480 mature individuals); the population decline over the last three generations is

believed being 50% or more.” Natural predators for Urials in the wild are wolfs (*Canis lupus*), foxes (*Vulpes vulpes*), bears (*Ursus arctos*), badgers (*Meles*), and lynx (*Lynx lynx*) (WWF 2021).

Urials live in large flocks in the winter and split up to smaller groups right before laming season starts. In the summer males and females live in separate groups until breeding season starts in September. Males fight over ewes in oestrus and defends their group from other males. The ewes are pregnant for five month and usually give birth to one, sometimes two lambs (*Tadzjikiskt stäppfår* u.å.). Urial lambs are what is called followers, they follow their mother as soon as they can walk. Just as domesticated sheep they depend on their mother for protection, comfort and food (Freitas-de-Melo et al. 2021).

As the animals are in a zoo there are certain hours of the day that visitors are present, and even if they are not in direct contact with the animals, the animals are affected by the visitors. To what extent they are affected has not been investigated and is of interest to this study.

### 1.1.1. Definition of play

There is a well validated and extensively used definition of play by Burkhardt (2005). He defines play as a behaviour fulfilling five criteria's.

“Play (1) is a behaviour that is not fully functional (by this is meant it includes elements that do not contribute to current survival); (2) is autotelic, that is self-rewarding; (3) differs in structure and/or timing from the adults, serious form of the behaviour; (4) is performed repeatedly, but not stereotypically; and (5) is initiated when the animal is in a relaxed field (by this is meant there are no immediate threats to the animal's fitness).” (Held & Špinka 2011, original source: Burkhardt 2005).

### 1.1.2. Previous research

To my knowledge there is no research on *Ovis v. bochariensis* behaviour in the wild. Their habitat in the wild are mainly areas where wars are ongoing and hence not suitable for research, meaning all studies on Urial have to be carried out in captivity. Garrido (2018) studied the same groups of animals kept at Nordens Ark zoo, and hence her work has been considered.

Previous research of mating behaviour in captive *Ovis orientalis laristanica* (*Ovis o. laristanica*) (Bazyan et al. 2015) have observed male-female and male-male interaction during mating season. The observation showed some distinct behaviours and a series of behaviour linked to mating. These behaviours can be mimicked by young individuals and lambs in play to learn. Bazyan et al. (2015) recorded foreleg

kicking as a common behaviour for driving back younger males from a ewe in oestrous. Also, butting had high frequency and can be a play behaviour. Butting was defined as a male-male interaction and described as “ram jerks down its head and hits ram’s horn or flank” (Bazyan et al. 2015), however also females butt.

As animals play it can be assumed that they have fulfilled their primary needs (Fraser & Duncan 1998) such as not being threatened by predators, enough food and energy. An earlier study has suggested that play has direct but also long-term positive effects for the animals (Held & Špinka 2011). Furthermore, play behaviour influences the group and initiates more play in the group, it can therefore be said that play is contagious (Gomendio 1988; Bekoff 2001).

### 1.1.3. Aim of project

The aim of this project is to gather basic information about the behaviour displayed by lambs and ewes of Urial sheep in ex situ conservation, with focus on play- and maternal behaviour. The aim is also to compare the behaviour of the sheep when the park is open with their behaviour when the park is closed.

Research questions:

What kind of behaviours do the Urials perform?

How do ewes behave towards their lambs?

Is there any difference in their behaviours between park open hours and park closed hours? And if any, what kind of differences?

## 2. Method

### 2.1. Selection of animals and area

During the study the only group of breeding Urials in Sweden were kept at the zoo Nordens Ark. The group of animals constituted of four ewes, two rams and three lambs; the lambs are one female and two males, the female and one male are twins. The age of the adult animals was between one and fourteen years. The lambs were born the 4<sup>th</sup> and 11<sup>th</sup> of May 2021. Throughout the year individuals were moved between different enclosures, however during course of the data collection and several months before this no animals were moved, and the group was therefore considered stable.

The enclosure was 2536 m<sup>2</sup> with natural terrain, bigger stone blocks, trees (mainly Beech (*Fagus sylvatica*), slopes, and hills. As shown in the map of the enclosure (Appendix 1) the animals had access to a sheltered area divided in two sections, one with straw bedding and the other with a gravel floor and feeding troughs. Here the sluice for the zookeepers was located and a gate towards the animals' winter enclosure was located. A heat lamp was hung over the straw bedded area before the lambs were born. This was done to make a dry and warm place available as the lambs born previously has had problems with coughing and some had not recovered. One of the focal lambs in this study was affected by some respiratory problems and examined by a veterinarian. The lamb recovered and this lamb was also marked with an ear tag. The two other focal lambs born in 2021 were not marked prior to the filming and throughout the filming remained unmarked.

The animals were feed hay, pellets, grass and sly when available. The pellets used for Urials were a commercial feed called Edel Viltfoder (Edel game feed). The feeding place was in the sheltered area. The maintenance routines were as follows: Morning, individual check, remove old feed from all feed troughs, refill hay if needed and change all hay on Fridays, remove old grass, sly and other during summertime, rake around feeding spot, refill pellets and Selenium with vitamin E, clean the water cup, check the electricity summertime. Afternoon: Feed shopped

carrots or apples, feed sly and grass summertime, check the water and all the animals. Saturdays: complete enclosure check, feed troughs cleaning and repairs or enrichment done.

Park opening hours were 10 am to 4 pm (six hours) during low season (30<sup>th</sup> August to 27<sup>th</sup> June) and 10 am to 6 pm (eight hours) during high season (28<sup>th</sup> June to 29<sup>th</sup> August).

## 2.2. Video recordings

In this study the behavioural observations were done from video recordings from one of the enclosures with Urials at Nordens Ark. The timeframe for the recordings was one (1) minute clips with game cameras. The model of game cameras was Stealthcam STC-G42NGNC and Albecom Serie number 1707180663, only Albecom records sound but both records with dark vision at night.

The equipment was placed in five different locations as shown on the map in Appendix 1. There were only four cameras filming at the same time. One location had to be changed because the urials moved the camera, and the footage could not be used. One camera was accidentally directed to the area outside the enclosure and hence those recordings could not be used and were deleted. The placement of the cameras was selected to see what kind of behaviours the Urials perform around the enclosure and for further research see if any specific behaviour is location based. The cameras covered a variation of the terrain. The material will be used in further research.

The video recordings were done from May 22<sup>nd</sup> to the 27<sup>th</sup> of July at all hours of the day. Recordings were both simultaneously on multiple locations at once but also, different recording days have been used in different locations. The material contained 2558 clips, 423 clips were deleted because of no animal present or faulty of files. As the recordings were sorted 1683 clips were filmed during closed hours, between 4 pm -10 am on low season and between 6 pm -10 am on high season. Furthermore; 452 clips were filmed during open hours at Nordens Ark, between 10 am – 4 pm on low season and between 10 am – 6 pm on high season. Of those filmed during closed hours 906 were filmed during dark hours and 777 were filmed during light hours. Light hours were defined as the period when the cameras did not use their IR night vision to record, and the time varied slightly during the observation period but approximately from 3:30 am to 10 pm. The time in between were considered dark hours. Timeframe for park closed was 10-12 hours and park open 6-8 hours, depending on the season.

The number of days without any observed behaviours differed between the categories but if one category had an observation all the other categories were taken in as result. This means that for example, if locomotor play had one or more observations the other was not removed even if they had zero observations. Only days with no observations at all were removed. Observations were done in May, June and July and 66 days were used.

## 2.3. Design of ethogram

The ethogram was designed and modified based on several earlier studies, on domestic sheep but also from wild sheep in captivity, more specifically Laristan Mouflon, *Ovis orientalis laristanica* (Augustsson 2014; Anderson et al. 2015; Bazyan et al. 2015). Definitions of the behaviours recorded were taken from other ethological studies such as, Bazyan et al. (2015), Dwyer and Lawrence (2000), Blank and Weikang (2012) and Anderson et al. (2015), together with a master thesis by Augustsson (2014), as well as supervisors' suggestions, based on previous knowledge and experience with sheep.

The behaviours selected for the ethogram were behaviours relevant for the aim of this study. In some of the behaviours not only frequency was recorded but also the duration and to whom the behaviour is directed. E.g. suckling duration was recorded, as well as who ended the nursing. Vocalisation was recorded events, and when possible, to whom it was directed.

One ethogram/protocol was developed for the play behaviour (Appendix 2) and one for maternal behaviour (Appendix 3).

### 2.3.1. Distinguishing behaviour recorded in the ethogram

The behaviour running was hard to distinguish from play and other running behaviours such as flight. To gain a deeper understanding of play behaviour it is crucial to separate these two and not mix flight behaviour with playing or running as movement. In this study, as there were no previous behavioural studies done on Urial sheep there had to be assumptions that flight behaviour in Urial could resemble flight in other prey animals. As Walther (1969) describes a gazelle (*Eudorcas thomsonii*) that see a threat "erects its neck, puts its ears forward, lower its croup, and tenses its muscles". Gazelles studied by Walther were wild animals and as Urial also flight animals. The description of this behaviour can be used to distinguish if a particular event of running was a flight or play behaviour.

One behaviour, "running unknown" was added to the ethogram as it was not always possible to determine why the animals were running. In multiple recordings the

animals were running by the camera and could not be classified as either play running, running as a movement or flight. This behaviour was still recorded for interest.

Adult and young animals make different sounds and are easy to separate from one another. In the ethograms the vocalisation was registered to be produced by either a lamb or an adult.

## 2.4. Statistical analysis

In this study no statistical analyses have been done. As observations were only done on one single group of Urials it was not possible to compare the differences with another group and see similarities or differences. But as the group observed at Nordens Ark was more than 25% of the total population in captivity in Europe (personal communication J. Loberg) and that Nordens Ark was the only park that had lambs the year of 2021, and because the data can be useful also when presented descriptively, these results were considered valuable even without statistical analysis. The results and suggestions of adaptation for the animals may be applicable for other groups of Urials, kept under similar conditions.

## 3. Results

The recorded material for this study consisted of 28 hours film, 2135 clips. To make it possible to handle the 906 clips recorded during dark hours were left out. I observed 1229 clips, 452 during open park open hours and 777 during park closed. Clips with content of interest to this study, i.e. contained behaviours included in the ethograms, was 381 for park closed light hours and 212 for park open hours.

### 3.1. Park open and park closed

Generally, only short episodes of play were performed during open hours at the park, where only one or two behaviours were shown in the same clip and often by one individual. With exception for “race”, where multiple participants were a must per definition. Longer periods of play were performed during park closed hours than during park open hours, some as long as the clip itself (60 sec.) and even continuing on the next clip. The play session often involved several participants at a time, for both social- and locomotor play behaviours.

Not all locomotor play behaviours were shown during park open hours. The most frequent play behaviour when the park was open was “jumping up on object” (see figure 1). Lambs performed this behaviour more frequently than adults. The second most performed play behaviour was “jump”, also performed more frequently by lambs. During park closed hours all locomotor play behaviours included in the ethogram were observed, and most frequently observed was “jump” (see figure 1). It was performed more than twice as many times as the second most frequent locomotor play behaviour, “running”. Lambs in general performed locomotor play more than adults. However, for social play it was the opposite (see figure 2); adults showed more of social play behaviours than lambs.

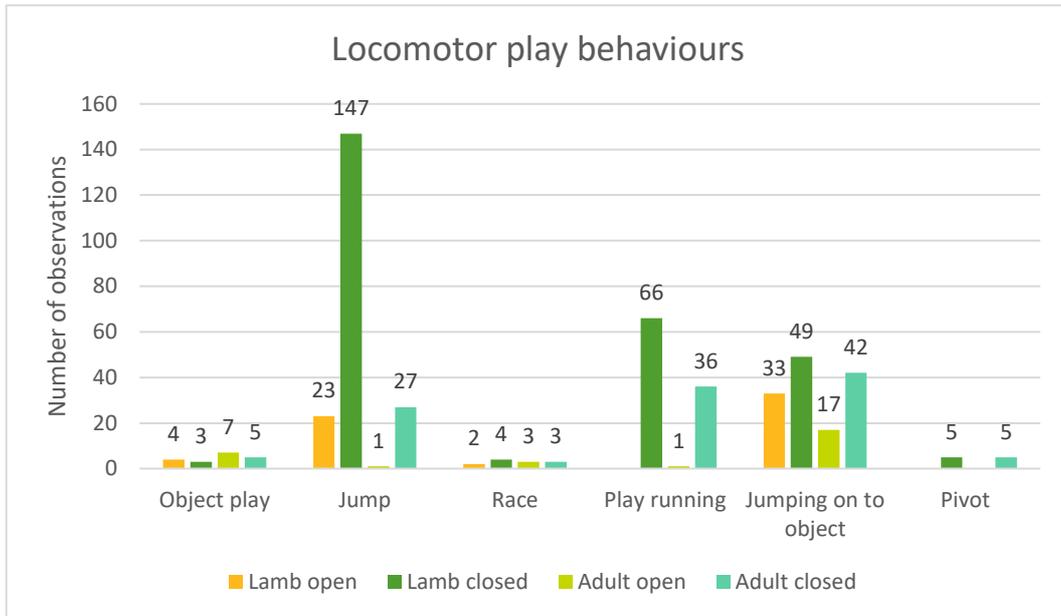


Figure 1. Locomotor play behaviours observed during park open and park closed hours, both lambs and adults

The third most performed behaviour during park open was “butting”, where adults preformed the behaviour more frequently than lambs (see figure 2). The other play behaviours had a range from 0-7 performed behaviours during park open observations (see figure 1 & 2). Locomotor play was recorded more than social play, both for lambs and adults in park open. But the somewhat higher frequency of locomotor play consists of the two most frequent observed behaviours mentioned above. Social play had low frequency throughout the observations period, except for butting for adults.

All but one social play behaviour was observed in park closed observations; “foreleg kicking” was the only behaviour not observed at all (see figure 2). Social play behaviours observed had the highest frequency of butting and mutual head-to-head butt (see figure 2). Mounting was only performed by lambs while mutual clash and rubbing head were only performed by adults.



Figure 2. Social play behaviours observed during park open, and park closed hours, both lambs and adults

During park open the behaviours labelled “other” was observed as seen in figure 3 with vocalisation being the most frequent behaviour. Only twice where the vocalisation responded in another vocalisation.

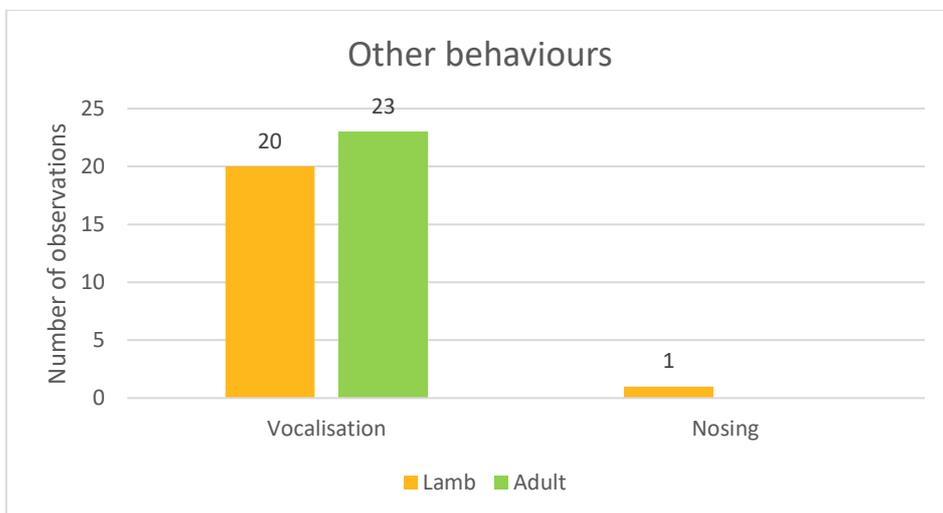


Figure 3. Vocalisation and nosing observed during park open hours throughout the observations period, both lambs and adults

During park closed hours other behaviours observed were vocalisation, licking or nibbling and nosing (see figure 4), vocalisation being the behaviour that was performed the most. Furthermore, the vocalisation was responded by another

vocalisation 17 times. Eight times a lamb was the one calling and the mother was the one responding and nine times the ewe was the one calling and the lamb responding. The repetitions of vocalisations were generally two to four times but in windy weather the repetitions were more frequent, up to twelve times.

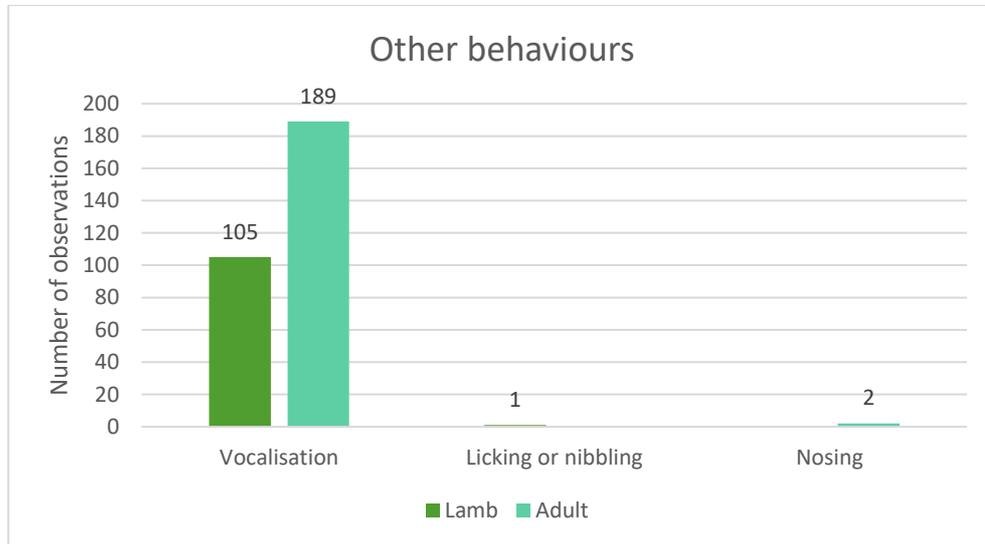


Figure 4. Vocalisation, licking or nibbling and nosing observed during park closed hours, throughout the observation period, both lambs and adults

Locomotor behaviour observations were categorized in; “flee”, “running unknown” and “running as a movement”. “Running unknown” was performed mainly both by lambs and adults, during park open hours. Adults were more often observed “fleeing”, “running unknown”, and during closed hours, also “running as a movement”. There were also more individuals, six adults, who could perform the behaviour. In table 1 number of observations are adjusted by number of individuals.

Table 1. Number of observations per individual of locomotor behaviours during park open and park closed hours

| <b>Behaviours open</b> | Lambs | Adults | <b>Behaviours closed</b> | Lambs | Adults |
|------------------------|-------|--------|--------------------------|-------|--------|
| Flee                   | 11    | 9.6    | Flee                     | 13    | 13     |
| Running unknown        | 19.6  | 11.6   | Running unknown          | 54.7  | 43     |
| Running movement       | 14    | 3.8    | Running movement         | 32    | 11.2   |

Maternal behaviours for park open (see figure 6) where low and throughout the observations period the total number of maternal behaviours was only 25. The suckling duration varied from 3 seconds up to 1 minute. For nine of the suckling bouts, the mother was the one ending the suckling by moving away. For the remaining three, it was not clear who ended the bout. Only four out of nine maternal behaviours in the ethogram were observed during park closed, the most frequent

being suckling (see figure 5). Suckling bout varied between 1-20 seconds. One second suckling bout was observed at the very end of a clip and hence the duration could not be measured. For 31 of the suckling bouts the mother was the one ending the session, only once the lamb ended suckling. Preventing suckling had higher frequency than nosing and butting or pushing.

During observation of suckling bouts, the lambs' tail wagging was noted if possible. The lambs wag their tail on and off during suckling bouts in almost all suckling observations.

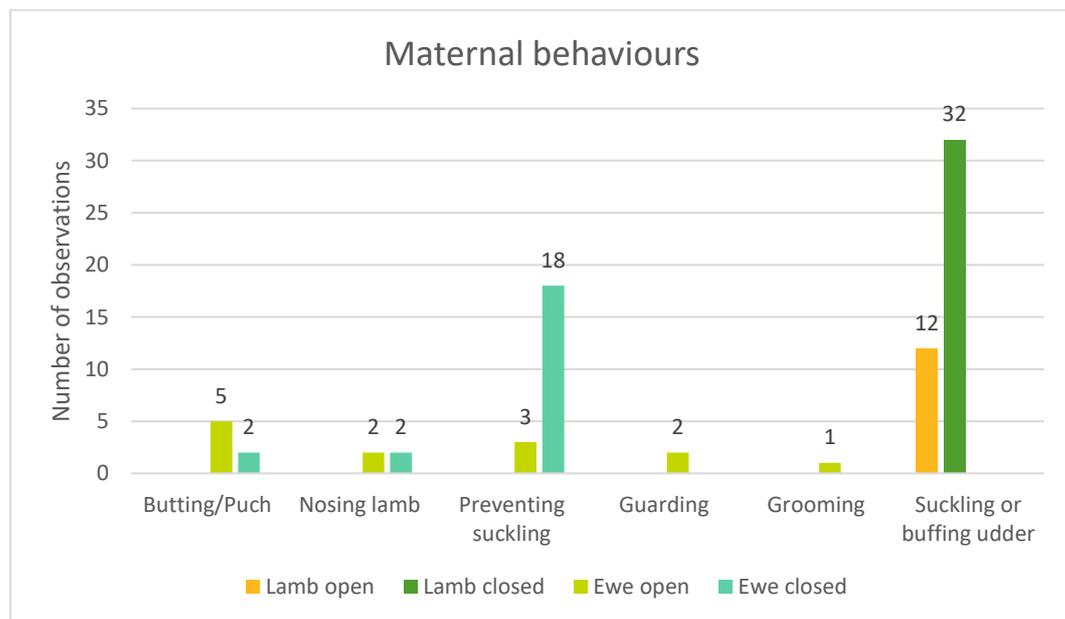


Figure 5. Maternal behaviours observed during park open, and park closed hours, throughout the observation period

During the observations period locomotor was the group of behaviours that varied the most (see figure 7) on open hours. Other behaviours had a peak on the 25<sup>th</sup> of May, and it consists of many vocalisations. No special events, that could explain the peak, have been identified to this day.

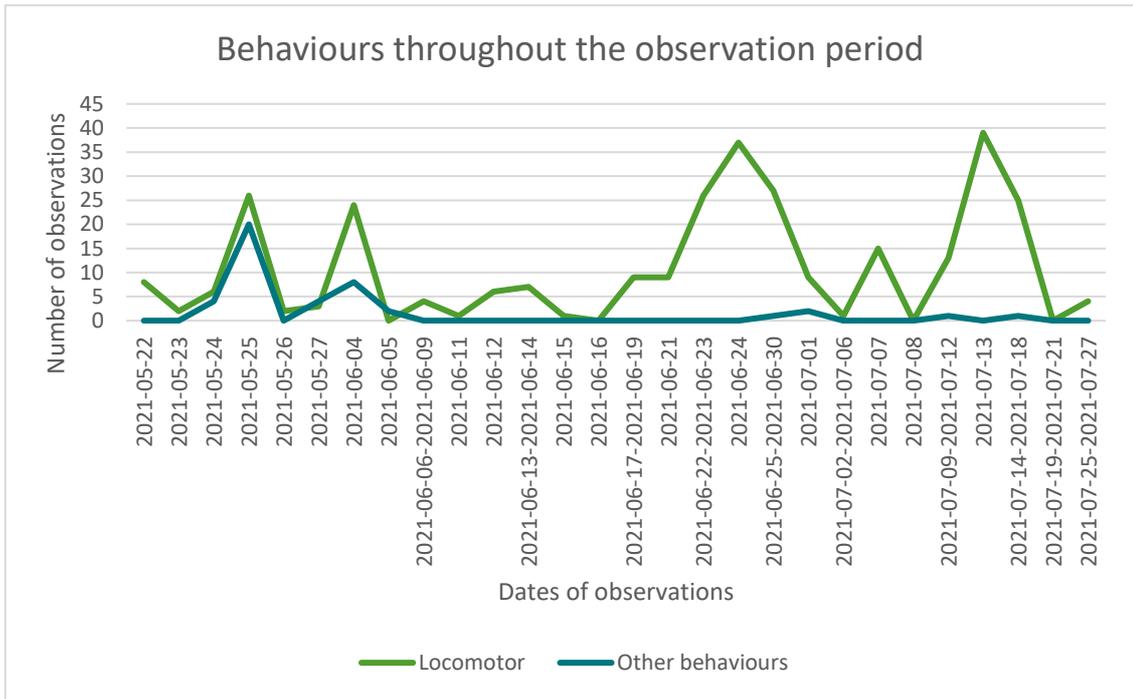


Figure 6. Behaviours observed during park open hours, throughout the observation period

Maternal behaviour during park closed observations had two peaks; during 24<sup>th</sup> of May and 4<sup>th</sup> of June and then remained steady (see figure 8). Locomotor play also had two peaks, one early in the observation period and one later.

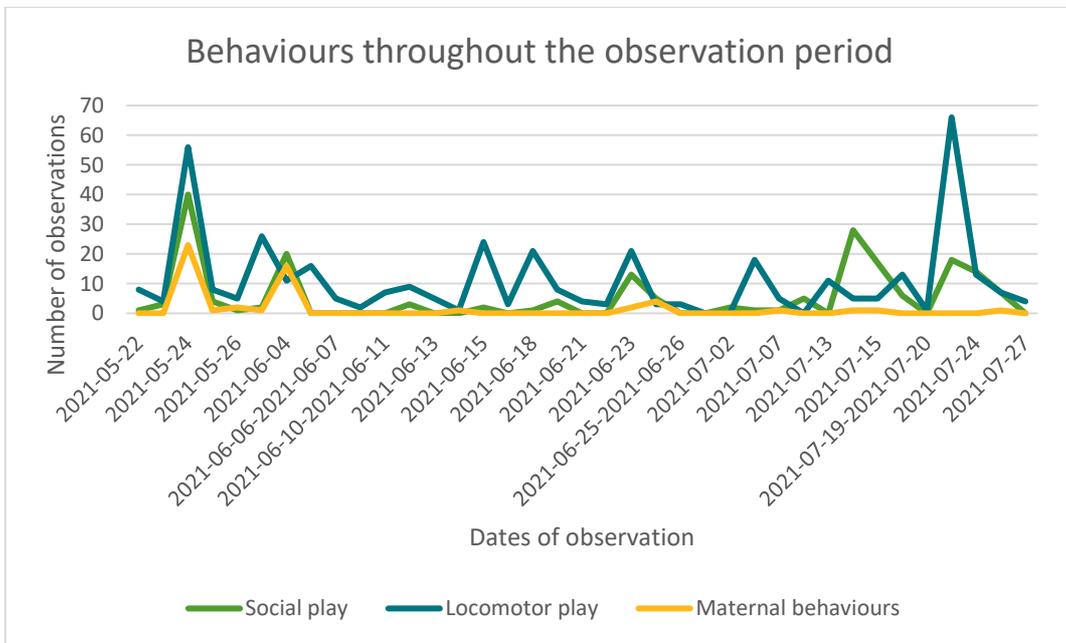


Figure 7. Behaviours observed during park closed light hours, throughout the observation period

As seen in figure 9 locomotor behaviours observed during park closed fluctuate throughout the observations period and other behaviours had two peaks 25<sup>th</sup> of May and 4<sup>th</sup> of June.

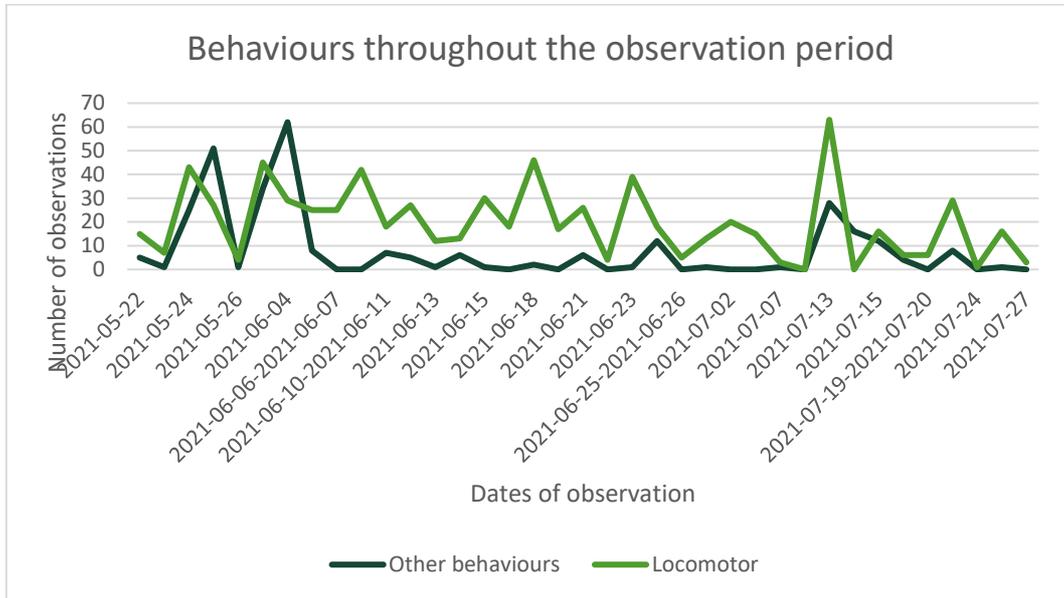


Figure 8. Behaviours observed during park closed hours, throughout the observations period

After combining the ethograms from park open hours nine behaviours did not appear. These behaviours were “foreleg kicking”, “rubbing head”, “chasing”, “pivot”, “head on upper back”, “licking or nibbling”, “withdrawing”, “kicking”, and “blocking”.

For park closed, “foreleg kicking”, “grooming”, “withdrawing”, “kicking lamb”, “blocking”, and “guarding” was not observed.

### 3.2. Comparison of results from park open and park closed hours

The number of hours for park open and park closed hours change during the observations period. As the open hours are divided in high and low season and the number of hours the sun is up during park closed hours also change. During low season (30<sup>th</sup> of August to 27<sup>th</sup> of June) the park is open 6 hours and during high season (28<sup>th</sup> of June to 29<sup>th</sup> of August) the park is open 8 hours. To make the hours for park closed hours as accurate as possible different numbers have been use for the time the observations were done (see table 2). This is according to when the sun goes down and up (*Solens upp- och nedgång i Uddevalla - DinStartsida.se* 2021) and therefore the cameras filming switch from day vision to night vision. And as

previously mentioned, only clips recorded during park closed light hours were studied.

Table 2. Hours observed during park closed hours on specific dates of the observation period

| Date                    | Time for observation    |
|-------------------------|-------------------------|
| 2021-05-22 – 2021-05-27 | 11 hours and 15 minutes |
| 2021-05-28 – 2021-06-24 | 11 hours and 45 minutes |
| 2021-06-25 – 2021-07-13 | 9 hours and 45 minutes  |
| 2021-07-14 – 2021-07-27 | 9 hours and 15 minutes  |

Locomotor play behaviour was higher in park closed than in park open (see figure 10). The number of observations during park open did only twice go above ten while park closed had most observations over ten. Only three times did the number of locomotor play behaviours reach zero for park closed while park open had multiple times of zero locomotor play.

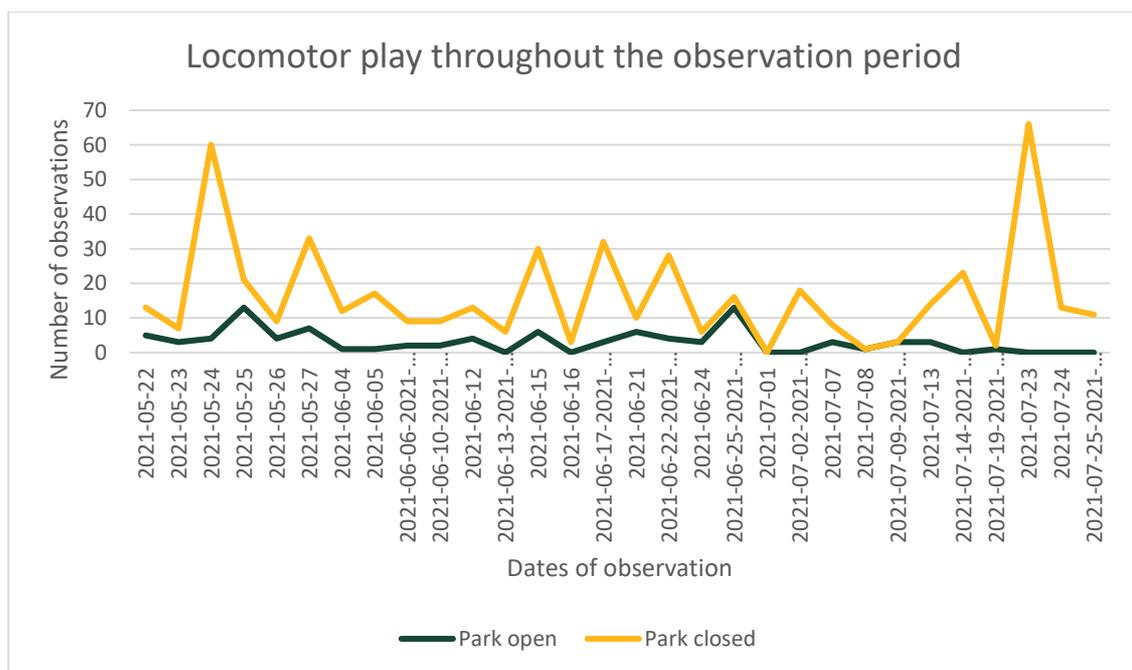


Figure 9. Comparison of locomotor play behaviour between park open, and park closed throughout the observation period

To make the comparison clearer as the observation time during park open and park closed hours differs a little throughout the observation period, figure 11 shows a comparison with locomotor play behaviours divided by observation time. As seen in figure 11 park closed have more observations per hours than park open, in most cases.

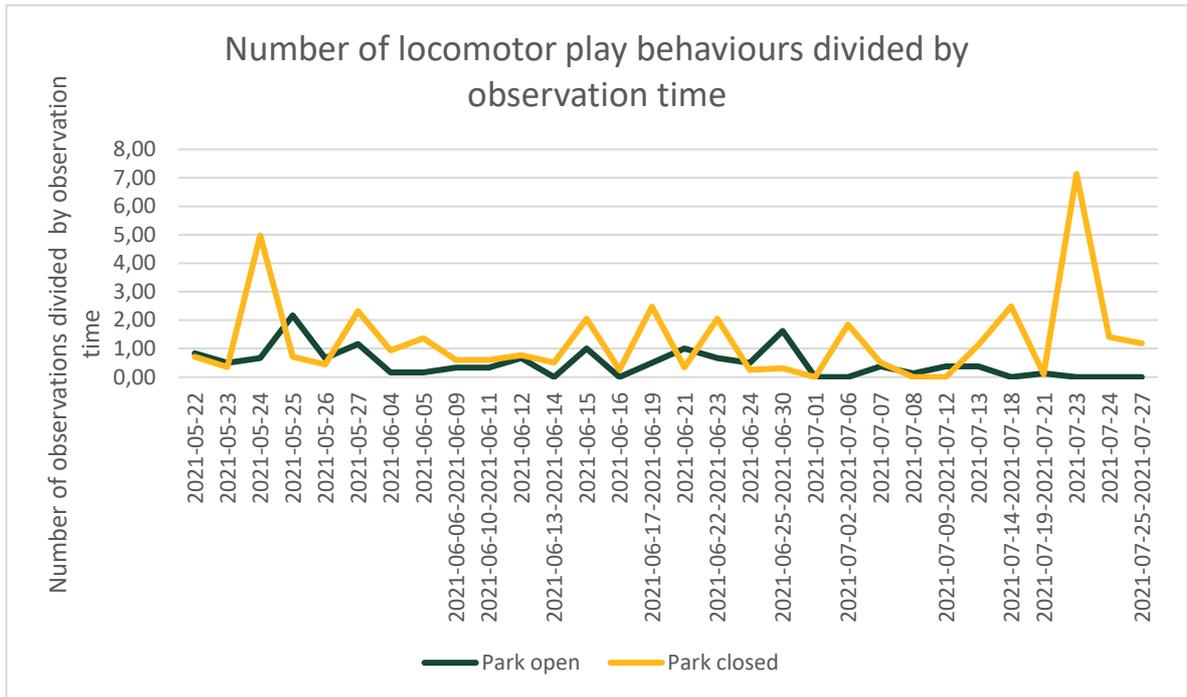


Figure 10. Number of locomotor play behaviours observed for park open and park closed hours throughout the observations period, divided by observation time in hours

Maternal behaviours differed between park open hours and park closed hours. When the park was open the lambs suckled fewer times than park closed but for longer periods and they performed more of the different behaviours. The mean of suckling durations were 12 seconds for park open and 10 seconds for park closed and the number of observations were 12 for park open and 32 for park closed. One outlier for park open was observed with 60 seconds duration.

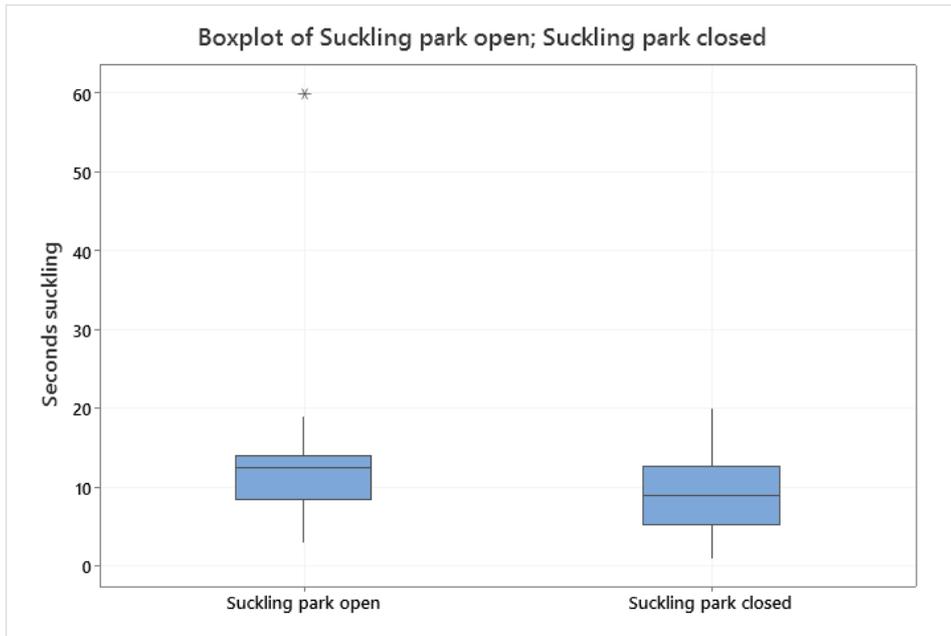


Figure 11. Boxplot comparison of suckling duration during park open hours and park closed hours

Social play behaviour was also higher in park closed than in park open. Not once did social play during park open go over social play during park closed. Only small fluctuations during park open was observed while bigger fluctuations were observed during park closed. To make a clearer view of the social play behaviours performed during observation the number of observations were divided by observations time in hours. As seen in figure 13 park closed had higher frequency of social play per hours on most of the observation days. Park closed also had several days with one or more social play behaviours performed each hour.

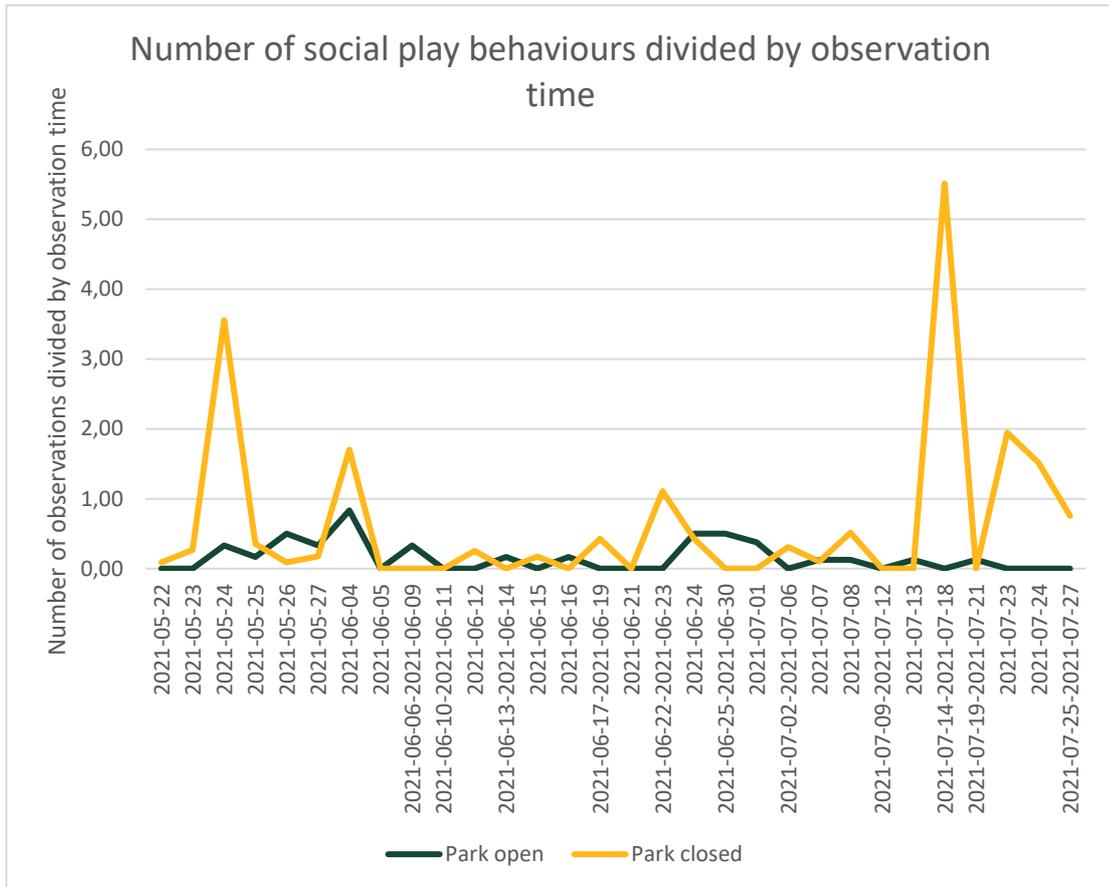


Figure 12. Number of social play behaviours observed for park open, and park closed hours throughout the observation period, divided by observation time in hours

Locomotor behaviours were fluctuating during the observation period, both for park open hours and park closed hours (see figure 15 & 16). During park closed the Urinals move more than during open hours but when number of observations were divided by observations time in hours park open and park closed both fluctuate a lot. And park open do have higher values of locomotor behaviours on several occasions.

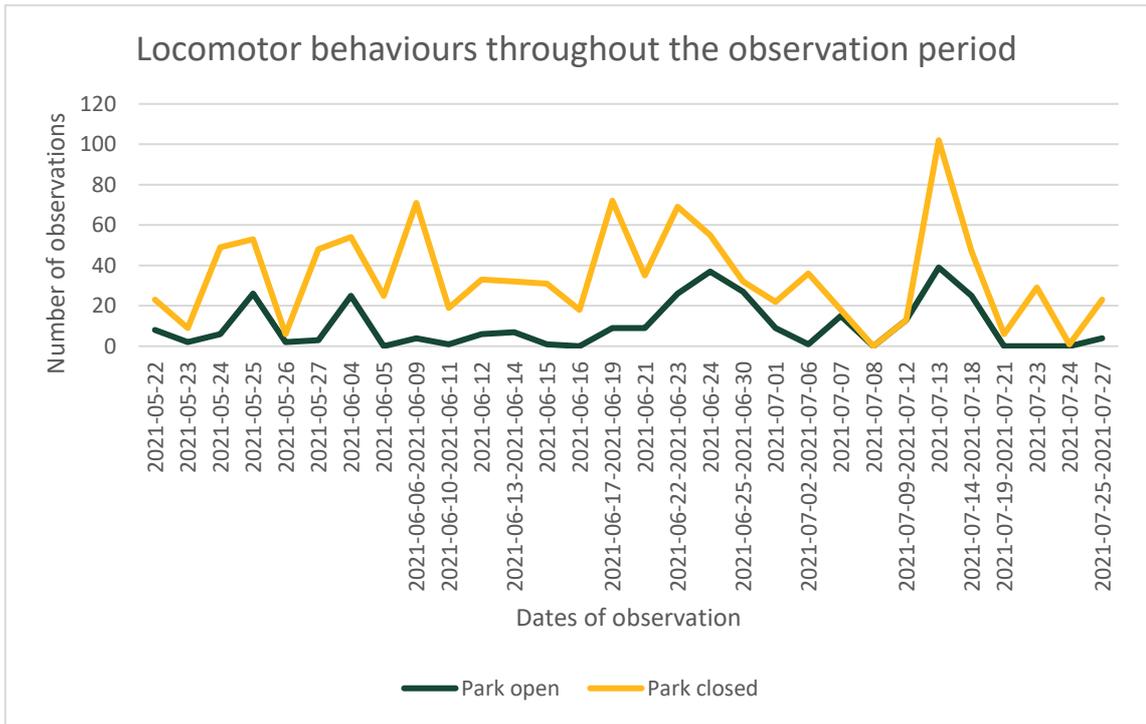


Figure 13. Comparison of locomotor behaviours during park open hours, and park closed hours throughout the observation period

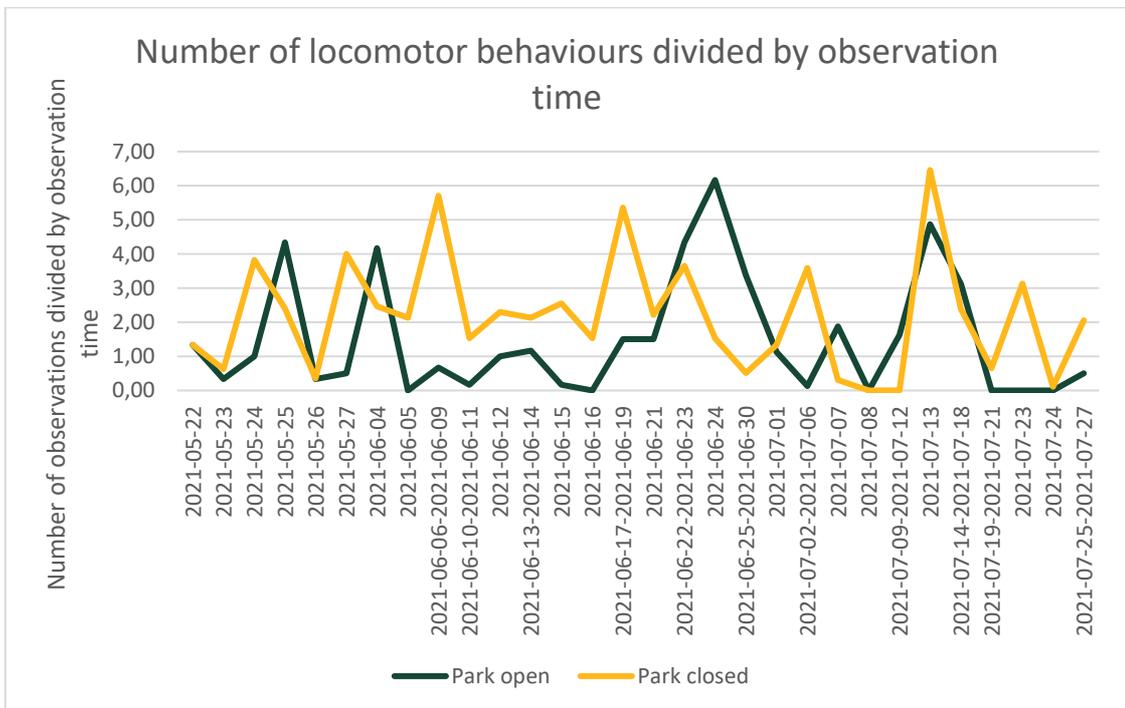


Figure 14. Number of locomotor behaviours observed for park open, and park closed hours throughout the observation period, divided by observation time in hours

## 4. Discussion

This study was done to better understand the needs of Urials and potentially how to adapt their enclosures, and how to meet the animals' needs in the future. As previous research seems virtually non-existing on Urial sheep, this is a pioneer study and hopefully it can highlight how important the work with this species really is.

### 4.1. Result discussion

#### 4.1.1. Play behaviours

The results indicate that both lambs and adults play, but does the adult behaviour showed really represent play? Behaviours like jumping up on object (in this case often stone blocks) does not necessarily mean that the adults are playing. In many of the observations it seemed more like the adult aimed to achieve higher ground, potentially to have better visual on the enclosure. They performed this behaviour both after fleeing and running without known cause. They also presented body language signalling alertness, similar to the behaviour Walther (1969) distinguished for gazelles.

The behaviours “butting” and “mutual head-to-head butt” was performed by adults to a high extent. Butting is an adult behaviour typically performed by adult males when competing for mating opportunities (Bazyan et al. 2015) and it therefore seems unlikely that the adult Urials were playing when they performed this behaviour. However, in this group there were no adult males and no real resource competition. Hence it is not possible to say that all butting performed by adults is a mature behaviour and that none of it is playful. As Gomendio (1988) and Bekoff (2001) wrote, play can be contagious and with play being performed around adults they may engage in play themselves and further research and observations is needed, particularly if play is going to be used as a welfare indicator for ex-situ kept animals.

The differences in play behaviour during park open and park closed seen in figures 15 and 16 may depend on several factors which are completely confounded. Firstly, when the park is open the Urials were exposed to visitors and zookeepers and as they are profoundly shy animals, threatened by poaching and hunted by humans (IUCN 2020) this may be stressful. On other zoo animals “visitors’ effects” have been shown. In previous research on European bison (*Bison bonasus*) have shown higher levels of stress hormone on days visitors were present (Klich et al. 2021). Secondly weather and light intensity differed. Due to the park opening hours light hours observed without humans present were always either early morning or late afternoon/evening and park open was always the mid of the day. Virtually all animals have circadian rhythm and many especially active during dawn and dusk (Bowman et al. 2021). As the Urials were fed by the zookeepers in the morning during early park open their behaviour may have been affected by being given fresh food. It is likely that, due to the evolutionary history and hunting pressure posed from humans, the Urials are strongly affected by human presence but this needs to be studied in a controlled design.

Animal welfare and play behaviours can be linked, as Held and Spinka (2011) wrote:

“Play has long been identified as a potential welfare indicator because it often disappears when animals are under fitness challenge and because it is thought to be accompanied by a pleasurable emotional experience.”

What does this mean for the Urials at Nordens Ark? The higher frequency of play behaviours during park closed could be an indicator that the Urials are under stress during park open and therefore do not play to the same extent. Other studies done on “visitors effect” have shown that the mere presence of visitors change the animals’ behaviours (Suárez et al. 2017), these effects being not only negative effects with less play and walk but instead performing behaviours like resting and using hidden spaces.

The fitness challenges or stress indicators described in the paper by Held and Spinka (2011) for both animals in the wild and in captivity were feed shortage, threat from predators, overcrowding, bad weather conditions, injures, illness, lack of shelter or lost mating opportunities. In this study the Urials have shelter, ad libitum feed with several feeding places, are not overcrowded, live in a fenced area but could still have presence of predators and have the opportunity to mate in mating season. The potential fitness challenges could be the disturbance from visitors, injures, illness and bad weather conditions. Bad weather conditions cannot be resolved but as the weather is not always bad and not only on open hours this was most likely not the fitness challenge causing the Urials to play less than the park was open. With shelter

they were also protected from bad weather if needed. Illness and injuries are hard to prevent but as the routine shows the handlers are doing everything they can to avoid it and during the study all animals were healthy. The fitness challenge remaining are the visitors and the potential stress they put on the animals. As showed in research on zoo orangutans (*Pongo spp.*), these apes were less likely to show play and social behaviour with visitors being less than 10 meters away (Choo et al. 2011).

The increased frequency of play behaviours could also be a compensatory reaction from the Urials after stress, induced by relieved stress when the park closed. Such an effect was found in calves (Jensen 1999) where confinement was the stress factor leading to compensatory play when the calves were released. It would be interesting to know more about visitors' effects on Urials behaviour and stress physiology. But that was not the aim off this study.

As mentioned before, play can be contagious and with that could also improve the welfare for the whole group (Held & Špinka 2011) of Urials. Play has not only short but also long-term benefits. It is practice of mature behaviours, strengthening of the body and better mobility as long-term benefits. Short-term could be influencing the situation, self-assessment of current health and to release endorphins (Held & Špinka 2011). It is however still not possible to say that the Urials are "happier" or have better welfare without the presence of visitors. Both because it is, to my knowledge, not known how and when play is performed in the wild, and also the visitor effect has not been studied in Urials. However, the decrease of play when the park is open raise some concern.

The Urials' general behaviour was not observed in this study but, is of interest and could well be a continued research area. Behaviours outside of this thesis' focus does affect the animals' well-being and health, for example foraging and ruminating.

Even if only taking the lambs' play behaviours into account, as we do not really know how much of the adult behaviour really is play, there is substantially more play behaviours during park closed than park open. The frequency of locomotor play was 50% higher during park closed compared to park open and social play frequency was four times higher when the park was closed. What causes this effect remains unknown and unfortunately, for the study design, the zoo Nordens Ark is open every day, whereas no control days exist.

#### 4.1.2. Maternal behaviour

As the maternal behaviours differs between park open hours and park closed hours ewes and lambs may potentially be affected by visitors in a negative way. For Merino sheep the frequency of suckling bouts was higher during daylight than night (Gordon & Siegmann 1991). If the visitors are a stress element (Hild et al. 2011) for the Urial ewes this could be a reason for the lower suckling frequency on park open hours. The difference in suckling was almost three times as many suckling bouts during park closed as during park open. As previous research is non-existing on this subject it is not possible to say for certain that is it not just a natural pattern, but it is crucial that the lambs get enough milk per day to grow and be healthy. How much the lambs need to suckle depends on the content in the milk, higher energy values do not require as many or as long suckling bouts as milk with lower energy values. Domesticated sheep (*Ovis aries*) have approximately a mean of 5.73 % protein and 6.99% fat in their milk (Barłowska et al. 2011). Urinals could be in the same range, but no assumptions can be made and as we do not know the content of Urinals milk. Growth in lambs is an important welfare indicator and a possibility for voluntary weighing of the lambs would have been valuable for the interpretation of the results.

When possible, lamb tail wagging was registered during suckling. In almost all observations of suckling the lambs did wag their tails on and off during suckling bouts. They seem to start wagging when they latch on to the teat and throughout the drinking process but, stop to buff and move around. It is not possible to know if the whole suckling bout gives milk to the lamb or if it is only short periods of milk let down as it is for pigs (Spjuth 2003). But to my knowledge it is a sign farmer are looking for to know that the lambs are given milk when suckling. So, if it is the case that lambs only wags their tail when they get milk the actual time the lambs eat is much less than the suckling time. With the suckling bouts being between 1 and 20 seconds (with one outlier of 60 seconds) it is not likely that the shorter suckling bout gives the lambs high quantities of milk. Numerically, suckling bouts during park open were longer than bouts when the park was closed but they were less than half in number. Potentially ewes and lambs compensate for fewer suckling bouts with prolonging them.

In all but one suckling bout the ewe was the one that ended the bout. It is the mother's decision to let the lamb suckle and she also decides when the suckling bout ends. One time a lamb was the one ending the suckling and the reason for that is unknown. No sound or movement was detected what could explain that the lamb stopped suckling.

The lower frequency in maternal behaviour during park open hours could also be a circadian rhythm that Urials have. In the night, dusk and dawn the natural predators of Urials are active and therefore resting during the day makes Urial more alert during darker hours, as dusk and dawn observed in this study. As for my knowledge Urials have good night vision and could detect predators even in dim light (Yngvesson 2021). If this is the case, there is a difference between Urials and domesticated sheep with circadian rhythm. Domesticated sheep have a higher activity during light hour (Giuseppe et al. 2006) but some behaviours are performed during all hours of the day. Even if Urials showed more different maternal behaviours during park open hours than park closed hours, the frequency was still low.

As the first weeks of the lambs' lives was not filmed the lack of maternal behaviour such as licking, buffing, nosing, grooming, and guarding could simply be that the maternal bond is already established prior to the filming (Pickup & Dwyer 2011). Domesticated sheep have been thoroughly studied when the lambs choose their mother over other ewes and during what circumstances (Sebe et al. 2010) and with that it seems that the bond between lamb and mother establishes the first days after birth. The first period in the Urial lambs' life was not recorded because we did not want to disturb the lambs and their mothers by moving around in the enclosure. Previously ewes have rejected lambs after disturbance in the enclosure and zookeepers handling the lambs (personal communication J. Loberg 2021). The zookeepers try to avoid any disturbances of the Urials the days after lambing, e.g. marking of individuals is not done until later or if any other intervention is necessary (personal communication J. Loberg 2021). However, if the filming could have been started directly after lambing, my strong view is, that more maternal behaviours and higher frequency of behaviours would have been observed.

#### 4.1.3. Locomotor behaviours

It is possible for predators to disturb the Urials during closed hours and make them stressed. This has not been seen in the clips observed in this study but could be visible on the clips remaining on park closed dark hours. No predators were visible on the clips observed, but the zookeepers have occasionally had to mend holes in the fence surrounding the enclosure big enough for badger (*Meles meles*), fox (*Vulpes vulpes*) or wolverine (*Gulo gulo*). These predators pose a threat to small lambs.

Other reasons for the locomotor behaviours being higher in park closed could be that the weather conditions are making it more favourable to move during hours when the sun is not at its highest. The clips were filmed during summer, and it could potentially be to preserve energy that the Urials move less during open hours as

these coincide with the warmest part of the day. As the enclosure had good opportunity for the animals to be in the shade, they should not be under heat stress. Research have showed that crossbreds of Dorper and Santa Inês sheep spend more time lying or standing still when not provided shade (Cleef et al. 2021). So if the Urials were affected by the heat during daytime could not be established with the current ethogram.

The lambs were often observed running as a movement, but that can easily be explained that the lambs need to run to keep up with the adults, even if the adults are not running. In figure 4 and 12 it looks like running unknown and flee were much higher for adults than for lambs but as written previously the number of behaviours per individual shows that lambs flee, run by unknown cause, and run as a movement to a higher extent than adults. This cannot be explained by the fact that lambs are smaller and must run.

As previously mentioned, Walther (1969) distinguished behaviour in gazelle for flee. The body language that gazelles do before fleeing is very similar to the body language Urials do before and after fleeing. Urials also make the quick stop and pointing ear forward as gazelles do when they stop.

#### 4.1.4. Other behaviours

Vocalisation in Urials were observed in both park open and park closed hours but to a much higher extent in park closed hours. It is hard to determine why the difference is so big. Some weather conditions may have caused the vocalisations to increase during closed hours as very windy conditions seems to make the Urials vocalise more. Generally, the weather conditions were not recorded but one specific day with very windy conditions observations were made the Urials vocalisation was up to twelve repetitions, while during not windy conditions the repetition were between two and four times. As far as it is known the Urials have good hearing, but can it still be that the Urials have trouble hearing each other during these windy conditions? Domesticated sheep and other farm animals have a “well developed sense of hearing” (*Sheep development board* u.å.) and it can only be assumed that Urials have at least the same sense of hearing.

## 4.2. Method discussion

To study video recordings, have both advantages and disadvantages. Advantages are that the animals are not in direct contact with the person observing and there should be no false results due to disturbance from the observer. Animals quickly habituate to the cameras themselves and the occasion when the cameras are

installed, taken down or checked, and memory card is replaced is connected to the normal, necessary management in the enclosure. In this study the memory card was replaced approximately once every week. Another advantage of recording is that it is possible to gather more comprehensive material than with direct observations when it is difficult to be present all hours of the day. The opportunity to go back and look again multiple times and be able to study a behaviour more closely is also a great advantage with recorded material. This is not possible with direct observations, and it can be hard to stay focused for long periods at a time. Direct observations entail that some results are lost when the observer cannot be present or when it is hard to focus. As the animals included in this study were non-domesticated the disturbance towards the animals should be kept to a minimum.

The disadvantages with video recording are that equipment can be hard to install so that the recordings show what the observer wants. The Urinals have also in some cases scratched themselves on the cameras and thereby moving them. Angles, objects, and other aspects can make the material partially or completely unusable. This was in some of the material collected the case and therefore some recordings done were not been processed and did not contribute to the result in this study.

The enclosure for the animals was too big to cover in camera angles so some areas are not recorded in the material. Video recordings cannot replace the flexibility to move around during direct observations to “follow” the animal around as they move in the enclosure. But in this study the observer could not implement direct observations and therefore video recordings were chosen as the best option. The recording angles focus, and other quality aspects are fixed and can only to very small extent be changed afterwards.

As the cameras were placed in different locations it is possible that the same behaviour was filmed from two or more cameras and creating double documentation. The different motion behaviours could easily be filmed on multiple locations in the enclosure, and it is therefore possible that the number of motion behaviours observed is not the same number of motion behaviours performed. To make an example, if the Urinals start fleeing at the sheltered area they can run past all the other cameras and the recorded observation would be four, but it was only one session of fleeing.

### 4.3. Ethical-, social- and sustainability discussion

Ethically there are some parts of this study that should be addressed. To keep wild animals in captivity could be questioned in many ways. Do humans have the right

to keep animals in enclosures? Is it for the benefit of the animals or ourselves? And can we assure that they are taken well care of and not suffering in any way (Iwuchukwu et al. 2020)? It is not easy questions to answer and will not be fully answered in this thesis. For the benefits of the Urials survival it is crucial to conserve them as there are so few left in the wild. It is not possible for conservation projects to operate in the area where Urials live. So, the work at Nordens ark is important and necessary for the Urials. If this gives us the right to have wild animals in enclosures? The aim is to do good.

So, to care on with the next question; is it for the benefit of the animals or ourselves? Both, it is to make sure that the animals survive, and this study aimed to learn more about the Urial behaviours to give the best possible care. But it is also for our benefit, as it is not possible to know what animals that will be needed in the future. It is also for our benefit to have these animals to learn from.

To the last question, can we assure that they are taken well care of and not suffering in any way? The simple answer, we cannot. But what we can do is to try to learn as much as possible about the Urials and make the enclosures and their environment the best possible for their needs. This study was aimed to do exactly that, learn.

The conservation of animals is to a large extent only necessary because of humans were causing the extinction or decline in the first place. You can argue that because it is our fault, we are the one that most solve it. So therefore, conservation of animals and wild animals in captivity are necessary. There is also a sustainability aspect of conservation. As mentioned in the introduction we cannot know what the world will need in the future and some of the animals that we try to preserve can be all great use further on (Broom 2019).

To have the opportunity to see animals from all around the world and learn about them (Clay & Visseren-Hamakers 2022) is from a social perspective advantageous. As Urials cannot be observed in their natural habitat the only possibility is in parks such as Nordens ark. To learn about the animals while we still have them could be of importance in the future.

#### 4.4. Delimitation of study

The first weeks after the lambs birth the group was not recorded. The lambs were born the 4<sup>th</sup> of May and the 11<sup>th</sup> of May 2021 and the first recordings analysed was from 22<sup>nd</sup> of May 2021. This delimitation was deliberately as there is a big risk when handlers enter the enclosure that mother and lambs get separated then they run away. Lambs can also fall and hurt themselves as the enclosure consists of hills,

slopes, and rough ground. Previous years lambs have been repelled by their mother when staff have handled the lambs, therefore only one lamb was marked during recording. No unnecessary handling is done with any of the animal as the bond between mother and lamb seems to be fragile in the early stages after birth.

## 4.5. Conclusion

To answer the questions previously in the aim of this study.

What kind of behaviours do the Urials perform?

- They perform social-, locomotor- and object play behaviours together with maternal behaviours towards their lambs. One particular form of social behaviour is vocalisation and Urials also demonstrate a high frequency of locomotor behaviours.

How do ewes behave towards their lambs?

- The ewes call on their lambs, let them suckle but also prevent them from suckling. Maternal behaviour needs to be studied right from birth of the lambs.

Is there any difference in their behaviours between park open hours and park closed hours? And if any, what kind of differences?

- There were large differences between park open and park closed observed behaviour. For example, the Urials both played and moved more during closed hours and the number of suckling bouts were more than double.

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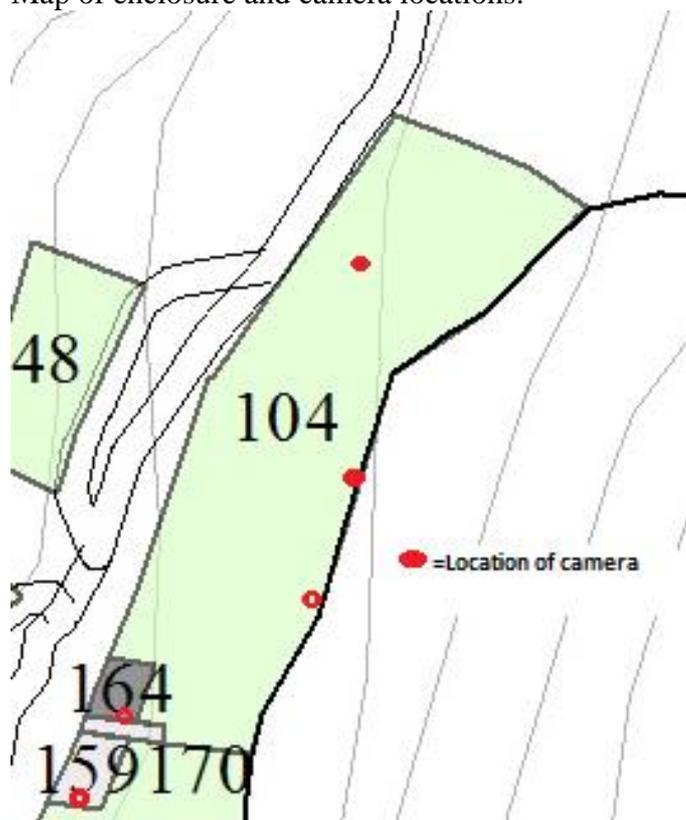
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# Appendix 1

Map of enclosure and camera locations.



## Appendix 2

Table 3. Ethogram for observation of video recordings

| Behaviour                             | Definition  |
|---------------------------------------|---|
| <b>Play</b>                           |   |
| <b>Social play</b>                    |   |
| Head-to-head butt                     | One animal head butting another animal  |
| Mutual head-to-head butt <sup>1</sup> | Jerk down their heads and heat their horns or foreheads   |
| Mutual clash <sup>2</sup>             | Slam their horns and/or foreheads after backing up and running at each other over a short distance  |
| Foreleg kicking <sup>3</sup>          | Raise foreleg and kick to the body  |
| Rubbing head <sup>4</sup>             | Rub their muzzle and horn to body   |
| Chasing <sup>5</sup>                  | Movement forward in straight trajectory in the direction of another individual that is moving away  |
| Butting <sup>6</sup>                  | Hitting head against the other animals' head, taking a stance in the direction toward the other animal, resulting in either a butt or not |
| Mounting <sup>7</sup>                 | Raising chest and forelegs onto the back of other animal from rear or side  |
| Pushing <sup>8</sup>                  | Pressing the front or side of the head or with the shoulder on the other animal   |
| <b>Object play</b>                    | Interacting with toy object by rubbing/pushing/biting the object with paw/head/mouth  |
| <b>Locomotor play</b>                 |   |
| Jump <sup>9</sup>                     | Making a jump so that no body part has contact with the ground  |
| Race <sup>10</sup>                    | Running in a group, commonly back and forth in the same area repeatedly. It involves at least 3 participants.                             |

<sup>1</sup> Bazyan. et al. Mating behaviour of wild sheep in captivity (Case study: Laristan Mouflon, Ovis orientalis laristanica. 2015

<sup>2</sup> Ibid.

<sup>3</sup> Ibid.

<sup>4</sup> Ibid.

<sup>5</sup> Augustsson. A survey of play behaviour in domestic lambs out on pasture. 2014

<sup>6</sup> Andersson et al. Behavioural expression of positive anticipation for food or opportunity to play in lambs. 2015. Swedish University of Agricultural Science, Sweden.

<sup>7</sup> Ibid

<sup>8</sup> Augustsson. A survey of play behaviour in domestic lambs out on pasture. 2014

<sup>9</sup> Andersson et al. Behavioural expression of positive anticipation for food or opportunity to play in lambs. 2015. Swedish University of Agricultural Science, Sweden.

<sup>10</sup> Augustsson. A survey of play behaviour in domestic lambs out on pasture. 2014

|  |  |
|--|--|
| Running  | Movement forward in straight trajectory to some direction and back or by circle around the group or individual |
| Jumping on to object                                       | Animal jumping up and down from object   |
| Pivot <sup>11</sup>  | Jumping so that no body part has contact with the ground and changing direction in the air                     |
| <b>Other</b>   |  |
| Keeping head on upper back of another animal <sup>12</sup> | Keeps its head on upper back of another animal   |
| Suckle or buffing udder                                    | Lamb nursing on an ewe, (record duration) or buffing with its mule on the udder                                |
| Vocalisation   | Animal making sound, (try to establish object of vocalisation)   |
| Licking or nibbling another sheep                          | An animal licking or nibbling another animal some ware on the body   |
| Nosing   | Contact with another animal with nose without licking or nibbling  |
| <b>Locomotor behaviours</b>                                |  |
| Running  | Movement in a direct avoidance of something or going towards something   |
| Flee   | Animal running away from object/sound that scares it   |
| Running unknown  | The animal is running without clear cause  |

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<sup>11</sup> Ibid.

<sup>12</sup> Bazyan et al. Mating behaviour of wild sheep in captivity (Case study: Laristan Mouflon, *Ovis orientalis laristanica*. 2015

## Appendix 3

Table 4. Ethogram for observations of video recordings on maternal behaviour

| <b>Behaviour</b>                  | <b>Definition</b>  |
|-----------------------------------|--|
| <b>Maternal</b>                   |  |
| Butting/ Push <sup>13</sup>       | Knocks lamb down or away with a movement of the head                             |
| Nosing lamb <sup>14</sup>         | Contacts lamb with nose without licking or nibbling                              |
| Preventing suckling <sup>15</sup> | Moving away from lamb trying to suckle, backing, forward or circling motion      |
| Grooming <sup>16</sup>            | Licking and/or nibbling directed towards lamb                                    |
| Withdrawing <sup>17</sup>         | Moves backwards away from the lamb when approached                               |
| Kicking                           | Kicking another animal to prevent from contact with lamb                         |
| Blocking                          | Ewe blocking another animal with her body to prevent from contact with lamb      |
| Guarding                          | Standing close to lamb and watching around, without grazing or touching the lamb |

<sup>13</sup> Dwyer & Lawrence. Maternal behaviour in domestic sheep (*Ovis Aries*): Constancy and change with maternal experience. 2000. Edinburgh.

<sup>14</sup> Ibid

<sup>15</sup> Ibid

<sup>16</sup> Ibid

<sup>17</sup> Ibid