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DIPLOMARBEIT

Changes in the behavior related to the reproductive cycle in the Black Rhinoceros (*Diceros bicornis*)

Zyklusabhängige Verhaltensänderungen im Spitzmaulnashorn (*Diceros bicornis*)

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Kitzingen, den 4.9.98

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1. INTRODUCTION

The Black Rhinoceros (*Diceros bicornis*) is found in many small populations today. The current range consists of reserves in Kenya, Tanzania, Namibia, Zambia and South Africa. The Black rhino stands at approximately 160 cm at the shoulder, is approx. 3m in length and weighs between 800 and 1400 kg. They can reach the age of 40 years, the female reaching sexual maturity between four and six years of age, with first parturition between seven and nine years. Males become sexually active between 10 and 15 years depending on their rank. (Adcock, Emslie; 1997).

The aim of this study is to determine if one can ascertain the day of peak receptivity in a Black Rhinoceros female. This is to be accomplished, solely by documenting the behavior and activity exhibited by her. For this reason, the natural behavior patterns shown by the Black Rhinoceros must be known.

1.1 Ecology

The habitat of the Black rhinoceros ranges between montane forest, through savanna woodland, bush and thicket, medium grassland-woodland ecotones, scattered tree grassland and semi-desert, to desert (Hillman-Smith, Groves; 1994).
Black rhinos are browsers and eat mostly leaves and twigs from bushes and shrubs, but also an occasional herb (Schenkel, Schenkel-Hulliger; 1969). In addition, in the dry season, they will sometimes eat grass (de la Fuente; 1977). Preferred feeding height is between zero and one meter, though they can reach over 2m. Twig diameters are three to ten millimeters, but could be up to 30 millimeters (Hillman-Smith, Groves; 1994).

The habitat chosen by the Black rhino is based on certain requirements. First, a permanent water supply must be within reach in the form of rivers or permanent water holes. Second, is the type of food preferred by the species (bushes and shrubs), which, at the same time, lend the animal shelter from the weather (sun and wind) and protection against its most dangerous enemy: man. Lastly, the need for wallows, either in the form of a mud wallow – stable base, with shallow sheet of mud and water – or a "dry" wallow consisting of dusty or fine-grained soil. The use of wallows may help regulate their body temperature, due to the absence of sweat glands, and/or have a favorable effect on skin condition and as protection against ectoparasites (Schenkel, Schenkel-Hulliger; 1969). These ecological requirements may be the reason why Black rhinos, though solitary, are not overly territorial. Home ranges tend to overlap. The exceptions are the home ranges of dominant bulls, which do not overlap with each other. Subordinate bulls are tolerated within the territory, when the dominant bull knows them well. Home ranges vary in size with habitat and possible population density (Hillman-Smith, Groves; 1994). Subordinate and old bulls tend to be pushed into dim areas (Adcock, Emslie; 1997).

Home ranges of the females are usually larger than those of the males are, and juveniles have larger home ranges than adults do. Mean ranges in Ngorongoro (Tanzania) of adult males in 1967 were found to be15.6 square kilometers, females 14.9 square kilometers, immature males 35.9 square kilometers and immature females 27.4 square kilometers. However, in ranges in forest with water, they were as small as 2.6 square kilometers (Hillman-Smith, Groves; 1994).

In regions with good growth, i.e. parts of the south african Bushveld with succulent growth, home ranges can be between 0.5 to 2 square kilometers. On the other hand, "desert rhinos" in Damaraland have up to 500 square kilometers for home ranges (Adcock, Emslie; 1997).

As mentioned above, homes ranges tend to overlap. Bulls fight from time to time with other males to expel them from their territory. However, usually subordinate males, and those that the dominant bull knows well, are tolerated. Fights usually occur when confronted with a strange male. Generally, these are young animals, which cannot defend themselves or whose mother does not protect them or adult males seeking to take over a portion of a dominant bull's territory (Adcock, Emslie; 1997)

1.2. Behavior

Black rhinoceroses must drink at least every two to three days, although they can distance themselves from water sources over 30 square kilometers. Where succulent plants are available, a small part of their water requirements can be met, and they can go longer without drinking. In the rainy season, they will even utilize puddles for water during their wanderings instead of going to water holes (Adcock, Emslie; 1997).

Generally, water holes are sought out in the evening. At sunset, the animals will make their way to their feeding areas. Common paths are used to and from water holes.

Rhinos are most active during the night, when it is cooler, and with increasing daylight, the number of resting individuals rises. At noon, most animals can be found resting in the shade or in a wallow. (de la Fuenta; 1977)

Oftentimes animals will meet at watering holes, wallows or along main tracks (Schenkel, Schenkel-Hulliger; 1969). When this occurs, they usually keep about 30 meters distance from each other and appear to ignore one another (Schenkel, Schenkel-Hulliger; 1969).

If animals do want to meet, females will approach each other cautiously, with little aggression. On contact, they will nudge each other with the sides of the head or horn, and then walk away.
The meeting of a male and female is likely to be accompanied by aggression. The male will approach with a stiff-legged gait, perhaps snorting and occasionally sweeping the head (Hillman-Smith, Groves; 1994). If aggression does occur, it will be initiated by the female. When males meet, aggression usually occurs, and may be violent, but usually the subordinate male or visitor will retreat (Hillman-Smith, Groves; 1994).

Since the eyesight of the Black rhino is very poor, olfactory communication is very important. To this end, the animals defecate on regularly used dung piles, often located near main tracks, at the edges of the home ranges of dominant males and often on hillocks. They scrape their hind feet in the pile before defecating, thereby scattering the old dung, and in the fresh dung. Since these piles are used by many individuals (sometimes even by white rhinos), the fresh dung tells which individual is in the area. Through scraping the feet in the fresh dung, a scent trail is laid in the direction of travel (Meister; 1997)
With such scent, trails mothers and their young can find each other if they become seperated and are out of earshot. Depending on the independence of the young and the tolerance of the mother, the distance between mother and child can reach 30 meters. Also, males can follow prospective mates with the help of these trails.

The estrus cycle of the female has been stated to be anywhere from 24 to 26.5 days (Schwarzenberger, 1993) to 26 to 46 days (Adcock, Emslie; 1997). Males become intensely interested in females approximately six to seven days prior to ovulation. When a cow comes into heat, she will often raise her tail and spray urine, which the male will then test through flehmen behavior (Adcock, Emslie; 1997). In the wild, females generally urinate in a non-ritualized manner: a continuous almost vertical stream without pressure, which is interrupted and pulsated towards the end of the process. Ritualized urination consists of a single squirt; a small quantity of urine is ejected with little pressure. (Schenkel, Schenkel-Hulliger; 1969)
The male will cautiously and stiff-leggedly approach the female, after testing the female's urine for her cyclic state. If the female is not ready for mating, she will attack him. The closer she is to ovulation, the more tolerant she becomes of his advances, until she ultimately allows him to mount. The male may remain mounted between 20 and 46 minutes. Females can copulate repeatedly with the same male or other bulls. (Adcock, Emslie; 1997) For the process to be successful, the female must mate within 24 hours of ovulation.
Pregnancy lasts about 15 months. The cow will allow previous young to stay with her until one month prior to parturition. One month after the birth she may allow them to return and

accompany her and her newborn. Young bulls often accompany their mothers 6 years or more when there are many adult bulls in the region (Adcock, Emslie; 1997).
During a calf's first year the female will stay in thick brush, sometimes leaving her young within for short periods. During mating, a calf can be endangered by the advances of the males, especially if they are older (Adcock, Emslie; 1997). The usual spacing between calves is about 27 months (de la Fuenta; 1977).

Another behavior observed mostly in captivity, is head and horn rubbing. In zoos, rhinos will rub their horns frequently on poles, rocks, fences etc. In most cases, it appears to be an outlet of a drive or urge, which, in a normal environmental situation would lead to some kind of appetitive behavior. The result is a shortened horn or special type of abrasion of the permanently growing horn (Schenkel, Schenkel-Hulliger; 1969).

1.3. Status

At the beginning of the 19th century, the Black rhinoceros had the largest population of all five species of rhinoceroses. A couple of hundred thousand roamed the African continent, from central west Africa to the Great Dragoo at the cape (Emslie, Adcock; 1997).
During the 19th century, the European influence in Africa increased and the Black rhino became extinct in the western and central parts of Africa. In southern Africa, the population numbers also decreased. In 1933, only two populations with 110 animals were left in South Africa and they were persecuted as vermin in Kenya. It is estimated that in 1960 only 100000 individuals survived. Throughout the sixties, the population continued to decline and in 1970, only 65000 animals remained. Kenya had the largest population of about 20000 animals; however, they were still widespread throughout the continent (Emslie, Adcock; 1997)
In the 70's and 80's, there was a massive increase in poaching, which was caused by a rise in the demand for horns. Due to this increase 96% of the world population disappeared in 25 years. Since 1992, the population has stabilized at around 2475 individuals. Conservationists hope this is not just the quiet before the next storm (Emslie, Adcock; 1997).

As mentioned above, the wild population of Black rhinos consists of many small populations today. There are four recognized ecotypes, with only minor differences between them: *Diceros bicornis bicornis* is adapted well to desert-like living conditions. *D. b. michaeli* has rib-like skin wrinkles on its trunk from its back to its belly. These are not seen in any of the other southern ecotypes. *D. b. minor* is smaller and *D. b. longipes* is found only in Cameroon (Adcock, Emslie; 1997).
These few subspecies live in different regions. With the exception of the completely isolated western subspecies (*D. b. longipes*), all boundaries of distribution are not clear-cut. However,

there are clear differences that exist in climate, environment and ecological conditions in the center of the subspecies region of distribution. Therefore, it is probable, that there are genetic and behavioral differences between the four subspecies. This is the reason why it was decided at the Workshop of Rhino Protection in Cincinnati (1986), that they should be listed separately (Emslie, Adcock; 1997).
Due to the alarming rate of decline in the rhino population, zoos have seen it to be their responsibility to breed these animals, so they will not go completely extinct, and genetic diversity is preserved.

1.4. Population management:

The main objectives of breeding programs, like the EEP (Europäisches Erhaltungszuchtprogramm) is to minimize inbreeding, to equalize genetic representation of all founder individuals, and to reach minimum viable population sizes. In order to retain a defined level of variability over a specified number of years (Schreiber, Kolter, Kaumanns; 1995)

The proximate aim is to avoid inbreeding depression. The ultimate aim, is to preserve sufficient genetic plasticity for populations to adapt to changing environments after their reintroduction into the wild (Schreiber, Kolter, Kaumanns; 1995)
In the regional and global management programs, aims for the population size of a species and in what time frame this aim is to be reached, are given. The size of a population is determined by genetic and demographic analysis, in order to preserve genetic variation, the age-pyramid and so on. To further these aims, the ancestry of each species is kept in databanks, so called stud - books, which are accessible regionally and internationally. These allow the breeders to maintain genetic diversity by insuring the relationship between individuals.

1.5. Captive breeding:

In order for genetic variation to be preserved through captive breeding, knowledge of a species' requirements for successful propagation is necessary. In many species, today, this data is either limited or completely lacking. Therefore, zoo-based, species-specific research of reproductive mechanisms is essential (J.K. Hodges; 1995)
Reproductive research, as related to captive breeding, can be classified into three main areas, according to the level of application (J.K. Hodges; 1995):

1. The assessment of reproductive status, which provides practical information in the day to day management of captive breeding-programs.

2. Monitoring the reproductive status provides the basis for studies designed to control or regulate fertility through contraception.
3. In vitro reproductive technologies, which generally involve the manipulation of natural reproductive processes, using gametes or embryos.

The assessment of an animals' reproductive status is essential for many reasons, when dealing with captive propagation.

Knowing an animal's reproductive potentiel, which is based on its gonadal function (Ovary cycles; testicular function) is necessary when selecting animals for pairing, especially between zoos. Early and reliable detection of pregnancy is important in evaluating breeding or insemination attempts. More specifically, information on timing of ovulation is indispensable for effective use of timed matings and assisted reproduction procedures, such as artificial insemination and embryo transfer.

There are many different ways of determining the reproductive status of animals. These include invasive methods (laparotomy, laparoscopy and blood samples) and non-invasive methods. Among the non-invasive methods some require restraint of the animal (vaginal smears, Ultrasonography or saliva samples) and others do not (behavioral observation, urine samples or fecal samples) (J.K. Hodges; 1995).

Most of the time, non-invasive procedures, that do not require the animal to be captured, would be preferred, since this exposes the animal to the least amount stress. This is especially true when dealing with exotic non-domestic animals.

1.6. Analysis methods:

Since changes in hormone production are significant to all aspects of reproduction, analysis of the endocrine status is the most effective of the indirect methods of monitoring.

Although the measurement of hormones from blood samples is one method, advances have been made in less invasive methods for measuring the hormone levels. These alternative methods measure metabolites in animal excreta. Thus, samples can be collected on a daily basis for prolonged periods, without the need for physical contact. Therefore, long-term physiological assessments can be made in most exotic species.

One difficulty, however, does exist: different species can differ in the metabolism of hormones, and thus may excrete different metabolites of the same parent compound (Heistermann, Möstl, Hodges; 1995).

Additionally, species can very with respect to whether they excrete hormones preferentially into the urine or the feces.

An alternative to measuring species-specific hormones is to use non- or group-specific antibodies, by which a range of chemically similar metabolites is measured in a single assay.

The major benefit in this method is improved practicality, since non-specific assays can be applied to a wide range of endangered species (Heistermann, Möstl, Hodges; 1995).

In most mammalian species, reliable information on a female's reproductive status can be obtained by the measurement of two groups of metabolites (urinary hormone analysis):

1. Estrone conjugates (E1C).
2. Pregnanediol-3-glucuronide (PdG)

The measurement of E1C usually includes estrone glucuronide and Estrone sulfate, as well as free Estrone. PdG measurements reflect a poorly defined group of 20-α-hydroxylated progesterone metabolites (Heistermann, Möstl, Hodges; 1995).

These analyses are so far the most widely used method of monitoring reproductive status and pregnancy in most species.

As mentioned above, urinary steroids are excreted in most species in a conjugated form. Unconjugated steroid metabolites usually predominate in feces.

With respect to ovarian cycles and pregnancy group specific assays for the measurement of 20-oxo and/or 20-hydroxylated progestines provides reliable information in a variety of species. Concerning pregnancy, the non–specific measurement of total estrogens in fecal matter through the use of an antiserum, which collectively detects estrone, estradiol-17–α and estradiol-17-β, has been successful in diagnosing and monitoring of pregnancy in a variety of species (Heistermann, Möstl, Hodges; 1995; Schwarzenberger, 1996).

As mentioned, urinary steroids are excreted, in most species in a conjugated form. Unconjugated steroid metabolites usually predominate in feces.

Reliable information on ovarian cycle in a variety of species can be obtained from group-specific essays, that identify progesterone metabolites (20-oxo- and/or 20- hydroxylated progestines). In diagnosing and monitoring pregnancy, the non-specific measurement of fecal total estrogens (specifically estrone, estradiol-17–α and estradiol-17-β) using antiserum has been successful.

Both aspects of endocrine monitoring of ovarian function are illustrated in Fig.<1>. It demonstrates the pattern of urinary estradiol-17-β and 20-α-dihydroprogesterone in comparison to mating behavior during two successive ovarian cycles in an individual northern white rhinoceros (Heistermann, Möstl, Hodges; 1995).

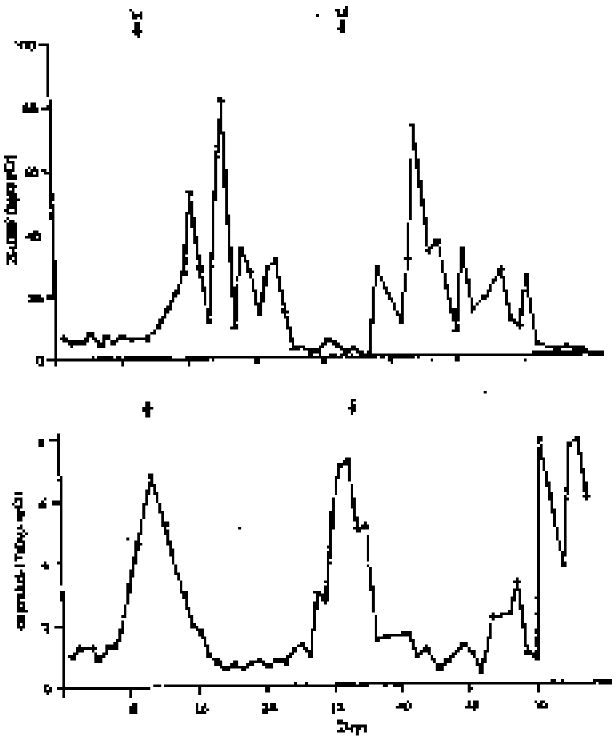


Figure 1: Excretion profiles of urinary 20α-dihydroprogesterone (20αDHP) and oestradiol-17β during consecutive oestrus cycles in a Northern White rhinoceros. Arrows indicate time of mating (M). Figure adapted from HINDLE et al. 1992 Hodges 1995)

Concerning estradiol excretion, the profile shows distinct periods of high concentrations with peak levels being associated with the time of behavioral estrus. Following estrus, a rise in 20-α-dihydroprogesterone indicates the onset of the luteal phase.

Predicting the presumed time of ovulation is possible, because the onset of the preovulatory increase in estradiol-excretion precedes behavioral estrus by three days. The measurement of 20-α-dihydroprogesterone enables the confirmation of ovulation some days later (Heistermann, Möstl, Hodges; 1995).

Principally, the same information can by gained through measurement of estrogen and progesterone in feces, however, the excretion of hormones into feces shows a more significant time lag, in relation to reproductive events (Heistermann, Möstl, Hodges; 1995).

Furthermore, perfecting in vitro methods, such as artificial insemination and embryo transfer should be a priority. These technologies will eliminate costly animal transfers between zoos, which must often allow socialization of the animals before breeding can take place, and will allow the pairing of captive wild genome without the risks of loosing genetic material through death.

1.7. Status in zoos:

Since 1968, Black rhinos have been bred in zoos. The starting population was 143 animals, consisting of 73 males and 70 females. At this time, they were kept almost exclusively in pairs.
Until 1975, the population steadily increased to 178 animals (99 females and 79 males), due to an increase in the numbers kept in some zoos (57 individuals from the wild, 47 births and 71 deaths). Starting in 1977, no more animals were taken from the wild, so the population did not increase, but stayed at about the same level. From 1976 to 1980, there was a slight decline to 171 animals. However, until 1982, the population grew again to 183 animals. In 1990, 204 animals could be found in zoos around the world, with the largest populations being in North America (85) and Europe (55). More than half of the population was of breeding age (Klös, 1990).
As of 1995, 219 Black rhinos were held in captivity (Foose,Miller, 1997).

One of the greatest difficulties in captive breeding of solitary animals, like the Black (or also the Indian) rhinoceros, is determining the time of ovulation. Although the above-described analysis identifies this period in females, it is a costly procedure, which not all zoos can perform. In the Indian rhinoceros, it has been established that the female becomes increasingly agitated and urinates with an increasing frequency (almost constantly) when she comes into heat. These outward signs have been used for years as a guide for timed mating (Wieland, personal communication). Such have not been positively identified in the Black rhinoceros. At this time, most zoos tend to bring the male and female together when the male appears to have an increased interest in the female. This, of course, only works when the animals are housed in adjoining stalls and they have a certain amount of contact with each other (sniffing possible and flehmen of the female's urine on the part of the male possible). In zoos with more than one female, it would be more affective, if peak estrus could be determined by the female's behavior as well, instead of having to rely solely on the male.

1.8. Hypotheses:

The ultimate aim of this study is to determine if it is possible to detect the status of the females' reproductive cycle, in the Black Rhinoceros (*Diceros bicornis*), solely based on her exhibited behavior.
In a previous study by L.J. Mills in 1995 on behavioral characteristics of the Black rhinoceros, behavioral patterns began to crystallize which seemed to coincide with the females estrus cycle. The aim of this study is to confirm the observations made by Mills through independent observations and verify the findings.

The hypotheses derived from the earlier study are as follows:

- During peak receptivity, the female will spend less to no time lying down.
- Just prior to estrus, there will be small peaks in the time spent standing.
- There will be small peaks in eating following estrus.
- Time spent pacing will increase steadily up to peak receptivity and fell off gradually following estrus.

Additional hypotheses:

- Since Black Rhinos are dependent upon olfactory input, the behavior "smell" should increase with the approach of estrus (would be helpful in determining the occupants of the home range in the wild, in order to find a male)
- Leaning on observations made in the Indian Rhinoceros, the urination frequency should increase with the approach of estrus or at least peak on the day of peak receptivity.
- Since dung piles play an important role in to Black Rhinos in the wild, and estrogen / progesterone can be detected within it, it is assumed, that around the time of estrus, defecation will increase. In the wild, this may help males find females in estrus within their territory.
- The behavior of 'alert' would be expected in an animal which has a reason for greater vigilance. Since the Rhinoceros does not have natural predators (except man), this may be an indication of peak receptivity (the female may be searching for the presence of a male in the surrounding bush), and therefore this behavior should increase with the approach of estrus.
- Since rubbing is not observed in the wild, it may be a form of tension release for captive rhinos. With the approach of estrus, rubbing should therefore increase.

2. Materials and Methods

Three females were observed over a six-month period, in the Berlin Zoological Garden. Each animal was observed for 94 consecutive days.

2.1 Animals and their environment:

"Sita" (# 428) was born in 1990 in the Berlin Zoo. All previous attempts to mate her have been unsuccessful, possibly because she was orphaned around the age of one year. Her stable was approximately 20 square meters. Her paddock was approximately 100 square meters and was situated behind the paddock of the other females. This led to the fact that she was fairly isolated from the visitors, and had visual contact to the other rhinos when they were outside. The paddock was fenced by thick wooden planks and the ground consisted of sandy soil. A patch of trees and bushes was cordoned off, also by wooden planks, which was roughly 20 square meters in size (not include in previous estimate. Two sides of her paddock were lined by the other females paddock, between which were also trees. The third side consisted of the wall to the stable, and the fourth side was lined with trees, behind which the outer wall of the zoo was located.

"Ine" (#388) was born in the Berlin Zoo to "Kilaguni" in 1988. At the time of this study, she had a daughter present, who was born in June of 1995. This was her first offspring. "Ine" occupied a Mother/child stable, which was almost circular in nature and was approx. 40 square meters

"Kilaguni" (#220) was born in 1974 in Kenya, and was brought to the Berlin Zoo in the late seventies. She also had daughter present at the time of the study, which was born in August of 1997. This was her fourth offspring.
"Kilaguni" usually had the use of two stalls. The smaller stall was approx. 24 square meters and the larger of the two, where she spent most of her time, was also about 40 square meters.

"Ine" and "Kilaguni" utilized the same paddock outdoors, which was about three hundred square meters. This paddock is next to the visitors walkway, and therefore has a ditch lining it on that side approx. two meters wide. There are three down-ramps for the animals to walk into the ditch that are lined with cobblestones and two raised areas lined with boulders at the height of the walkway, separated by the ditch. There is a small section of the enclosure covered by a roof, for shade and protection from the rain, at the far end of the paddock. Included in this paddock are two vertical log cemented between the two doors, through which the animals are released, and two pieces of log about 50 cm long which are moveable.

"Ine" and "Kilaguni" are released alternately into this enclosure, the length of time dependent upon the weather (see Fig. 2).

Inside the male was located in a stall between "Kilaguni" and "Ine". This facilitated a certain amount of olfactory recognition between the animals. "Sita" had a stall, which was located on the other side of "Ine". The male usually occupied a paddock outdoors that was located on the other side of the house, so the animals did not see, smell or hear each other under normal conditions. When it was too cold outside to let the animals stay out very long the male would be let out into the large paddock of the two females. This led to the meeting of "Sita" and the male on occasion across the fence. When the male was let together with "Ine" for possible mating this also occurred in the large paddock (see Fig. 2).

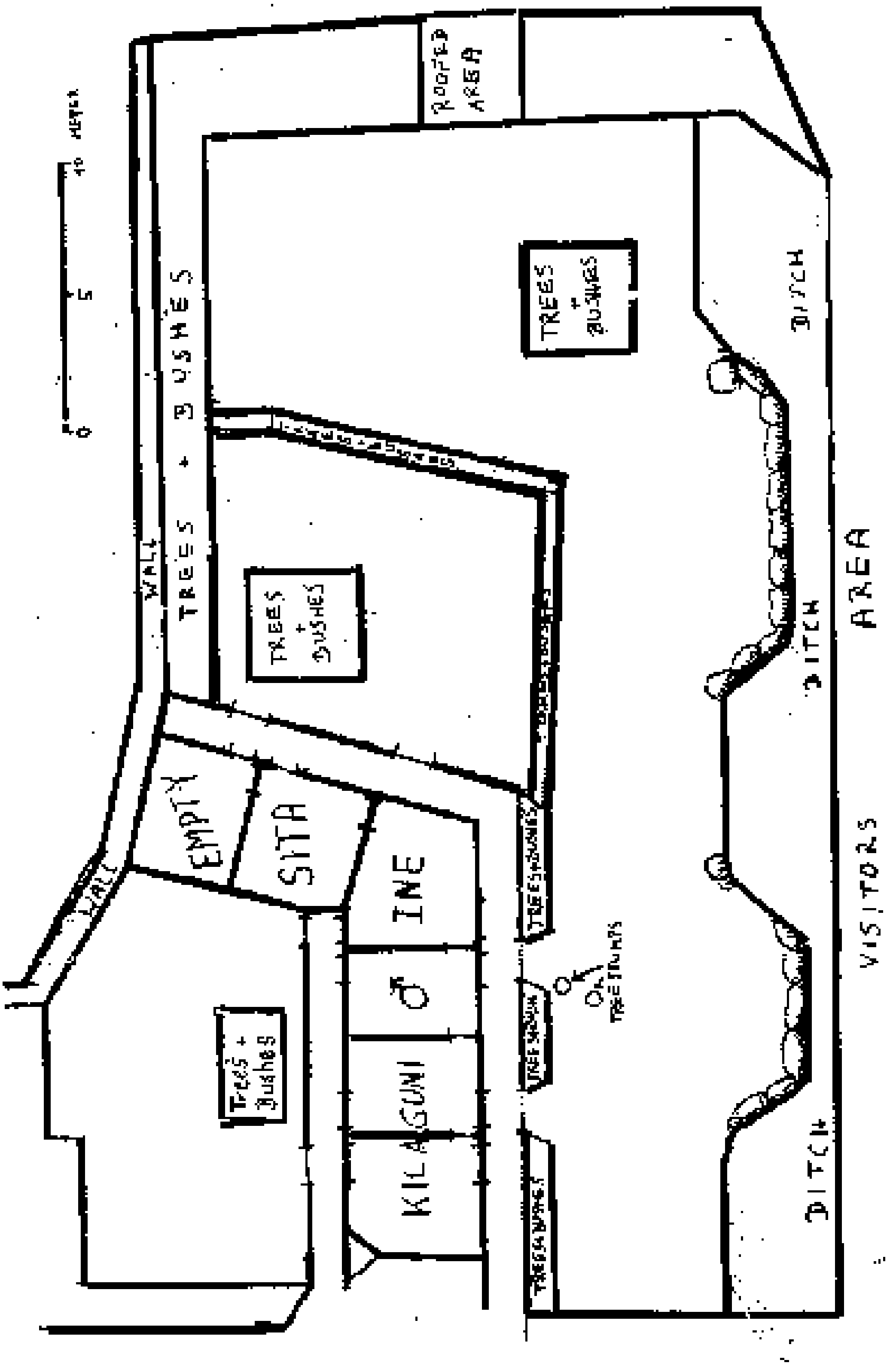
The keepers usually arrived around 8:30 a.m. and would start cleaning the stalls. When weather conditions allowed they would let "Ine" and "Sita" outside and begin with their stalls. When the animals stayed outside for the morning (or day in "Sita's" case), they received their big feeding of alfalfa, hay, vegetables and pellets when they were let back inside in the afternoon. If they could not stay out very long or if was too cold to let them out, they would receive hay or alfalfa, or on rare occasions nothing, after their stalls were cleaned. When not let out they were shunted from one stall to the other to facilitate cleaning. The big feeding usually took place between 2 p.m., and 3 p.m.
During the first months of observation, "Kilaguni" was not let outside for very long, due to the youth of her calf. Therefore, "Ine" was often released twice in one day, after having spent the lunch hour indoors. As the calf got older, towards spring, "Kilaguni" stayed outside longer, usually in the afternoon.

Observations took place from 13 October1997 to 15 January 1998 for "Sita" and "Ine" and from 26 January 1998 to 29 April 1998 for "Kilaguni".

2.2. Methods:

All animals were observed on 94 consecutive days for approx. 4 hours each day, therefore, each animal was observed 376 hours altogether. To ensure a correct representation of their behavior throughout the day, they were watched alternately in the morning (8:30 a.m. to 12:34 p.m.) and the afternoon (11:41 a.m. to 3:45 p.m.). This means forty-seven days (or 188 hours) were morning observations and the rest were in the afternoon. Due to the working hours of the keepers, observations could start no earlier than 8:30 a.m. and end no later than 3:45 p.m. Since four hours of observation were a minimum requirement, a 55 minute overlap period was created over midday (11:41 to 12:34), in which the animals were observed daily.

Figure 2: The outside paddocks of all rhinos and their inside stalls (named). The Large Paddock by the visitos area, belongs to Ine and Kilaguni. The area at the side belongs to Sita, and the Area behind the house to the male.



The time-periods chosen to use for comparison were ten days prior to the given estrus and seven days thereafter. For Kilaguni, who had no estrus cycle, the days were chosen to coincide with the days used for Ine. This means the days 20 to 38 represented the first time-period; the days 46 to 63 represented the second time-period and the days 67 to 84 the third time-period. This left the first days of the observation unused, since the animal required time to get used to my presence, and the last days unused, because of construction in the outside paddock. The reason Kilaguni was observed after the other females, as opposed to observing her with each female, was due to the youth of her daughter at the time the study began. Due to this Kilaguni, was not released outside as often or as long as the other females during the first part of the observation. After the other animals had been observed, Kilaguni's daughter was old enough to remain outdoors in the winter for longer time-periods. It was hoped to thereby allow a comparison between all females, since the time spent indoors and outdoors was approximately the same.

For collecting the behavioral data, the all events method was used, which is equivalent to focus animal when observing one individual (Altmann, 1973)
The beginning of a behavior was noted, and the length in minutes that the behavior lasted. For a behavioral duration to be recorded, it had to last at least thirty seconds of a given minute. Behavior elements that did not last for more than a few seconds, but were consequential to the study, such as urination, were simply noted and counted, leading to the frequency of said behavior.

The following behavior patterns were recorded.

Pacing:	Apparently walking up and down the paddock without destination.
Standing:	Standing with no other activity occuring.
Lying down:	Resting or sleeping.
Eating:	Any activity, which involves obtaining and ingesting food.
Rubbing:	Rubbing horn or body against an inanimate object.
Restless:	Moving straw and or food around for no apparent reason. Usually, by pushing it with the horn along the floor or tossing it into the air.
Smell:	Sniffing at something intently.
Urinating:	The frequency of urination was noted.
Defecating:	The frequency of defecation was noted.
Alert:	Attention of the animal is focused on a certain object or person; with its head raised and ears pointing forward. This occurred, when the animal was startled by a noise.

To determine their reproductive cycle, fecal samples were taken from the first two females three times a week, and frozen for later analysis. From the third female, unlikely to show a reproductive cycle due to recent birth, no samples were taken.

Fecal analysis was based on progesterone concentrations. During the cycle, progesterone is at a minimum during menstruation and up to ovulation. With the onset of ovulation, progesterone concentrations begin to rise.
With these parameters, three ovulations were found for Ine and two for Sita.
Since, both females showed a fertility cycle after fecal analysis; the curves of their behavioral patterns were combined. A period was selected which surrounded the estimated estrus, and all possible curves were overlaid, with the eleventh day being the day of ovulation.
By overlapping all curves of a given behavior pattern at ovulation, it was hoped, a pattern would emerge, that would allow the prediction of estrus in female Black rhinos.

2.3 Data analysis:

The analysis of the fecal matter that was taken three times a week delivered the days of suspected estrus in the two females with a reproductive cycle. The word "suspected" is used here, because of the gaps made in sampling. This means the actual estrus may be located within a 24-hour period before or after the suspected date. Estrus was determined as the day showing the lowest concentration of progesterone in the sample.
The dates determined for Sita were 3 December and 29 December, and for Ine 12 November, 8 December and 29 December.
As to the methods with which the resulting data was evaluated, it was made clear that the curves of the females with a reproductive cycle could not be treated as equal. Therefore, the animals had to be discussed as individuals. This led to descriptive statistics, due to the small amount of heat cycles obtained for each individual.

For each behavior pattern, curves were determined, which surrounded the day of estrus, as previously mentioned, with ten days prior and seven days after estrus shown. Estrus was therefore always on the eleventh day. Thus, behavior patterns before estrus could be compared with those after the day of peak receptivity. Therefore, one could determine if the observed behavior was related to the approach of estrus, or if this behavior was part of the norm, since it occurred after the day of peak receptivity as well.
The diagrams used were at first the combination of Sita's and Ine's heat cycle curves, for each behavior. Additionally the averages of each heat cycle curve were derived and visually compared, to determine if the behavior patterns of the individuals could be treated as equal.

Since this was not the case, each behavior pattern was drawn up for each individual separately. While visually comparing the behavioral curves of Ine and Sita, there appeared to be a decline in the 'eat' curve over time. To ascertain if this decline was correlated with time, Pearson's product-moment correlation coefficient was determined (Engel; 1997). Furthermore, the days surrounding estrus were separated into the morning sessions and afternoon sessions in which the observations were made, to determine if the behavior patterns were dependent upon the time of day the were made. Within these curves, patterns leading to a prediction of estrus were also examined. Since observations were on a rotating basis there was usually the same amount of morning and afternoon sessions. The exception to this was during Ine's last heat cycle: due to Christmas Eve, no afternoon observation was possible, so she was observed in the morning instead.

Additionally to these curves, the behavioral curves of the entire observation periods (October to January and January to April) were compared with the average temperature curve. In this way, a dependence of the behavior pattern upon the temperature could be examined. Besides the visual comparison, the correlation coefficient after Spearman (Engel; 1997) was determined to further underlay the independence of the behavioral curves from the temperature.

3. RESULTS

3.1 Pace

3.1.1 Daily Observations and Average Curves:

3.1.1.1 Sita and Ine

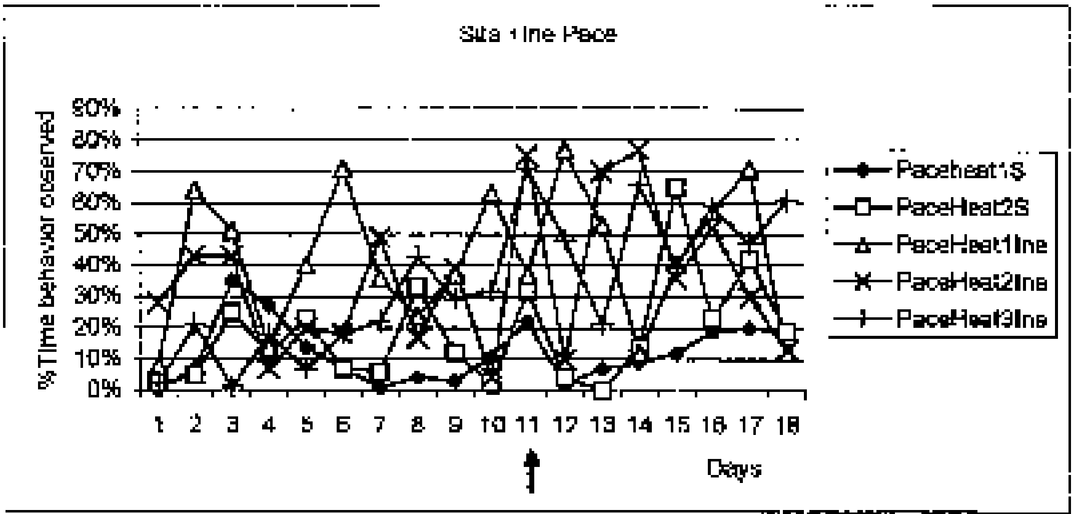


Diagramm1: Combination of all pace curves of Ine and Sita with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation time pacing was recorded. Heat1S: Curve of days surrounding Sita's first estrus; Heat2S: Curve of days surrounding Sita's second estrus; Heat1Ine: Curve of surrounding Ine's first estrus; Heat2Ine: Curve of days surrounding Ine's second estrus; Heat3Ine: Curve of days surrounding Ine's third estrus.

At first glance, the only common feature in most of the curves, was an increase in pacing on the day of ovulation, which decreased again the following day.
In an attempt to clarify the commonalities of all five curves, the median of each day was determined, and its curve was added to the diagram. It was hoped that this would show any distinct pattern on or around the day of peak receptivity (Diagram 2).

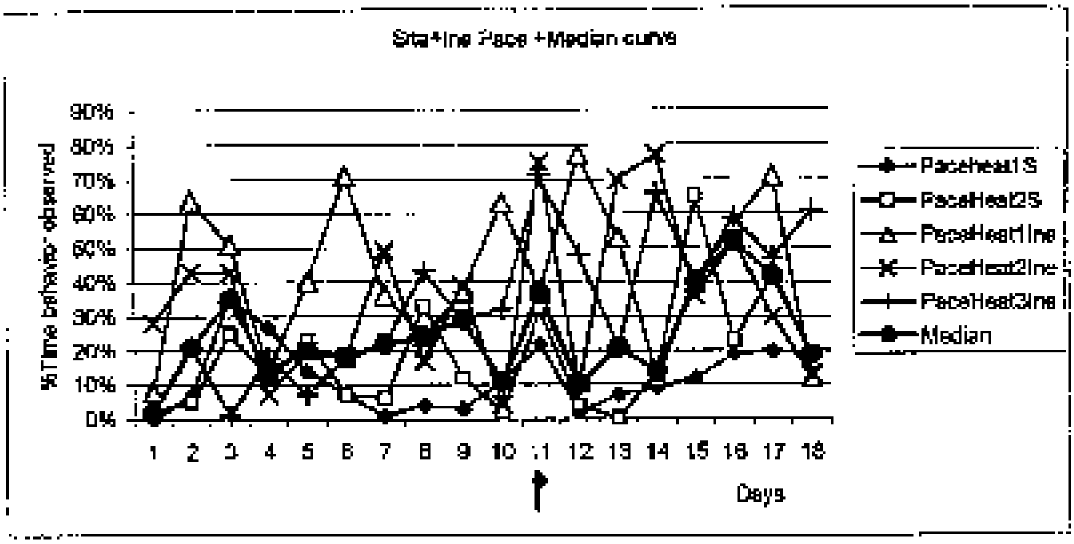


Diagram 2: Combination of all pace curves of Ine and Sita with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation time in which pacing was recorded. Additionally, the median of each days data points is given with its corresponding curve. PaceHeat1S: Curve of days surrounding Sita's first estrus; PaceHeat2S: Curve of days surrounding Sita's second estrus; PaceHeat1Ine: Curve of days surrounding Ine's first estrus: PaceHeat2Ine Curve of days surrounding Ine's second estrus; PaceHeat3Ine: Curve of days surrounding Ine's third estrus..

The resulting curve (diagram 2, black circles) showed a peak in pacing on the day of estrus, which was generally surrounded by lower levels of pacing, before and after estrus occurred. However, this could not be seen as a positive indicator of ovulation, since this peak was not distinctive in itself, as if it were the highest po nt of the entire curve, or the highest point of many days surrounding estrus. However, it must be observed, that the peak occurred in all five curves, four of which were during the given estrus and the fifth (triangles) occurred one day later.

In order to determine if comparing all curves with each other is justified, the average of each curve was determined and compared (Diagram 3).

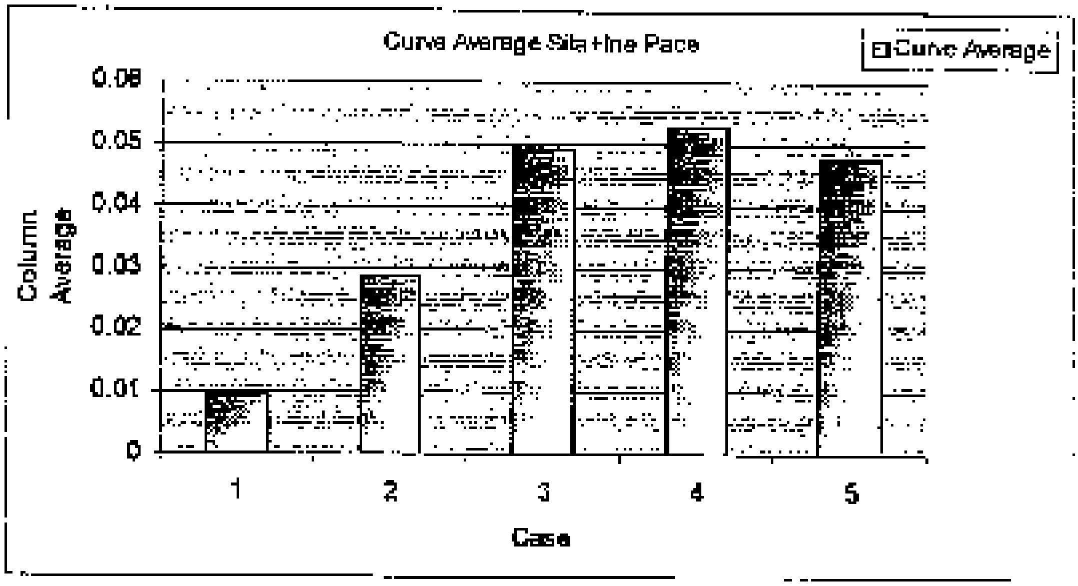


Diagram 3: Each curve for the behavior of pace is numbered 1 through 5, and their averages represent the height of the column. 1: Sita's first ovulation curve; 2: Sita's second ovulation curve; 3: Ine's first ovulation curve; 4: Ine's second ovulation curve; 5: Ine's third ovulation curve.

Unfortunately, since the curve averages of the individual females were too different from one another, their behavioral patterns could not be seen as equal. This means that each individual showed a behavioral pattern that was unique, and no general behavior pattern could be described. Therefore, each behavioral pattern will be described for each individual separately, however, the rest of the diagrams with Ine's and Sita's curves combined will be shown in the appendix for further demonstration.

In the case of pacing, however, it would also appear, that the curves shown by Sita are largely dissimilar and no general behavior pattern for this behavior should be attempted for Sita.

3.1.1.2 Sita

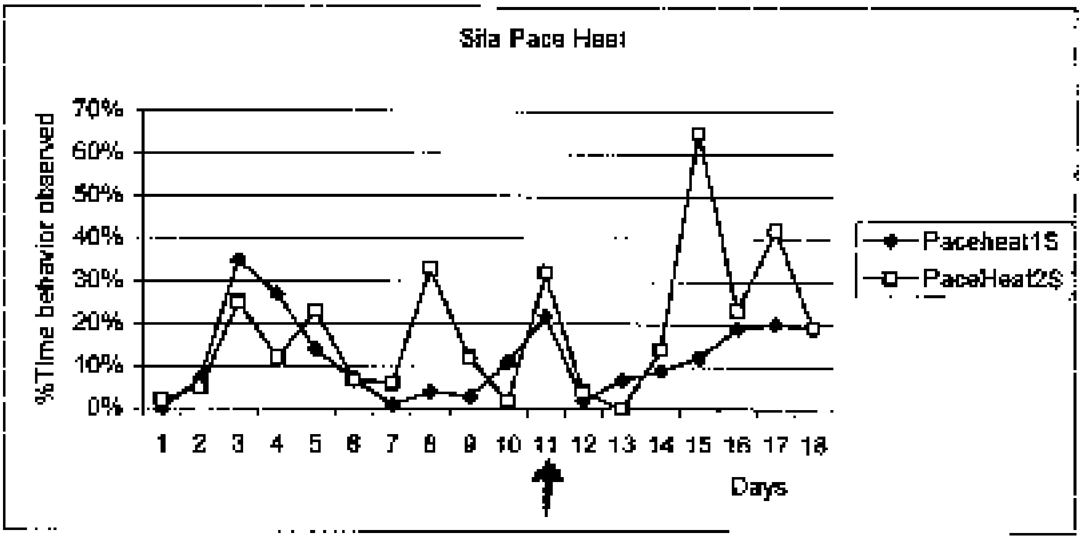


Diagram 4: Behavioral curves for Sita with peak receptivity on day 11. Data points show the percentage of time Sita spent each observation period pacing. PaceHeat1S: Curve of days surrounding Sita's first estrus; PaceHeat2S Curve of days surrounding Sita's second estrus.

During Sita's first heat cycle (diagram 4, black diamond), pacing decreased steadily up to the day before peak receptivity (day 9), when it started to increase again (day 10).

Although the curve fell again immediately after estrus (day12), it is impossible to say this is a characteristic, which points to estrus having taken place. Especially when one considers the second heat-cycle curve, that shows at least three such peaks (day 8, day 11 (estrus) and day 15).

To be certain no trend is hidden from view within the curves, the average curve was determined and added (Diagram 5). The average curve was used, because of the small amount of data points available per day, to avoid an overemphasis of a data point, which would not accurately reflect the observed behavior.

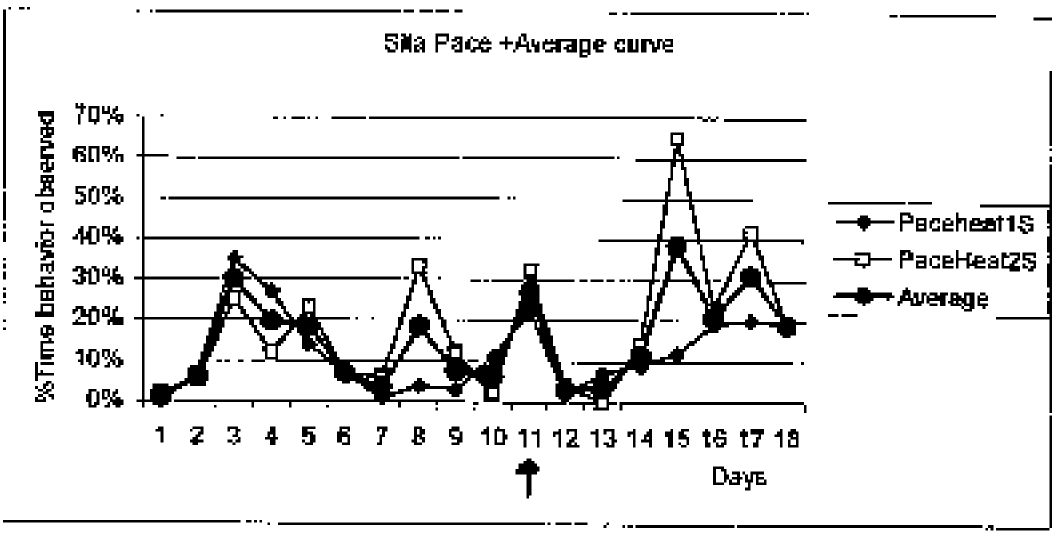


Diagram 5: Behavioral curves for Sita, with peak receptivity on day 11, and the average curve. Data points show the percentage of time Sita spent each observation period pacing and the average of each day's pace percentage. PaceHeat1S: Curve of days surrounding Sita's first estrus; PaceHeat2S: Curve of days surrounding Sita's second estrus; Average: Average of each days data point and the resulting curve.

With the addition of the average curve (diagram 5, black circle), the behavioral pattern appeared to be more inconsistent.

It showed a decrease in pacing before peak receptivity, which then escalated to 30% during estrus. After estrus, the curve appeared to pick up where it left off the day before estrus (at about 20%), but started to increase again and reached an overall peak at 40% on day 15. Thereafter, the curve wavered between 20% and 30%.

3.1.1.3 Ine

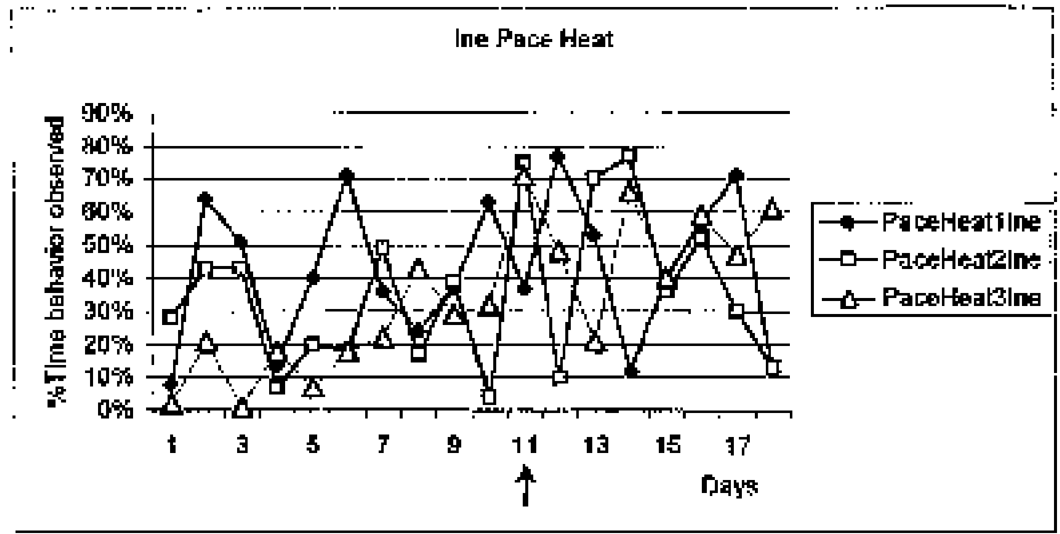


Diagram 6: Behavioral curves for Ine with peak receptivity on day 11. Data points show the percentage of time Ine spent each observation period pacing. PaceHeat1Ine: Curve of days surrounding Ine's first estrus; PaceHeat2Ine: Curve of days surrounding Ine's second estrus; PaceHeat3Ine: Curve of days surrounding Ine's third estrus..

In Ine's case, a slight rise could be discerned in curve 1(diagram 6, black diamond) (the curve's lowest points rose gradually from 10% to 50%). Yet, on the assumed day of estrus, a decrease in pacing occurred, with a higher level of pacing the following day. After day 12, pacing steadily decreased from 80% back down to 10 % on day 14. Despite this, pacing increased again to 70 % on day 17, instead of staying at a lower level.
As with Sita, Ine's second heat-cycle (white scuare) showed only a peak of pacing (around 80%) at estrus with lower levels of pacing surrounding it on the previous and following days (between 0% and 10%). The rest of the curve appeared to be unpredictably rising and falling. Curve three (white triangle), steadily increased from 0% to 70% on the day receptivity and slowly decreases thereafter to about 20% on day 13. After this day, it rises to 65% and slowly begins to waver around 55 % the rest of the period in question.

Again, to shed some light on these apparent erratic increases and decreases of the curve the average of each day was determined and added.

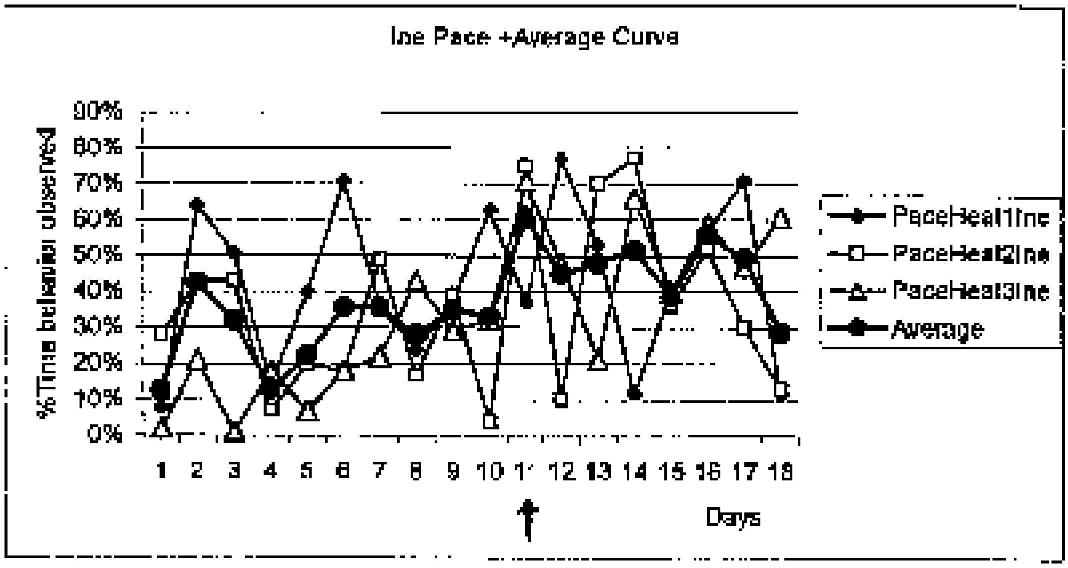


Diagram 7: Behavioral curves for Ine, with peak receptivity on day 11, and the average curve. Data points show the percentage of time Ine spent each observation period pacing, and the average of each day's pace percentage. PaceHeat1Ine: Curve of surrounding Ine's first estrus; PaceHeat2Ine: Curve of days surrounding Ine's second estrus; PaceHeat3Ine: Curve of surrounding Ine's third estrus; Average: Average of each days data point and the resulting curve.

In the average curve(diagram 7, black circle), a steady increase in pacing was seen, however, it did not end with estrus. Rather, the decline started five days after estrus took place (day 16). Still, it must be mentioned that a peak was observed on the day of estrus itself, which was not quite reached on day 16, the point of declination.

The only commonality of all curves was that on day 15, pacing took up about 40% of the observation time.

3.1.1.4 Kilaguni

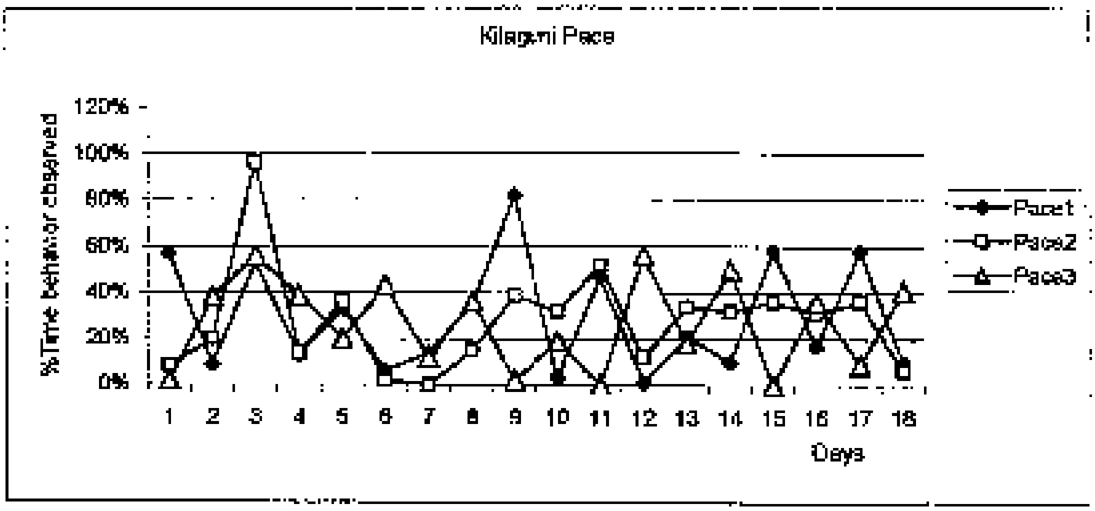


Diagram 8: Behavioral curves for Kilaguni. Data points show the percentage of time Kilaguni spent each observation period pacing. Time-periods were chosen to match those of Ine. Pace1: Kilaguni's first time-period; Pace2: Kilaguni's second time-period; Pace3: Kilaguni's third time-period.

As expected for a female without a reproductive cycle; Kilaguni showed a greatly varied pattern in pacing behavior (diagram 8). Fluctuations in the curve usually have a big amplitude. The first curve (black diamond) started at a level of 58% and dropped the second day to about 10%, after which it climbed again to 50% on day 3. This was followed by a fluctuating curve between 18% and 38 % the next two days. Starting day 6, the curve began a steady rise form 8% to peak at about 80% on day 9. Days 10 through 12 showed vacillation between 1% and approx. 45%. Days thirteen and fourteen stayed low, around 10% to 20%, which was followed by another fluctuation the last four days between 59% and 10%.

The second curve began with a slow rise from 10% to 98% (day 3), which immediately dropped again to 18%, which was the beginning of a fluctuation between 2% and 38% from days 4 to 6. Starting on the seventh day, the curve began a steady rise from 0% to peak at 40% (day 9), after which it dipped to about 32% on day 10, and increased the following day to ~52%. After a decline to 12% the curve stayed steady from day 13 to 17 between 35% and 6%.

The last curve (white triangle), rose from 1% to 55% (day3), which was followed by a slow decline to 20% (day 5). After this, the curve wavered between 10% and 40% for the day 4 through 8. The ninth day decreased to 1%, the tenth day showed an increase to 19% and day 11 dropped again to 0%. Thereafter the curve fluctuated between 55% and 18% from days 12 to 14, while the fifteenth day showed no activity. The remaining days (16 to 18) vacillated between 36% and 8%.

As with the other females, the average curve was added to discover any hidden rise or fall in the three curves (Diagram 9).

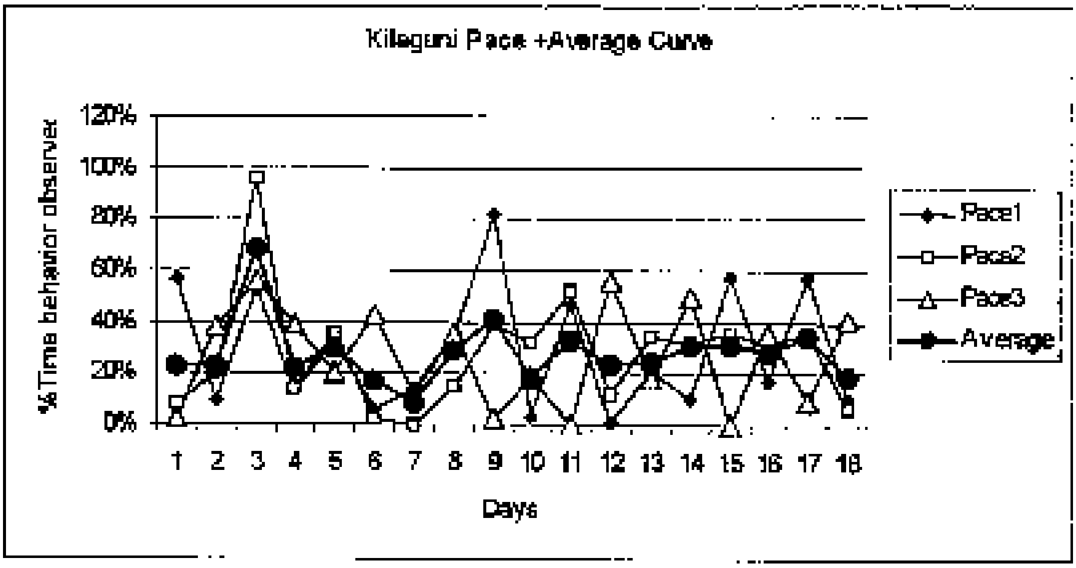


Diagram9. Behavioral curves for Kilaguni, with the average curve. Data points show the percentage of time Kilaguni spent each observation period pacing, and the average of each day's pace percentage. Time-periods were based on Ine's heat cycle. Pace1: Kilaguni's first time-period; Pace2: Kilaguni's second time-period; Pace3: Kilaguni's third time-period; Average: Average of each days data point and the resulting curve.

With the average curve present, it was even more obvious, that Kilaguni tended to pace about the same amount everyday, around 30%. There was only one obvious peak present, on day 3, of about 70%, and one valley, on day 7, at about 10%.

As with the other individuals, the average of each curve was determined, in order to see how consistent she behaved over the chosen three observation periods (Diagram10).

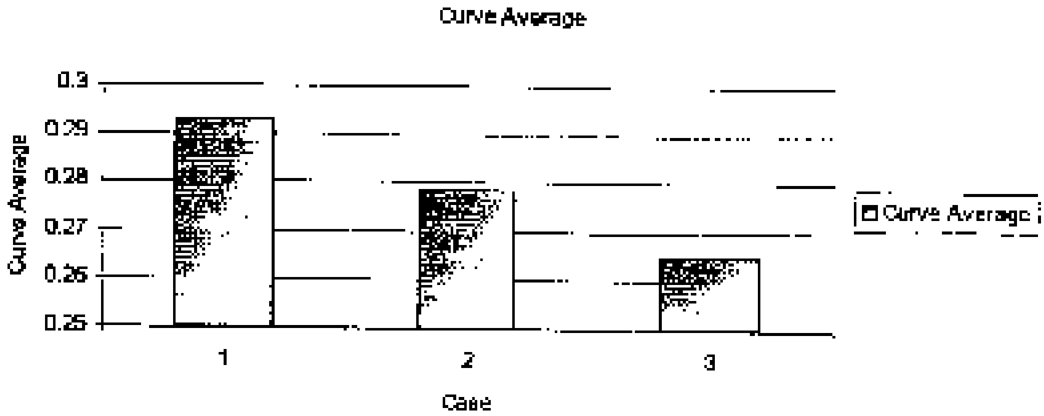


Diagram 10. Each curve for the behavior of pace is numbered 1 through 3, and their averages represent the height of the column. 1: Kitaguni's first pace curve; 2: Kitaguni's second pace curve; 3: Kitaguni's third pace curve.

Since Kitaguni did not show a reproductive cycle during the observation period, the difference between each curve is comparable to the difference between Ine and Sita. Each time-period is unique in itself and cannot be compared with the other two time-periods. Additionally, the influence of the time of day the observations were made, must be examined (Diagram 11).

3.1.2 Morning/ Afternoon Sessions

3.1.2.1 Sita

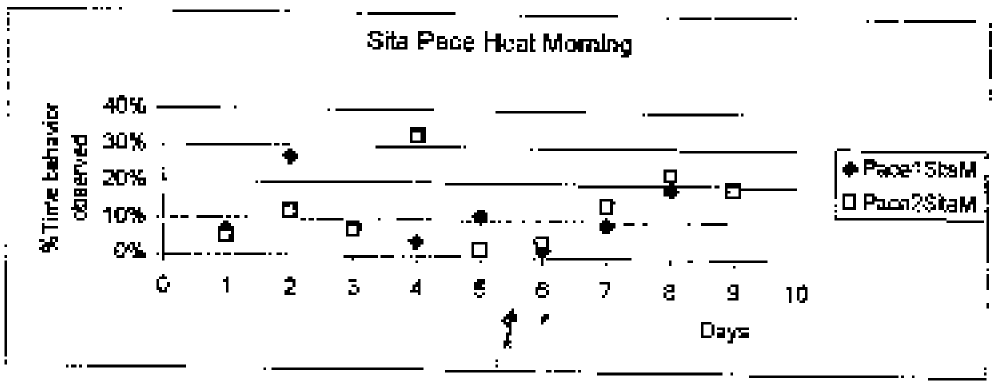


Diagramm 11: Data points represent the percentage of time Sita spent pacing on each morning of observation during the time period previously discussed. Here estrus lies between days 5 and 6 which means peak receptivity lies on an afternoon observation day. Pace1SitaM: Morning observations of days surrounding Sita's first estrus; Pace2SitaM: Morning observations of days surrounding Sita's second estrus.

Strictly looking at all morning sessions (Diagram 11), with estrus being between the fifth and sixth day, no rise in pacing could be observed in either heat-cycle. The exception was a peak well before estrus in both cases (day2, curve 1; day 4, curve 2). The steady rise in pacing appeared to occur after estrus had taken place.

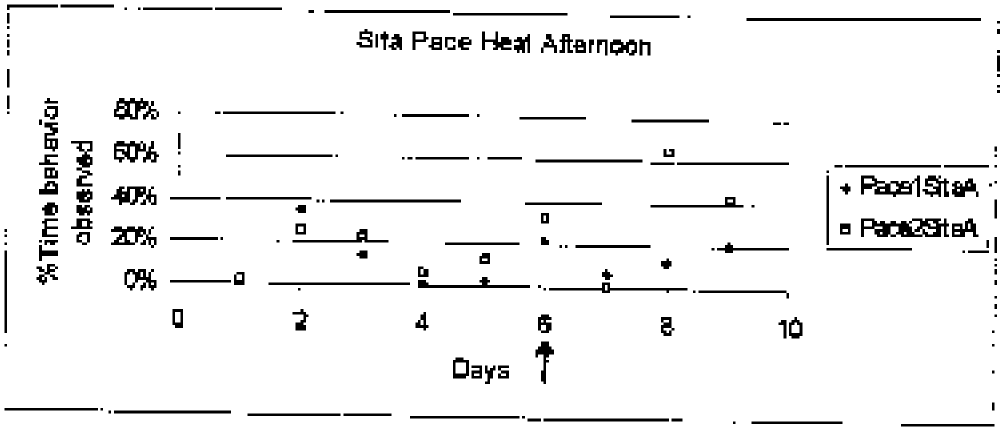


Diagramm 12: Data points represent the percentage of time Sita spent pacing on each afternoon of observation during the time period previously discussed. Here estrus lies between days 5 and 6, which means peak receptivity lies on an afternoon observation day. Pace1SitaA: Afternoon observations of days surrounding Sita's first estrus; Pace2SitaA: Afternoon observations of days surrounding Sita's second estrus.

Concerning the afternoon sessions, the largest percentage of time spent pacing, occurred on afternoon 2. A dip in pacing activity occurred prior to estrus (days 3 to 5). The day of peak receptivity (day 6) showed a slight increase in pacing, which disappeared again the following afternoon session. After the small peak during estrus, pacing started to increase again steadily (curve one) or sharply (to 60%, in curve two).

3.1.2.2 Ine

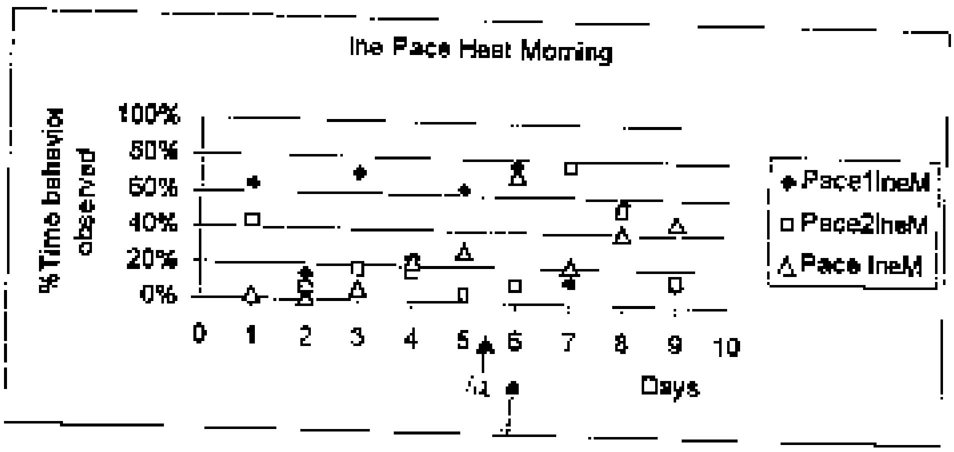


Diagramm13: Data points represent the percentage of time Ine spent pacing on each morning of observation during the time-period previously discussed. Here estrus lies between days 5 and 6 for the first two curves, which means peak receptivity lies on an afternoon observation day and on day 6 for the third curve (day of estrus a morning session). Pace1IneM: Morning observations of days surrounding Ine's first estrus, Pace2IneM: Morning observations of days surrounding Ine second estrus; Pace3IneM: Morning observations of days surrounding Ine's third estrus.

For Ine, the separation of morning (diagram 13) and afternoon (diagram 14) sessions shows the behavior curves to be even more erratic than they appeared to be for the daily curves. For the first (black diamond) and second (white square) heat-cycle, estrus was between session 5 and 6, which, means it occurred on the day of an afternoon session. The first heat-cycle showed a constant rise and fall from one session to next, with the exception of session 5 and 6. These sessions break the chain by showing an increase in session 6 instead of the expected decrease. This was again followed by a decrease in pacing activity and the chain continued again.

The second heat-cycle showed a steady pattern at 0% to 20% of pacing, with a strong peak two mornings after each peak of receptivity and a slow decrease thereafter.

The third heat-cycle showed a steady increase in pacing activity leading to estrus with decrease in pacing after estrus (20%), after which the curve started to steadily climb again..

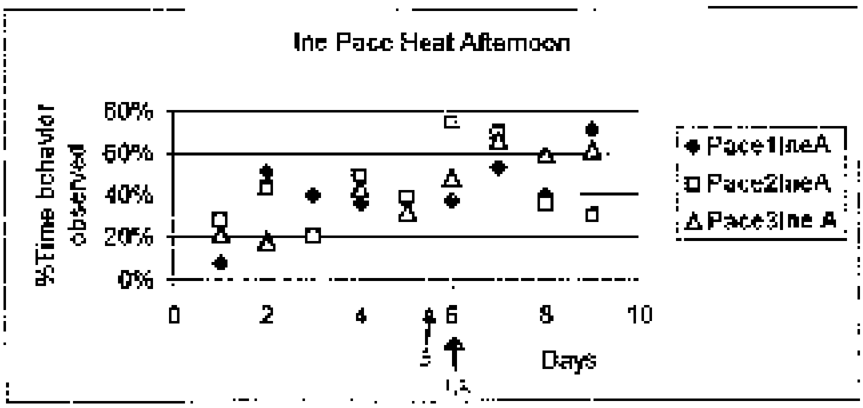


Diagramm14: Data points represent the percentage of time Ine spent pacing on each afternoon of observation during the time period previously discussed. Here estrus lies between days 5 and 6 for the third curve, which means peak receptivity lies on a morning observation day and on day 6 for the first and second curve (day of estrus an afternoon session). Pace1IneA: Afternoon observations of days surrounding Ine's first estrus; Pace2IneA: Afternoon observations of days surrounding Ine's second estrus; Pace3IneA: Afternoon observations of days surrounding Ine's third estrus.

When examining the afternoon sessions (diagram 14), again heat-cycle 3 (white triangle) showed a steady increase in pacing activity. However, here it did not decrease after peak receptivity, but kept rising and stayed at this elevated level from session 7 (estrus between sessions 5 and 6).

For heat-cyclest and 2, estrus was during session 6.

During her first heat-cycle (black diamond), Ine's pacing activity increased from about 10% during session 1 to 50% during session 2. From session 2 to session 8 her pacing activity stayed between 40% and 50%. During session 9, there was another increase to about 70%. During heat-cycle 2 a daily fluctuation between 20 and 50% occurred, before peaking on estrus at 78%, after which the curve steadily sank again.

3.1.2.3 Kilaguni

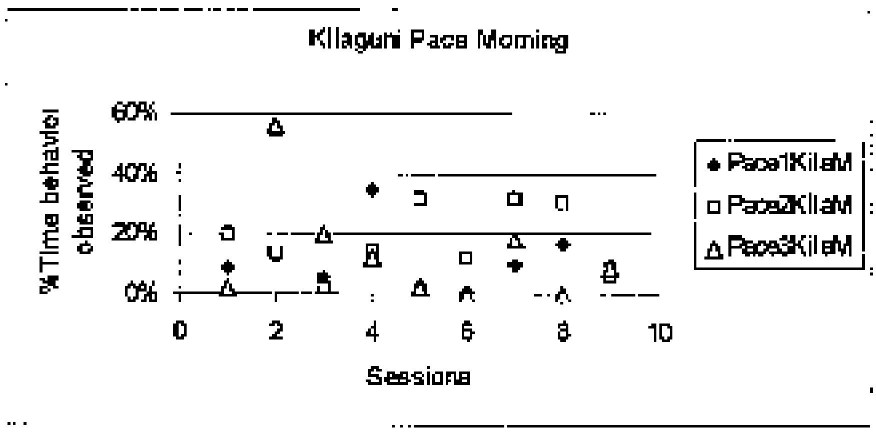


Diagramm 15: Data points represent the percentage of time Kilaguni spent pacing on each morning of observation during the time-period previously discussed. Pace1KilaM: Morning observations of Kilaguni during the first time-period; Pace2KilaM: Morning observations of Kilaguni during the second time-period; Pace3KilaM: Morning observations of Kilaguni during the third time-period.

As expected for Kilaguni, no consistent behavior is seen in her behavior pattern. No rise in pacing activity was seen in any of the three heat-cycles.

Heat-cycle 1 (black diamond) stays between 0% and 20% with the exception of one peak during session 4 which reached about 40%. Heat-cycle two (white square) started with a decrease for three sessions (1 through 3), then it increased again and vacillated at 20%. The third heat-cycle (white triangle) showed a big peak during session 2 of about 60%, which then steadily fell to 0% (session 6), after which it wavered between 0% and 20%.

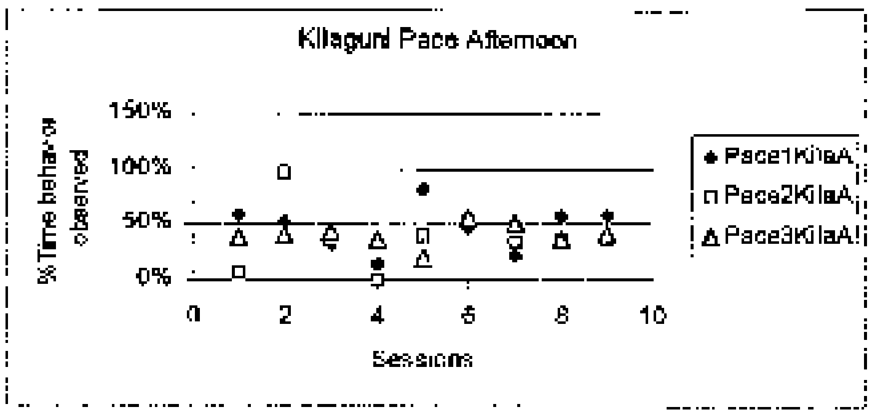


Diagramm 16: Data points represent the percentage of time Kilaguni spent pacing on each afternoon of observation during the time-period previously discussed. Pace1KilaA: Afternoon observations of Kilaguni during the first time-period. Pace2KilaA: Afternoon observations of Kilaguni during the second time-period. Pace3KilaA: Afternoon observations of Kilaguni during the third time-period.

The difference between the afternoon (diagram 16) and the morning sessions was evident here in the fact that Kilaguni paced around 50%, instead of 20%. During the first heat-cycle (black diamond), a decrease was seen for the first four morning sessions from 50% down to almost 0%. During the fifth session, it rose again to 80%, after which the pacing activity vacillated at 50%. The second heat-cycle (white square) showed a big peak during session 2 at around 100%, which fell again to 0% during session 4. Heat-cycle 3 (white triangle) stayed steady around 50% throughout the nine afternoons.
Overall, all sessions average out to around 50%.

The last possible influence on the behavioral pattern to be examined, is the weather or rather the effects of the temperature.

3.1.3 Temperature curves

3.1.3.1 Sita

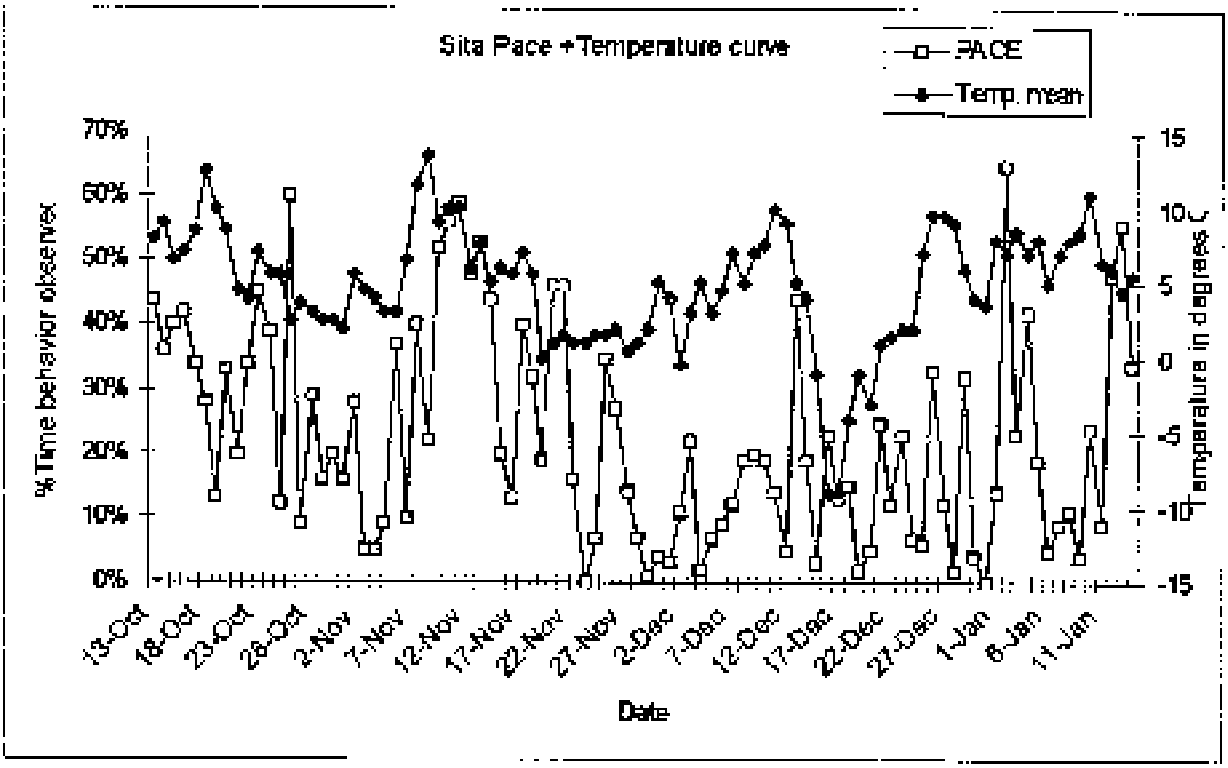


Diagram 17: Temperature curve, showing the average daily temperature in degrees Celsius and Sita's pace curve showing the percentage of the observation time she spent pacing for the entire observation period. Temp. average: Average daily temperature; PACE: Curve depicting Sita's daily pacing behavior.

As can be seen, there are no obvious effects of the temperature on Sita's behavioral pattern. Increases or decreases in temperature do not effect her percentage of pacing in a consistent manner. Occasional delayed reaction to an Increase can be seen by an Increase in pacing (6 Nov. to 9 Nov.) and vice versa (10 Nov to 15 Nov). However, this does not occur at all times. For example, between 16 Nov and 26 Dec the temperature steadily rises, however, Sita's pacing activity fluctuates around 15% without a corresponding increase.

The correlation coefficient, calculated by the Spearman method, for Sita lies at 0.264, which indicates that less than 26 % of the 94 data points are positively correlated with the temperature. This agrees with the description of the curve.

3.1.3.2 Ine

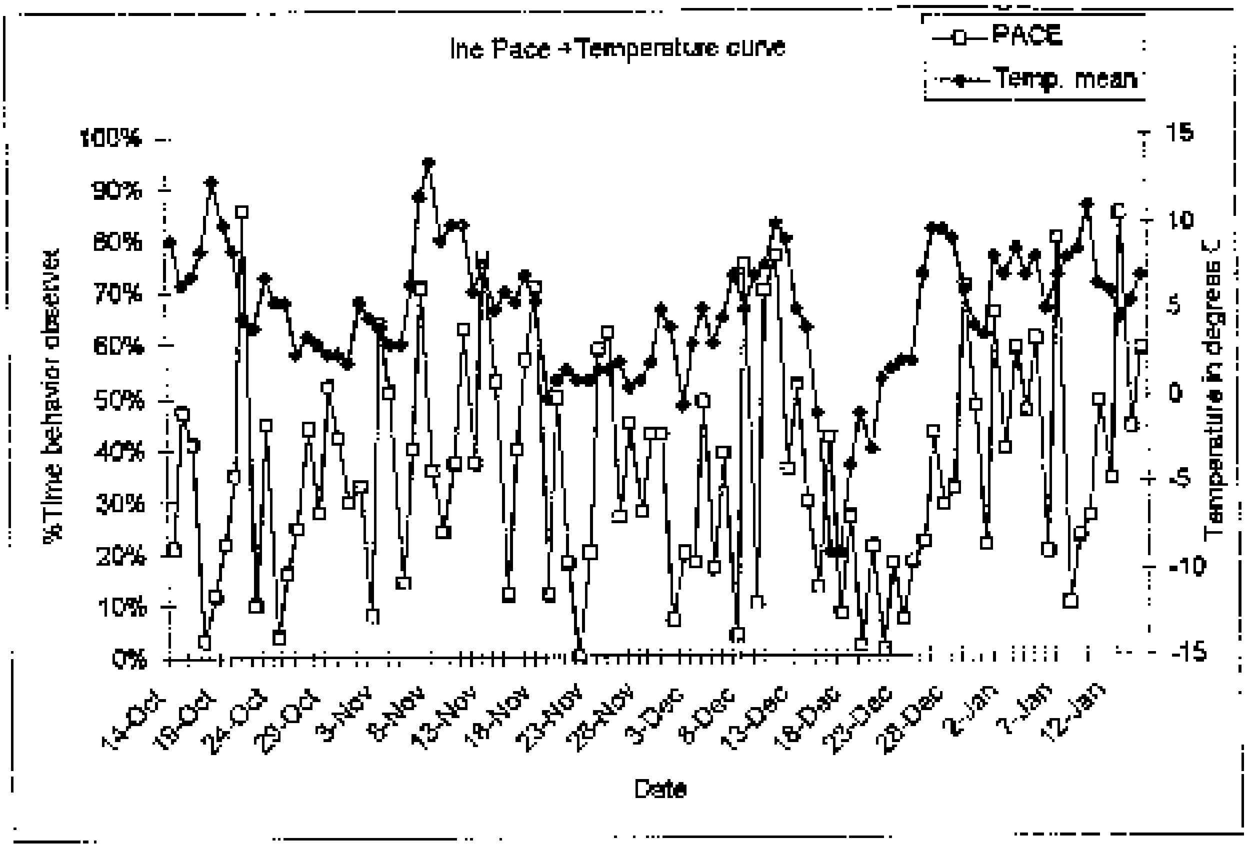


Diagram 18: Temperature curve, showing the average daily temperature in degrees Celsius and Ine's pace curve showing the percentage of the observation time she spent pacing for the entire observation period. Temp. average. Average daily temperature; PACE: Curve depicting Ine's daily pacing behavior.

As with Sita, no pattern in Ine's behavior could be discovered that would lead to the conclusion that the amount of time she spent pacing depended upon the temperature. There was a period of time, when she showed a delayed reaction similar to Sita, when increased/decreased pacing followed the temperature curve (10 Dec to 5 January). With the steady decrease in temperature, Ine showed a steady decrease in pacing (10 Dec to 23 Dec). With a slight delay to the temperature increase, her pacing activity increased again up to 28 Dec, and is comparable to the temperature curve until 5 Jan. After this time, however, no correspondence is evident, on the contrary, her pacing activity almost runs counter to the temperature.

In Ine's case, the correlation coefficient is similar to that found for Sila, at 0.249. This indicates that less than 24% of the 94 data points are positively correlated with the temperature. This agrees with what was demonstrated in the description of the curves.

3.1.3.3 Kilaguni

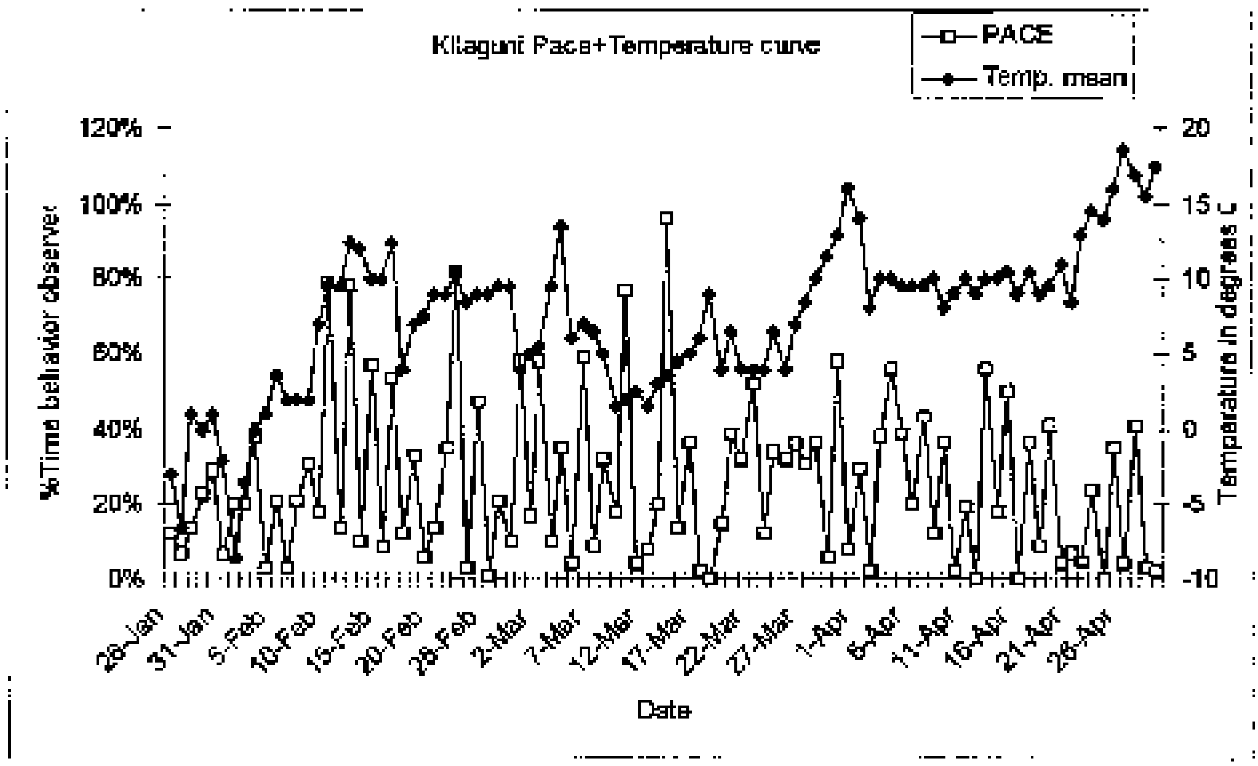


Diagram 19: Temperature curve, showing the average daily temperature in degrees Celsius and Kilaguni's pace curve showing the percentage of the observation time she spent pacing for the entire observation period. Temp. average: Average daily temperature; PACE: Curve depicting Kilaguni's daily pacing behavior.

For Kilaguni, there were no correspondences between the temperature curve and the behavioral pattern. That goes for increases and decreases equivalent to those in the temperature curve and for counter reactions (increase in temperature = decrease in pacing activity).

Here the correlation coefficient lies at 0.046, which is extremely low and can thus be discounted. No significant correlation was found between Kilaguni's behavior 'pace' and the temperature.

Since no consistent correlation between the behavioral patterns and the weather was observed the remaining charts that demonstrate this further, will be placed in the appendix.

To summarize the results of the behavior 'pace':

Although a small peak was indicated on the day of estrus, when all curves of the females with a fertility cycle were compared with each other, it was later shown that these individuals should not treated as equal. The reason for this was the individuality of their behavioral patterns during their heat cycles. Therefore, each animal was discussed separately.

Sita: Although a small peak was evident in each curve on the day of estrus, it did not reach a higher level than other parts of the curve. Therefore, these are not in themselves indicators of estrus. The separation of morning and afternoon session, further underlines this, because both curves increase after estrus. Thus, not much weight should be given to these peaks. There was, however a strong peak on day 15, in the second curve, which must be kept in mind and later compared with the results of other behavior groups.

Ine: In Ine's case, the peaks at estrus (or the day after) are also not indicative of estrus, since similar peaks are seen throughout the observation period, that is before and after estrus.). Again, as seen for Sita, a peak developed after estrus, this time on day 16 (or 17), in any case, five days after the previous peak in the curve. The separation of morning and afternoon showed curve 3 in the morning sessions to rise gradually, peaking at estrus during session 6. The second curve, in the afternoon, increased gradually to peak at estrus during afternoon session 6. However, it must be noted, that the second curve also peaked in the morning, during session7. And the third curve also gradually rose in the afternoon, however without showing a peak.

Kitaguni: Here no obvious patterns could be detected, and all curves fluctuated over a wide range throughout the time-periods (0% to 60%).

The temperature curves, although occasional matches in increases and decreases were found, generally did not indicate a dependence of the behavior on the temperature. This can be said for all three individuals and is confirmed in the calculated correlation coefficients.

3.2 STAND

3.2.1 Daily Observations and Average Curves:

3.2.1.1 Sita

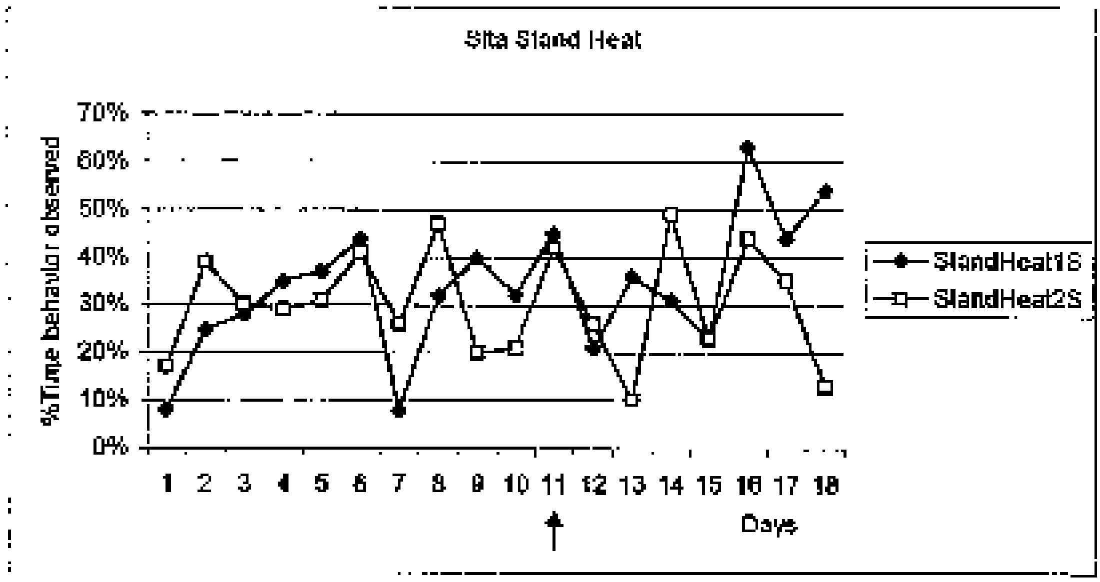


Diagram 20: Behavioral curves for Sita with peak receptivity on day 11. Data points show the amount of time Sita spent each observation period standing. StandHeat1S: Curve of days surrounding Sita's first estrus; StandHeat2S: Curve of days surrounding Sita's second estrus.

The first heat cycle (diagram 20, black diamond) started out with a steady climb in the percentage of standing from about 10% to around 45%, over a period of six days. The seventh day showed a decrease to the starting level which then increased again the following day to waver between 30% and 45% (day of peak receptivity). After estrus the curve became increasingly erratic, falling to ~20% on day 12, climbing to 35% the next day only to fall slowly to ~25% on the fifteenth day. On day sixteen, a dramatic increase was observed, which also represented the high point of the curve at around 65%. The last two days wavered between 45% and 55%.
Sita's second heat cycle (white square) showed a more wildly variable behavior, in that the percentage of time she spent standing changed almost daily from higher levels to lower and back again. There is no discernible difference between pre-estral and post-estral behavior.

Again, perhaps the average curve can distinguish a pattern, which is not immediately evident.

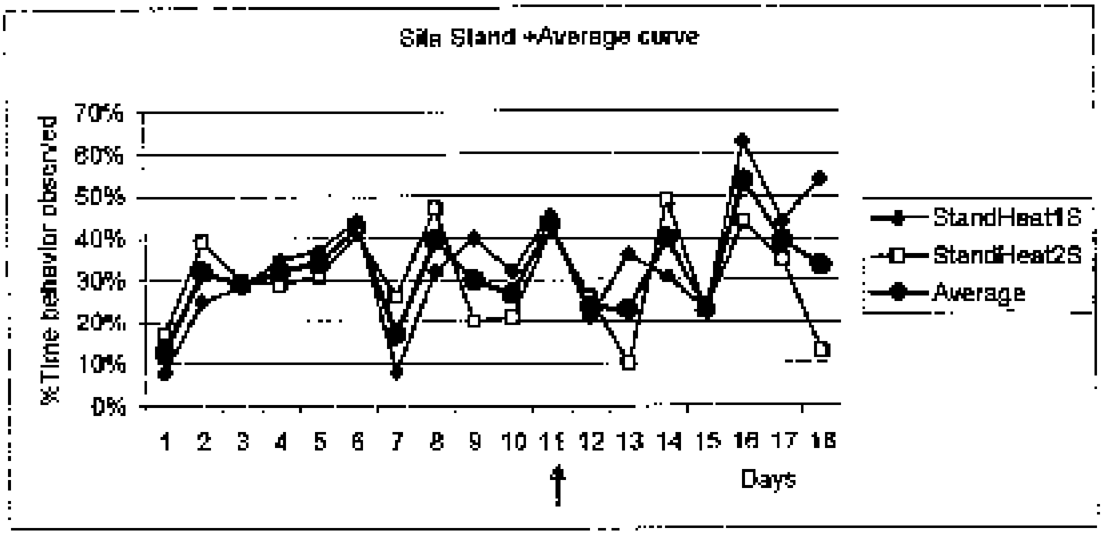


Diagram 21: Behavioral curves for Sita with peak receptivity on day 11, and the average curve of all data points. Data points show the amount of time Sita spent each observation period standing.
StandHeat1S: Curve of days surrounding Sita's first estrus; StandHeat2S: Curve of days surrounding Sita's estrus; Average: Average curve of all data points.

Interesting to note, when looking at the average curve (diagram 21, black circle), were the days 3 to 8. In this period, both heat curves were very similar. From day three, a steady rise in standing occurred until day six, when it stopped at 40%. The seventh day showed a decrease in both curves, although one not as strongly as the other, with a rise on the following day, again not to the same levels. The next similarity is the day of peak receptivity, when both curves reach approx. 45%, and decline on the day after estrus. Between days 13 and 15, no correspondence takes place in the curves. However, day sixteen shows another increase, although this is not very evident in curve two.

3.2.1.2 Ine

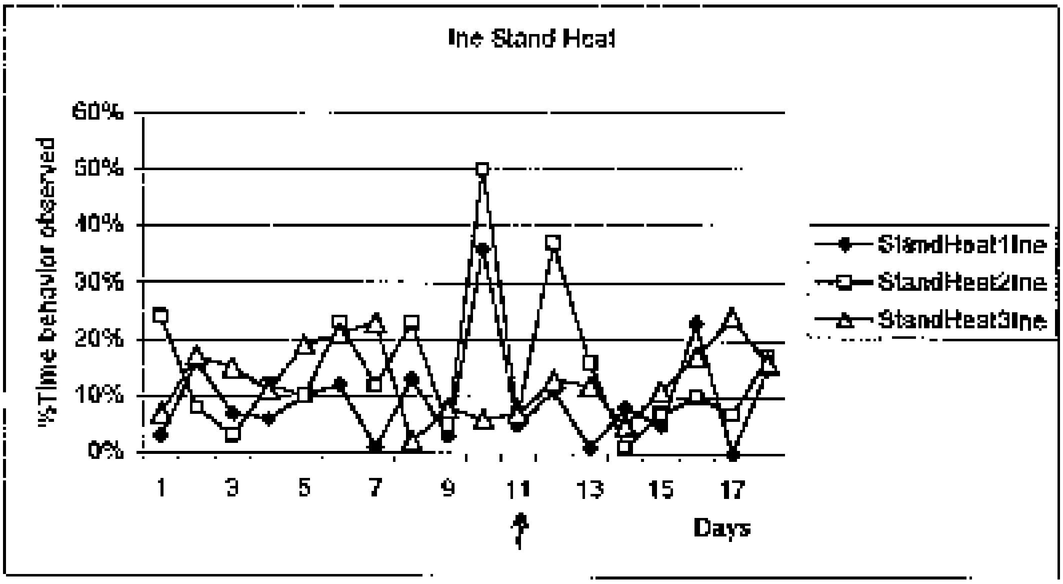


Diagram 22: Behavioral curves for Ine with peak receptivity on day 11. Data points show the amount of time Ine spent, each observation period standing.
StandHeat1Ine: Curve of days surrounding Ine's first estrus; StandHeat2Ine: Curve of days surrounding Ine's second estrus, StandHeat3Ine: Curve of days surrounding Ine's third estrus.

During Ine's first heat-cycle (diagram 22, black diamond), she stood between 2% and 12% for the first nine days (two days prior to estrus). On the day of estrus, the curve peaked at around 38%, the highest level of the curve, and fell on the day of estrus, to about 5%. After peak receptivity, the curve repeated it's vacillation between 2% and 12%, before peaking again on day 16 at ~22%. From that day on, the curve appeared to start fluctuating again between 0% and 15%.
The second heat cycle (white square) was similar to the first. However, the curve fluctuates at a higher level (10% to 25%). Again on day nine, standing dropped to 5%, only to peak on day 10 (day before estrus) at 50%, the highest point of the curve. Once more, on the day of estrus, levels sank to 5%. This time, however, the curve rose again on day 12 to 38%, before falling again to vacillate around 19% (day13 through18).
The third heat cycle (white triangle) was completely different from the first two. In this instance, standing activity steadily increased from about 8% to 22% over the first seven days. On the eighth day, it fell back down to 2% and eventually fluctuated around 10% (days 9 through 14). After day 14, the curve slowly rose to peak at 25% on the seventeenth day.

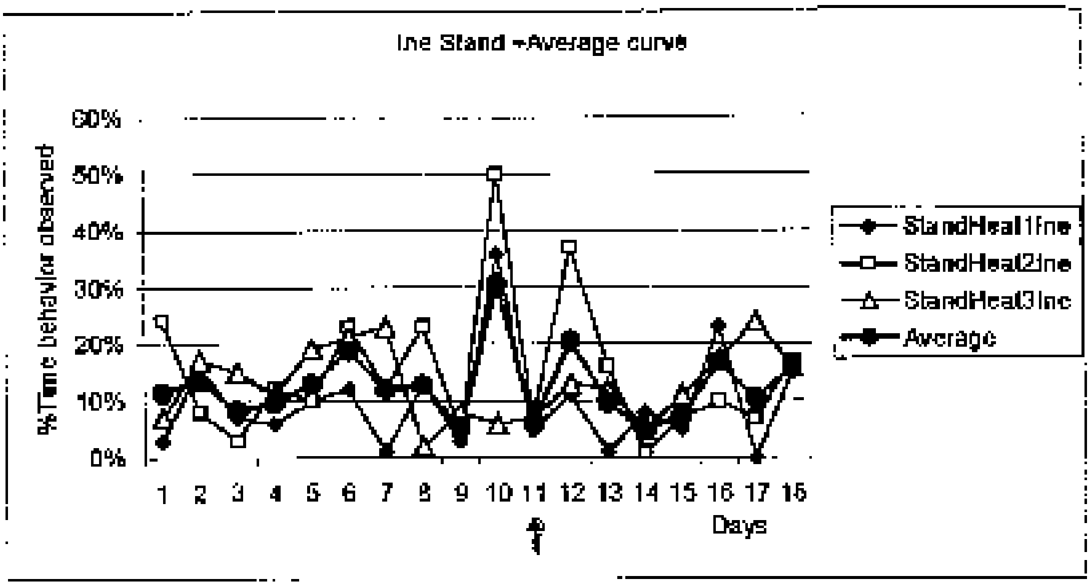


Diagram 23: Behavioral curves for Ine with peak receptivity on day 11 and the average curve. Data points show the amount of time Ine spent, each observation period standing, and their respective averages.
StandHeat1Ine: Curve of portion of Ine's first heat cycle; StandHeat2Ine: Curve of days surrounding Ine's second estrus; StandHeat3Ine: Curve of days surrounding Ine's third estrus; Average: Curve all averages of the daily data points.

The average curve (diagram 23, black circle) showed a more evenly distributed curve between day 1 and day 6, fluctuating and rising on the day before estrus to it's highest peak of 31%. Then the curve fel back down to about 5% on the day of estrus, after which it again vacillated between 10% and 20%.

3.2.1.3 Kilaguni

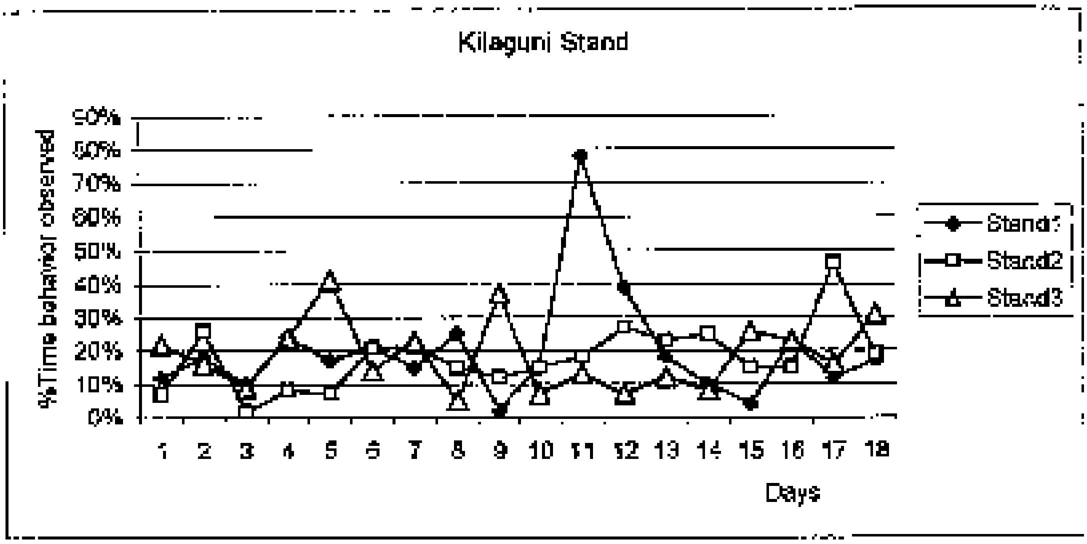


Diagram 24: Behavioral curves for Kilaguni. Data points show the amount of time Kilaguni spent, each observation period standing, during the chosen time-periods. Stand1: Curve of Kilaguni's first time-period; Stand2: Curve of Kilaguni's second time-period; Stand3: Curve of Kilguni's third time-period

The first time-period (diagram 24, black diamond) chosen for Kilaguni fluctuated between 10% and 25% up to the ninth day, when it fell to ~3%. Over the next two days, the curve rose to approx., 8% and slowly decreased afterwards to about 5% on day 15. The last three days, it again fluctuated between 10% and 20%.
The curve for the second time-period (white square) showed a peak on the second day of about 28%, which fell to ~3% on the third day. After this a steady rise occurred up to day 12, again at approx. 28%, with a slight dip between days seven and eleven, which started from 20% and fell to 10%, after which the curve returned to 20% . After day 12, the curve steadily decreased to 15% on day 16, only to peak on day 17 at 48%, the highest point in the curve.
The activity of the third time-period (white triangle) showed two peaks (day5 at about 40% and day 9 at around 38%), otherwise it fluctuated between 5% and 10% for the first ten days. Between day 11 and day 14 the curve stayed around 10%, and rose on day 15 to 25%. On the seventeenth it fell back to 15% and increased one last time on day 18 to ~30%

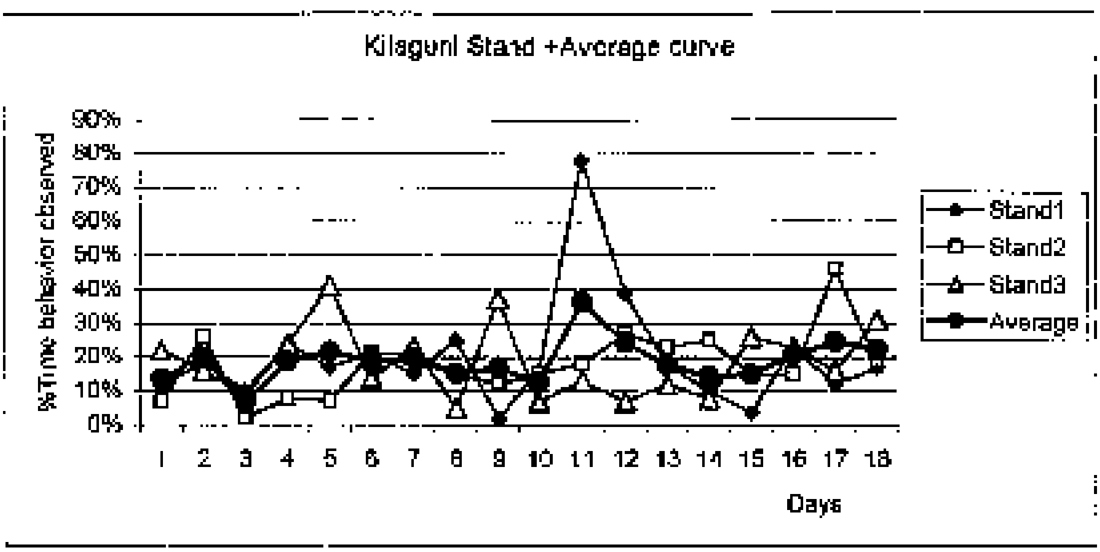


Diagram 25: Behavioral curves for Kilaguni. Data points show the amount of time Kilaguni spent, each observation period standing, during the chosen time-periods and the average curve, resulting form the daily averages.
Stand1: Curve of Kilaguni's first time-period; Stand2: Curve of Kilaguni's second time-period; Stand3: Curve of Kilguni's third time-period.

The average curve (diagram 25, black circle) flattened out all anomalous peaks in the three curves. This led to a steady curve that stayed between 10% and 20%, until the eleventh day. Here it rose to approx. 40% and slowly decreased again to vacillate between 15% and 25%.

3.2.2 Morning/Afternoon Sessions

3.2.2.1 Sita

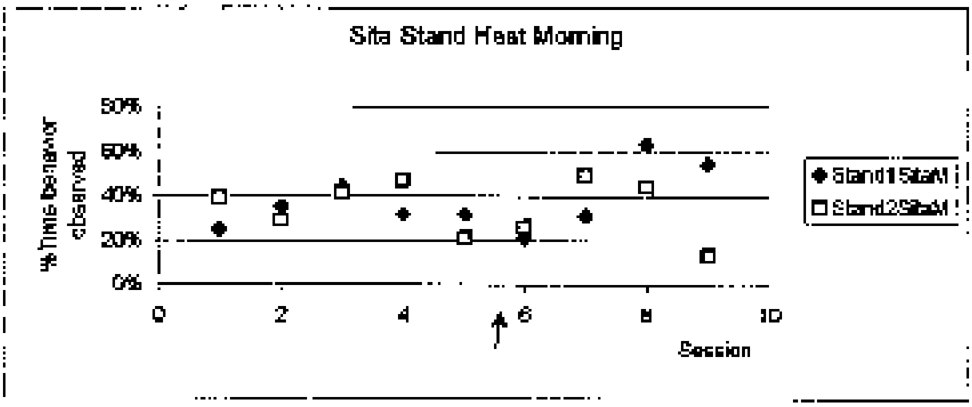


Diagram 26: Data points of Sita's heat cycles, which were observed during morning sessions, concerning the behavior "stand". Each data point depicts the percentage of time Sita was observed standing during a session. Estrus was situated between days 5 and 6, which means it occurred during an afternoon session. Stand1SitaM: Morning sessions during days surrounding Sita's first estrus; Stand2SitaM: Morning sessions during days surrounding Sita's second estrus.

Again dividing the days into morning and afternoon sessions, Sita's activity curves appear to flatten out considerably in the morning (diagram 26). Both curves fluctuate between 20% and 40% until after estrus (between the fifth and sixth day). After estrus, both curves started to rise. Curve 1 (black diamond) rose to 60% on day 8 and decreased slightly on day 9 whereas the second curve (white square), rose to 45% and then fell to 10% in session 9.

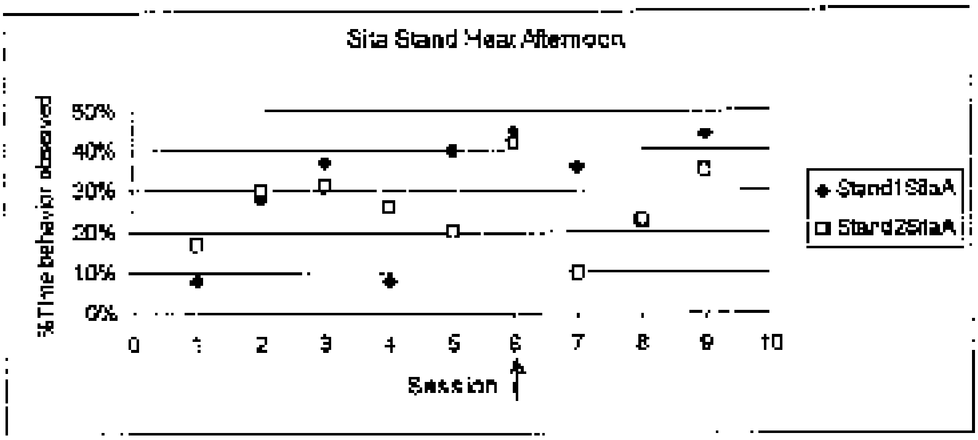


Diagram 27: Data points of Sita's heat cycles, which were observed during afternoon sessions, concerning the behavior "stand". Each data point depicts the percentage of time Sita was observed standing during a session. Estrus was situated between day on day 6. Stand1SitaA: Afternoon sessions during days surrounding Sita's first estrus; Stand2SitaA: Afternoon sessions during days surrounding Sita's second estrus.

The afternoon sessions (diagram 27) are more diverse than the morning sessions.
The first curve (diagram 27, black diamond) started rising the first three sessions from about 9% to 37% (day 3), and dipped to 9% during session 4. After this decrease, the curve returned to a height of 40 % and peaked in session 6 (estrus) at approx. 45%. After this peak the curve decreased to about 23%, but returned, in the last session, to 45%.
The second curve (white square) began similar to the first, starting at 18% and rising to 31% during session 3. After this, the curve descended to 20% in session 5, but showed a peak on the day of estrus at about 42%. The session following estrus started another ascent from 11%, to end during the eighth session at about 35%.

3.2.2.2 Ine

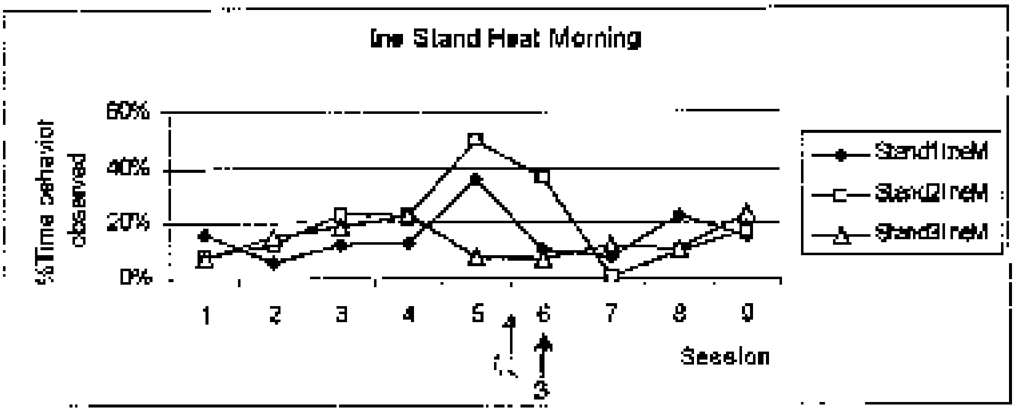


Diagram 28: Data points of Ine's heat cycles, which were observed during morning sessions, concerning the behavior "stand". Each data point depicts the percentage of time Ine was observed standing during a session. Estrus was situated between day 5, 6 for curves one and two, and on day six for curve three. Stand1IneM: Morning sessions during days surrounding Ine's first estrus; Stand2IneM: Morning sessions during days surrounding Ine's second estrus; Stand3IneM: Morning session during days surrounding Ine's third estrus

In Ine's morning sessions (diagram 28), the peaks before estrus become more obvious, at least regarding the first two curves. The curve for her first heat cycle (black diamond) stayed around 10% until the day before estrus (situated between days five and six for the first two curves). On the fifth day, standing rose to approx. 38%, after which the curve declined again to waver between 10% and 20%.

The second heat cycle (white square) showed a steady rise from about 10% to 20% during session 4. The fifth morning showed a strong increase, peaking at 50%, the highest point of the curve. Then it declined after estrus to 0% on session 7. After this decrease, standing slowly began to rise again to ~20% during session 9.

The third curve (white triangle) only showed a gentle wave-like motion. Starting at ~5% during the first session to about 20% on the fourth day, a decline during session 5 to around 5% (estrus being during session 6) was registered. After staying at 5% on the day of peak receptivity, the curve slowly rose again to 20% in the ninth session.

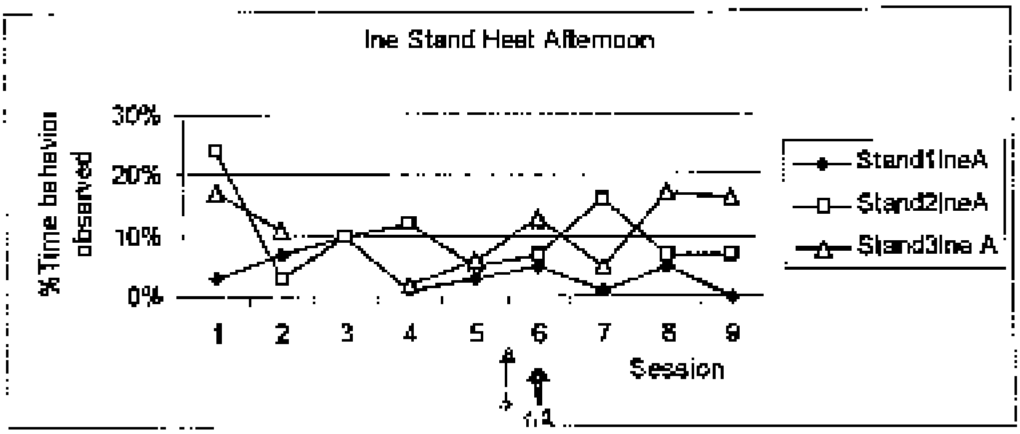


Diagram 29: Data points of Ine's heat cycles, which were observed during afternoon sessions, concerning the behavior "stand". Each data point depicts the percentage of time Ine was observed standing during a session. Estrus was situated between day 5 and 6 for

Curve 3, and on day six for the curves one and two. Stand1IneA: Afternoon sessions during days surrounding Ine's first estrus. Stand2IneA: Afternoon sessions during days surrounding Ine's second estrus; Stand3IneA: Afternoon session during days surrounding Ine's third estrus.

The afternoon session (diagram 29) did not show any obvious signs of estrus.

The first curve (black diamond) consistently fluctuated between 0% and 10% without any indication of estrus during session 6.

The second curve (white square) started at ~25% and fell to less than 5% during the second session, when it started to fluctuate between 3% and 12% until peak receptivity (session 6). During session 7 standing increased to a level slightly over 15%, only to fall back to ~8% in sessions 8 and 9.

3.2.2.3 Kilaguni

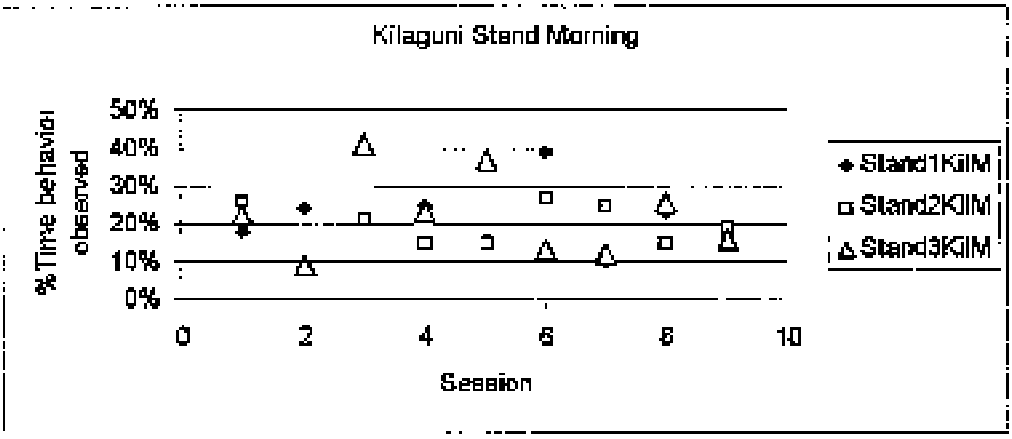


Diagram 30: Data points of Kilaguni's heat cycles, which were observed during morning sessions, concerning the behavior "stand". Each data point depicts the percentage of time Kilaguni was observed standing during a session. Stand1KilM: Morning sessions during Kilaguni's first time-period; Stand2KilM: Morning sessions during Kilaguni's second time-period; Stand3KilM: Morning session during Kilaguni's third heat cycle.

For Kilaguni all three curves differ, at least during the morning sessions.

Within the first time-period (diagram 30, black diamond), the time Kilaguni spent standing, stayed between 20% and 25% until session 5. During session 6, standing escalated to 40%, only to drop down to 10% the following session. Sessions 8 and 9 again fluctuated around 20%.

The second time-period (white square) generally vacillated between 15% and 25%. Only the second morning session dropped down to slightly below 10%.

The third time-period (white triangle) tended to fluctuate between ~10% and 20% with two peaks during session 3 at 40% and session 5 at 38%.

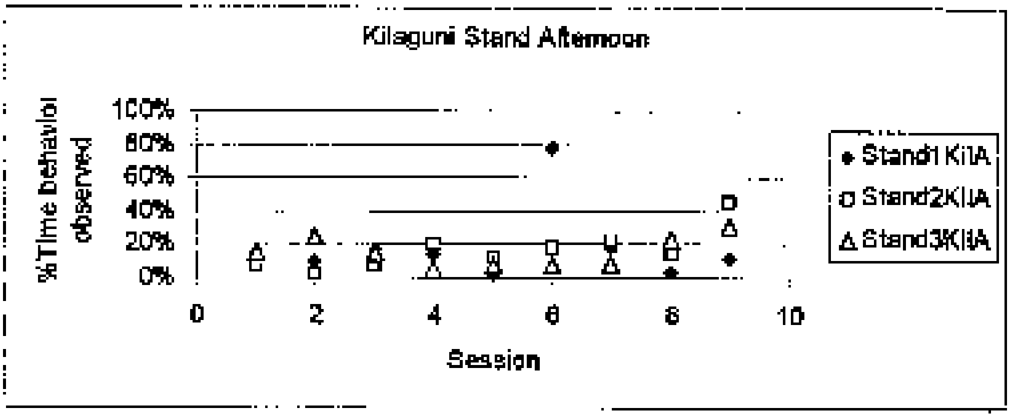


Diagram 31: Data points of Kilaguni's heat cycles, which were observed during afternoon sessions, concerning the behavior "stand". Each data point depicts the percentage of time Kilaguni was observed standing during a session. Stand1KilA: Afternoon sessions during Kilaguni's first time-period; Stand2KilA: Afternoon sessions during Kilaguni's second time-period; Stand3KilA: Afternoon session during Kilaguni's third heat cycle.

During the afternoon sessions (Diagram 30), all curves generally stayed between 0% and 20%.
Curve 1 (Black diamond) showed an anomaly during session 6, which was a peak at 80%. Curves two (white square) and three (white triangle) rose above 20% during session 9 (50% for curve 2 and 30% for curve three).

To summarize the results of the behavior 'stand'.

Sila: A peak was evident on day 16 in the first curve. While the second curve did show an increase on this day, it cannot be considered equal to the peak in curve two. The rest of the days showed no indication of estrus, since they tended to fluctuated throughout the observation period at about the same levels. The results of the morning/ afternoon separation show fluctuations in both curves during both sessions. Therefore, this behavior can be seen as daytime independent.

Ine: Here a peak in standing was evident on day prior to estrus, while the rest of the curve fluctuated at lower levels. Again, the separation of morning and afternoon sessions did not lead to different curves. The only difference between the curves was in the percentages around which they fluctuated.

Kilaguni: All curves generally fluctuated between 0% and 30% with only occasional peaks at higher levels in some curves. No similarities between the curves were evident therefore, no pattern could be discerned.

3.3 Eat

3.3.1 Daily Observations and Average Curves:

3.3.1.1 Sita

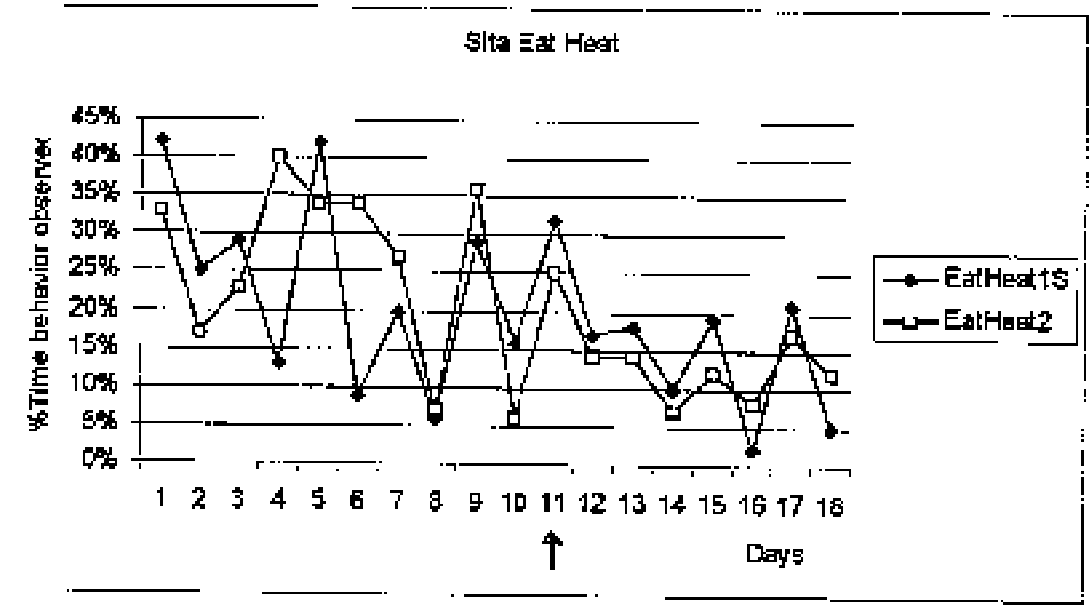


Diagram 32: Behavioral curves for Sita with peak receptivity on day 11. Data points show the amount of time Sita spent, each observation period eating.
EatHeat1S: Curve of days surrounding Sita's first estrus; EatHeat2S: Curve of days surrounding Sita's second estrus.

Both curves tended to fluctuate wildly from one day to the next (diagram 32), however, there appeared to be an overall decline in the curves.
The first heat cycle (black diamond) started at about 42%, fell to ~12% on the fourth day and peaked again at 42% on day 5. After this, daily differences occurred until after estrus, vacillating between 8% (day 6) and 32% (day 11, peak of receptivity). Days 12 and 13 were about the same, around 17%. The daily fluctuation started again on the fourteenth day, with a drop to 10%. The lowest point in the next days' fluctuations was about 2% on day 16, and the peak was around 22% (day 17).
The curve for Sita's second heat cycle (white square) started at approx. 33% and dropped to ~17% on the following day. Then it slowly rose back to 40% on the fourth day and steadily declined to 7% on day 8. From the eighth day onward, the two curves were similar in nature.. Day 9 showed a peak at 37%, day 10 fell again to 6%, only to rise again to 25% on the day of estrus. The following to days stayed around 14%, after which small fluctuations started leading to day 18. These fluctuations were between 7% and 17%.

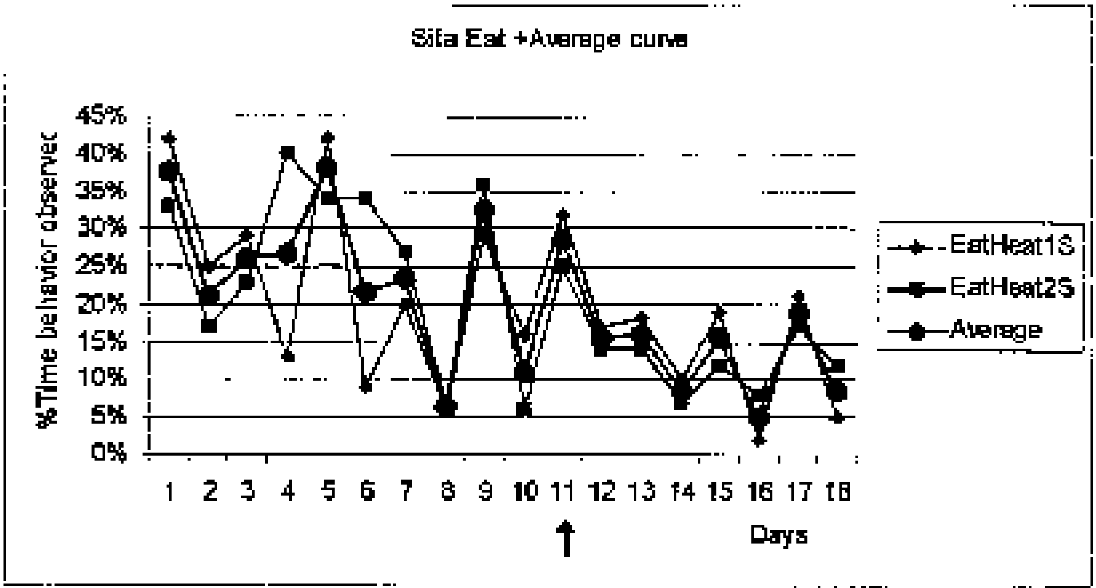


Diagram 33: Behavioral curves for Sita with peak receptivity on day 11. Data points show the amount of time Sita spent, each observation period eating and the averages of both curves, including the corresponding curve. EatHeat1S: Curve of days surrounding Sita's first estrus; EatHeat2S: Curve of days surrounding Sita's second estrus; Average: Curve of the daily averages of both curves.

With the help of the average curve (diagram 33, black circle) the similarities between the two curves become increasingly obvious from day 8 onwards. Before the eighth day strong fluctuations in the beginning decreased slightly, so two peaks appeared on day 1 and 5 at ~37% each. Between these the curve stayed within 22% and 27%.

Both curves are negatively correlated with the time. This means that as time progresses, eating decreases. In Sita's first heat cycle this means that 29% of the total variance of the data points (Pearson Coefficient r= -0.539, 0.025 <p> 0.02; N=18) is a result of the described relationship between time and the behavior 'eat'.

In Sita's second heat cycle 38% of the total variance (r= -0.623, 0.005<p>0.002; N=18) can be attributed to this relationship.

3.3.1.2 Ine

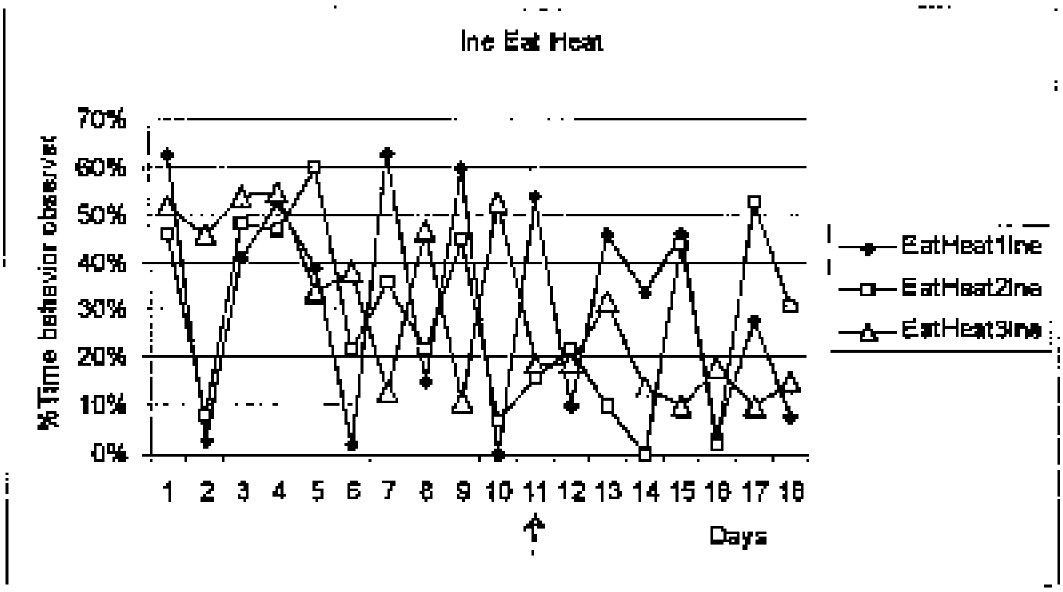


Diagram 34: Behavioral curves for Ine with peak receptivity on day 11. Data points show the amount of time Ine spent, each observation period eating.
EatHeat1Ine: Curve of days surrounding Ine's first estrus; EatHeat2Ine: Curve of days surrounding Ine's second estrus; EatHeat3Ine: Curve of days surrounding Ine's third estrus.

Ine also showed wild daily fluctuations in her eating pattern (diagram 34).
The curve for the first heat cycle (black diamond) started at 63%, fell down on the second day to 2%, increased again to 41% on the third day and to 52% on day 4. The fifth day showed another decrease to 38% and 2% the following day. This was followed by an ascent to 62% on day 7, a decline on day 8, another rise to 60% the next day and on the day before estrus, eating had fallen again to 0%. The day of peak receptivity showed another increase to ~55%. These fluctuations continued after estrus with the twelfth day showing a decline to about 10%, followed by day 13 at 47%, a slight decrease to 33 % on the fourteenth day. This was succeeded by a rise back to ~47% on day 15. The following day showed a declination to 5%, after which the curve rose again to ~28%, only to fall on the last day to around 8%.
The second heat cycle (white square) vacillates similarly, however, not always on a daily basis, as did the first curve.
The starting point was situated around 47% and fell on the second day to approx. 8%. On the third and fourth days, the curve stayed steady at about 48% and rose the next day to 60%. Between days 6 and 8, the curve remained between ~21% and approx. 37%. The ninth day showed another rise to 45% and declined again on the day before estrus to about 8%. After

this the curve steadily rose until day 12 to about 22%, and decreased again slowly to 0% on the fourteenth day. Thereafter wild fluctuations set in between ~53% and 2%.
The third curve (white triangle) stayed around 50% for the first four days, then slowly decreased to 11% on day 7. From days seven to eleven (the day of peak receptivity), the curve increased and decreased daily: day8 ~48%, day 9 approx. 11%, day 10 52% (highest point in curve) and day 11 ~19%. No change was observed on day 12, and the curve peaked at about 32% on day thirteen. From day 14 to 18, fluctuation set in around 15%.

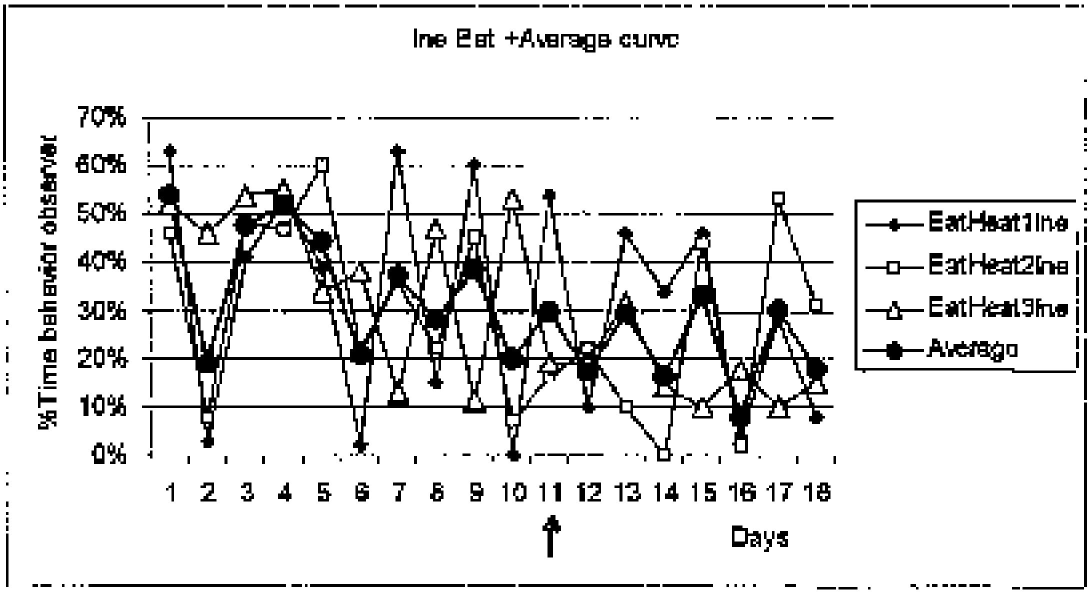


Diagram 35: Behavioral curves for Ine with peak receptivity on day 11. Data points show the amount of time Ine spent, each observation period eating and the averages of both curves, including the corresponding curve. EatHeat1Ine: Curve of days surrounding Ine's first estrus; EatHeat2Ine: Curve of days surrounding Ine's second estrus;EatHeat3Ine: Curve of days surrounding Ine's third estrus. Average: Curve of the daily averages of all curves.

Through the average curve (diagram 35, black circle), the strong fluctuations disappeared almost completely. Only at the beginning of the curve was a strong fluctuation apparent, when eating dropped from ~55% to approx. 20%. Thereafter a small hill appeared in the curve (days 3-5) at around 50%. The sixth showed a valley at around 20%. Between days 7 and 9, the curve vacillated between 30% and 40%. Form days10 to 15 the curve wavered between 18% and 30%, after which the amplitude increased again to between 34% (day 15) and 9% (day 16), these being the highest and lowest points of the remaining days.

All three curves are negatively correlated to time in Ine's case as well. In Ine's first curve 6% of the total variance of the data points ($r=-0.254$, $p>0.1$; $N=18$) is a result of the relationship between time and the behavior 'eat'.
Ine's second curve is very similar, in that only 7% of the total variance ($r=-0.277$, $p>0.1$; $N=18$) can be attributed to the relationship between time and 'eat'.
The last curve, however is quite extreme in that 56% of the total variance ($r=-0.748$, $p<0.001$; $N=18$) can be attributed to the described relationship.

3.3.1.3 Kilaguni

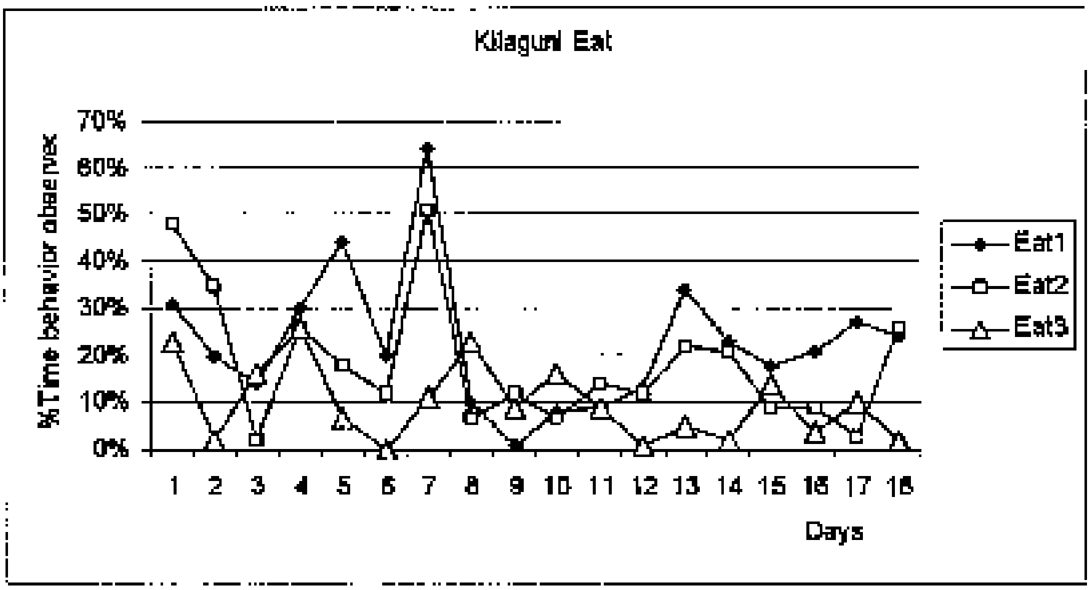


Diagram 36: Behavioral curves for Kilaguni. Data points show the percentage of time Kilaguni spent each observation period eating. Time-periods were chosen to match those of Ine. Eat1: Eat during Kilaguni's first time-period; Eat2: Eat during Kilaguni's second time-period; Eat3: Eat during Kilaguni's third time-period.

Kilaguni also showed fluctuations in her eating pattern (diagram 36), however, not on such a regular basis, and not with such big differences as with the other two females.
The curve for the first time-period (black diamond) started at about 30% and decreased to ~15% on the third day. Thereafter it steadily rose to 45% (day 5), has a valley on day 6 (20%), only to increase again to almost 65% on the seventh day. This was the highest point of the curve. From day 8 to 12 the curve fluctuated between 0% and 10%, showing a small peak on day 13 at 35% and settling down around 25%.
The second time-period (white square) began at approx. 49% of time spent eating, to drop to almost 0% on the third day. The following day showed an increase to about 28%, after which a steady set in to the sixth day (~12%). Again day 7 showed the highest the point of the curve

at approx. 51%, which immediately fell down to fluctuate around 10% from days 8 to 12. A small hill developed on days 13 and 14 at about 21%, which fell again to 10% on the fifteenth and sixteenth day. Day 17 showed a slight decreased (~5%) and day 18 rose to approx. 27%. The curve the third time-period (white triangle) stayed entirely between 0% and 30%. The curve began at 22%, fell to about 2% (day2), and steadily rose to ~26% on day 4. Between the fourth day and the sixth day, a slow decrease occurred to 0%. Thereafter, the curve rose again to 22% on the day 8. From day 9 onward, the curve vacillated between 15 % and 2%.

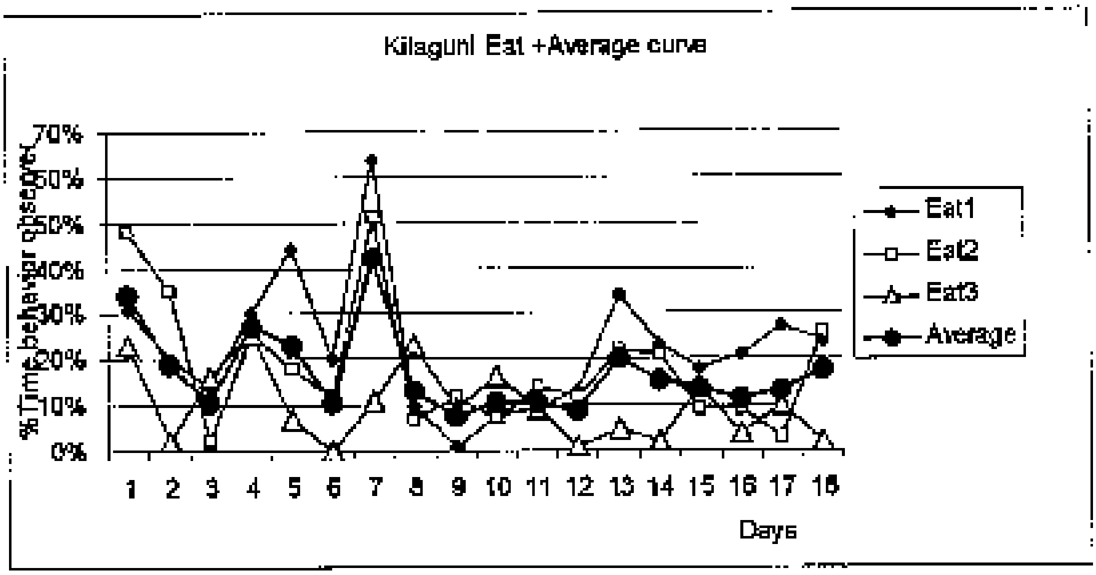


Diagram 37: Behavioral curves for Kilaguni. Data points show the percentage of time Kilaguni spent each observation period eating and the resulting average of each data point. Time-periods were chosen to match those of Inc. Eat1: Eat during Kilaguni's first time-period; Eat2: Eat during Kilaguni's second time-period; Eat3: Eat during Kilaguni's third time-period. Average: Curve corresponding to the average of the daily data points.

With the addition of the average curve (diagram 37, black circle), the fluctuations disappear for all but the first seven days. The first three days, the curve from 35% to ~10%, then it rose again to approx.28% and decreased to 11% on day 6. Day 7 showed a peak at around 42%. which was followed by a stabile curve starting day 8, that stayed between 10% and 20% for the remaining days.

Similar to the previously discussed curves, Kilaguni's 'eat' curves are negatively correlated with time. Here, the percentage of the total variance that can be attributed to this relationship is much smaller. In Kilaguni's first curve, 2.2% ($r=-0.149$; $p>0.1$; $N=18$) of the total variance is a result of the relationship between time and the behavior 'eat'.

In the second curve 16% of the total variance ($r = -0.400$, $p=0.1$; $N=18$)) can be attributed to the relationship between time and 'eat'. In the third curve 17.6% ($r = -0.419$, $0.05<p>0.025$; $N=18$) of the total variance can be attributed to the described relationship.

3.3.2 Morning/Afternoon Separation

3.3.2.1 Sita

The strong fluctuations in Sita's and Ine's behavioral curves, may be the result of different eating pattern in the morning and afternoon. Perhaps through separation of the two sessions a pattern will emerge.

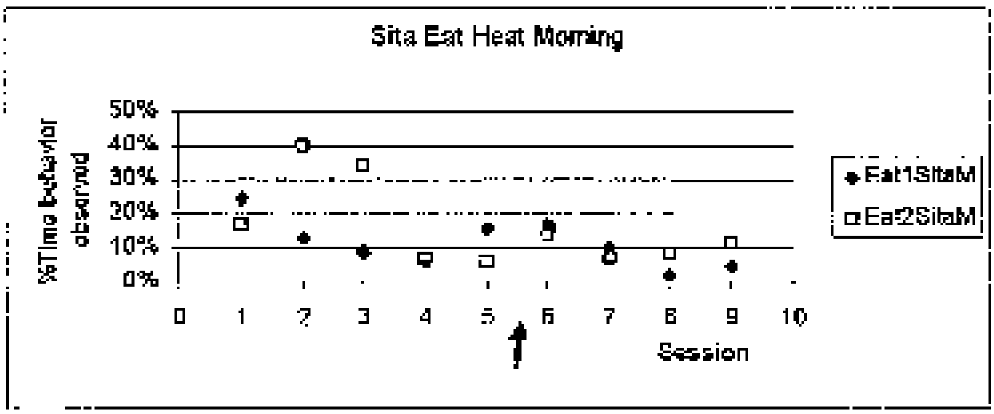


Diagram 38: Data points represent the percentage of time Sita eating on each morning of observation, during the time period previously discussed. Here, estrus lies between days 5 and 6, which means peak receptivity lies on an afternoon session. Eat1SitaM: Morning observations of Sita surrounding her first estrus; Eat2SitaM: Morning observations of Sita surrounding her second estrus.

For Sita both peaks in receptivity occur during the afternoon sessions (diagram 39), therefore estrus lies between day 5 and 6 in diagram 38. During the first heat cycle (black diamond) very little difference in eating occurred. For most of the sessions, eating wavered around 10%. The exception being the first session, which was could be found around 25% After this the fluctuations around 10% set in.

The beginning of the second heat cycle (white square), demonstrated a hill starting at ~18%, rising to 40% (day 2) and slowly descending again to 18% on the fourth day. From then onward, the curve gently fluctuated around 10%.

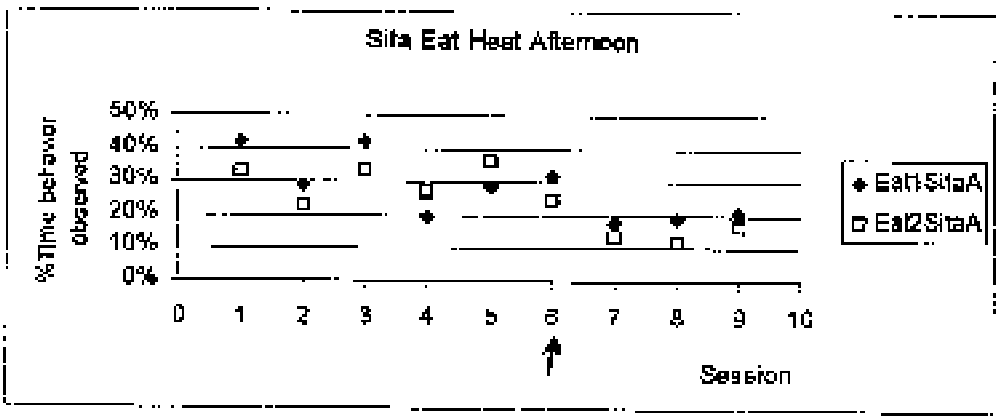


Diagram 39: Data points represent the percentage of time Sita eating on each afternoon of observation, during the time period previously discussed. Here, estrus lies on day 6. Eat1SitaA: Afternoon observations of Sita surrounding her first estrus. Eat2SitaA: Afternoon observations of Sita surrounding her second estrus.

During the afternoon session (diagram 39), a small decrease in eating is apparent in both curves. Curve 1 (black diamond) vacillated between 42% and 30% for the first three sessions, then dropped to 20% during session four. Eating showed a slight increase to 32% on day 6, the day of peak receptivity. After estrus, eating stayed at approx. 20%.

The second heat cycle (white square) fluctuates for the first five days sessions around 30%. After that it slowly decreased to ~12% on day 8 and started to rise again on the ninth (18%).

3.3.2.2 Ine

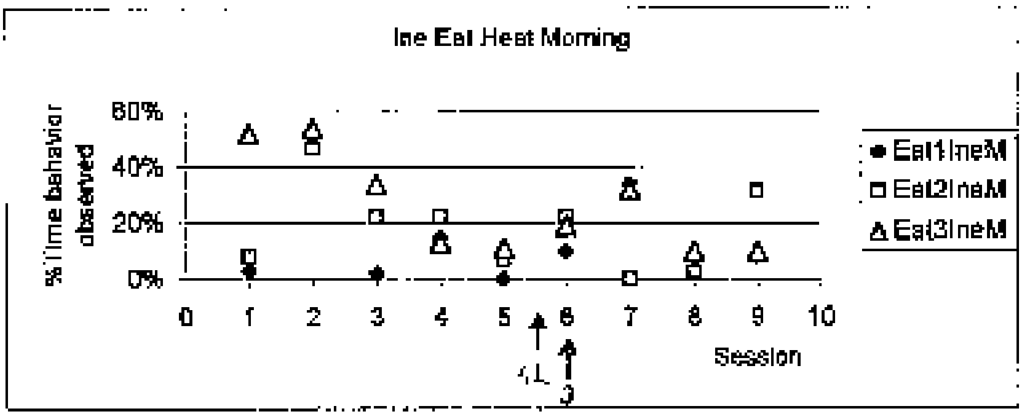


Diagram 40: Data points represent the percentage of time Ine eating on each morning of observation, during the time period previously discussed. Here, estrus lies on day 6 for curve three and between days 5 and 6 for curves one and two. Eat1IneM: Morning observations of days surrounding Ine's first estrus; Eat2IneM: Morning observations of days surrounding Ine's second estrus; Eat3IneM: Morning observations of days surrounding Ine's third estrus.

For Ine, one must again keep in mind, that for curves 1 and 2, estrus was situated between sessions 5 and six, while for curve 3 it was on day 6 (diagram 40).
Both curves one (black diamond) and two (white square) began at quite low levels, ~5% and 10% respectively, and rose to almost 50% during session 2. Thereafter, they began to differ. Curve 1 (black diamond) fell on session 3 back to 55% and began to fluctuate between 5% and 15% until session 6. The seventh session showed a peak at slightly over 30% only to decrease again to 5% during session eight and reached 10% in the last session.
Curve 2 (white square) started vacillating between 10% and 20% after the second session until the sixth session. Sessions 7 and 8 showed levels close to 0%, while session 9 increased again to ~30%.
The third curve (white triangle) started around 50% and began to decline during session 3. It stayed around 10% until session 6, the day of estrus, when it started to slowly rise to a second peak in session of 30%. Afterwards the curve dropped down 10%.

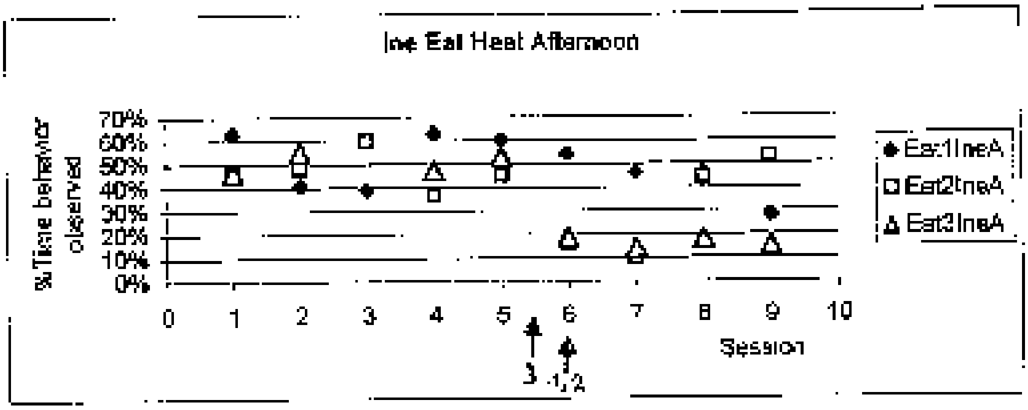


Diagram 41: Data points represent the percentage of time Ine eating on each afternoon of observation, during the time period previously discussed. Here, estrus lies on day 6 for curves one and two and between days 5 and 6 for curve three. Eat1IneA: Afternoon observations of days surrounding Ine's first estrus: Eat2IneA: Afternoon observations of days surrounding Ine's second estrus: Eat3IneA: Afternoon observations of days surrounding Ine's third estrus.

During the afternoon (diagram 41), the curve of Ine's first heat cycle (black diamond) began a about 65%, fell to 40% for sessions 2 and 3, rose again to 65% and slowly fell over the next four sessions to ~45%. During the last session, it fell below 40% for the first time to approx. 30%.

The second heat cycle (white square) showed a slight increase from 45% to 60% for the first three sessions. Thereafter, the curve steadily declined to about 10% in session 7 only to increase again for the last two sessions (45% to50%).

The last curve (white triangle) started around 50% for the first two sessions. From session4 to session 7 the curve closely followed the second curve, but stayed at about 20% for the last two days.

Overall a decline in curves one and three were apparent, whereas curve 2 appeared to be evenly distributed from beginning to end, unlike the curves seen for Sita.

3.3.2.3 Kilaguni

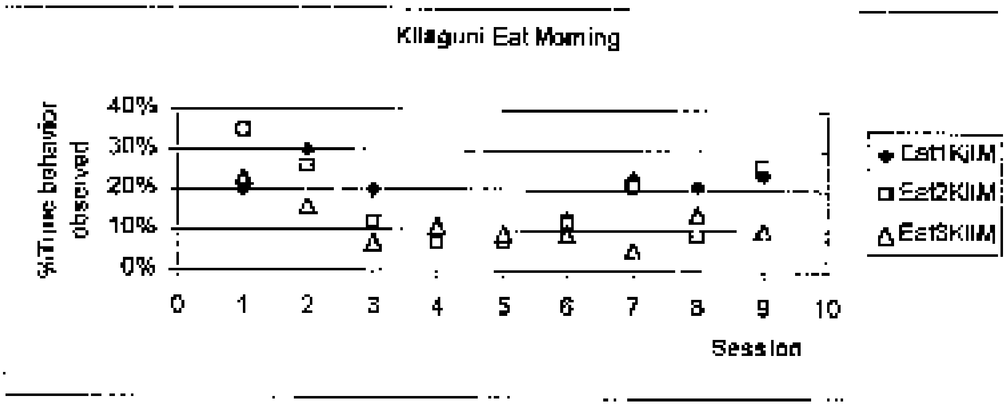


Diagram 42: Data points represent the percentage of time Kilaguni eating on each morning of observation, during the time-periods previously discussed. Eat1KilM: Morning observations of Kilaguni during her first time-period; Eat2KilM: Morning observations of Kilaguni during her second time-period; Eat3KilM: Morning observations of Kilaguni during her third time-period.

For the first time-period (black diamond), Kilaguni's eating stayed between 20% and 30% for first three sessions (diagram 42). Then it dipped to around 10% for the following three and increased again to 20%-25% the last three sessions.

The second time-period (white square) started at approx. 35% for session 1 and decreased to about 8% during sessions 4 and 5. Between sessions 6 and 8, the curve wavered between 10% and 20% until it increased to 25% in the ninth session.

The third time-period (white triangle) also began at ~20%, but fell to approx. 8% by session 3 and fluctuated around 10% for the remaining sessions.

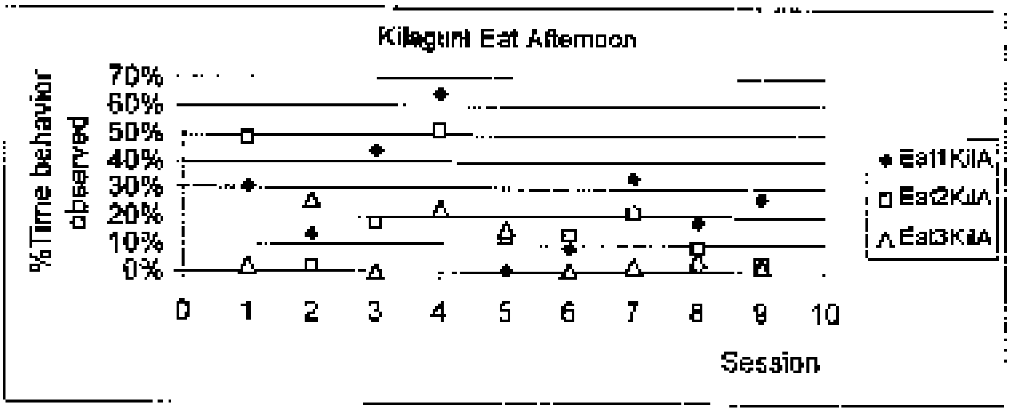


Diagram 43: Data points represent the percentage of time Kilaguni eating on each afternoon of observation, during the time-periods previously discussed. Eat1KilA: Afternoon observations of Kilaguni during her first time-period; Eat2KilA: Afternoon observations of Kilaguni during her second time-period; Eat3KilA: Afternoon observations of Kilaguni during her third time-period.

After a slight dip from 30% to 15%, the curve of the first time-period (diagram 43, black diamond) rose steadily to ~65% (day4), then it fell drastically on day 5 to 0%. Thereafter, the curve fluctuated between 15% and 25%.

The second curve (white square) appeared similar to the first, starting at 50%, then dipping down to 0% during session 2 and slowly rising to 50% during session. After this point, however, it stayed around 20% (days 5 to 7). During the last sessions the curve declined to 0%.

The last curve (white triangle), started at 0%, then climbed to ~20%, only to decrease again to approx. 0% in session 3. During session 4 eating is back up to 20% and fell back to 0% where it stayed for remaining days.

To summarize the results of the behavior 'eat':

Sita: Although the overall curve of this behavior appeared to decline slowly throughout the 18-day period. The correlation coefficient showed that in the first curve 28% and in the second curve 38% of the total variance observed could be attributed to a relationship with the time. Both curves were negatively correlated in regards to time. In the morning sessions, the first curve wavered around 10%, and the second curve increased to 40% during the second session, after which it fluctuated around 20% (sessions 4 to 9). The afternoon sessions vacillated at a higher percentage: Curve 1 between 30% and 40%, curve 2 between 25% and

35%, for most sessions. The first curve dropped to 20% during the last three sessions, while the second curve dropped to 10% in the last session.

Ine: The overall curves showed wild fluctuations on an almost daily basis. Looking at the separated sessions, this becomes obvious. The morning sessions generally wavered between 10%-and 20%, showing only occasional peaks. The afternoon sessions, on the other hand, were located in the higher percentage range, at least until the sixth session, when the second and third curves dropped to around 20%. Curve three ended the session in this range, while the second curve returned to its original height of about 50% during session 8. The correlation coefficient demonstrated that the third curve had a strong relationship with the progression of time, namely 56% of the total variance. The other two curves showed only about 7% of the total variance could be attributed to the elapse of time.

Kilaguni: Time spent eating, fluctuated between 0% and 30% with only two visible peaks in the first and second curve at 65% and 52% respectively. In the morning, eating fluctuated between 10% and 20%, while the afternoon sessions tended to be divers. The exception was the third curve, which fluctuated between 0% and 30%. The coefficient correlation showed even here a small relationship between the progression of time and the behavior 'eat'. In the first curve 2.2%, in the second curve 16% and in the third 17.6% could be accounted for this relationship. As with the other females this was a negative correlation.

3.4 Lay

3.4.1 Daily Observations and Average Curve:

3.4.1.1 Sita

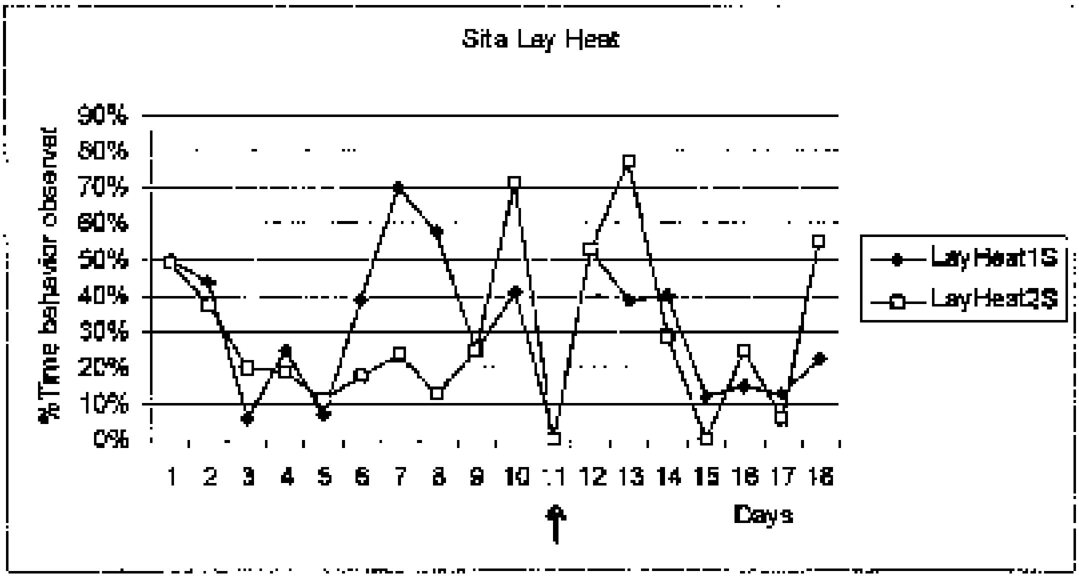


Diagram 44: Behavioral curves for Sita with peak receptivity on day 11. Data points show the amount of time Sita spent, each observation period lying.
LayHeat1S: Curve of days surrounding Sita's first estrus; LayHeat2S: Curve of days surrounding Sita's second estrus.

Before and after estrus both curves appeared to be very different (diagram 44).
The first curve (black diamond) began at 50% and dropped to about 5% on the day 3. Then it climbed to 25% on day 5 and returned to approx. 5%. Thereafter it steadily rose to 70% (day7), followed by a slow decline to 25% on the ninth day. The day before estrus, showed a small increase to about 40%. On the day peak of receptivity, Sita did not lay. The following day, this activity rose to 55%, after which it slowly fell again to fluctuate between 15% and 25% from the fifteenth to thirteenth day.
The second curve (white square) also started at 50%, then fell to 20% for days 3 and 4, and ended up at approx. 12% on day 5. The following days the activity steadily rose to 25%, only to decrease again on day 8 (15%). The next day a slight increase (25%) led to a sharp peak (70%) on day 10, the day before estrus. On the day of estrus, Sita again did not lay. After estrus, a strong ascent lasted for two days to reach 80% on day 13. Thereafter, the curve fell sharply 0% on day 15. The sixteenth and seventeenth days showed another increase (25%) and decrease (5%), to end at 55% on day 18.

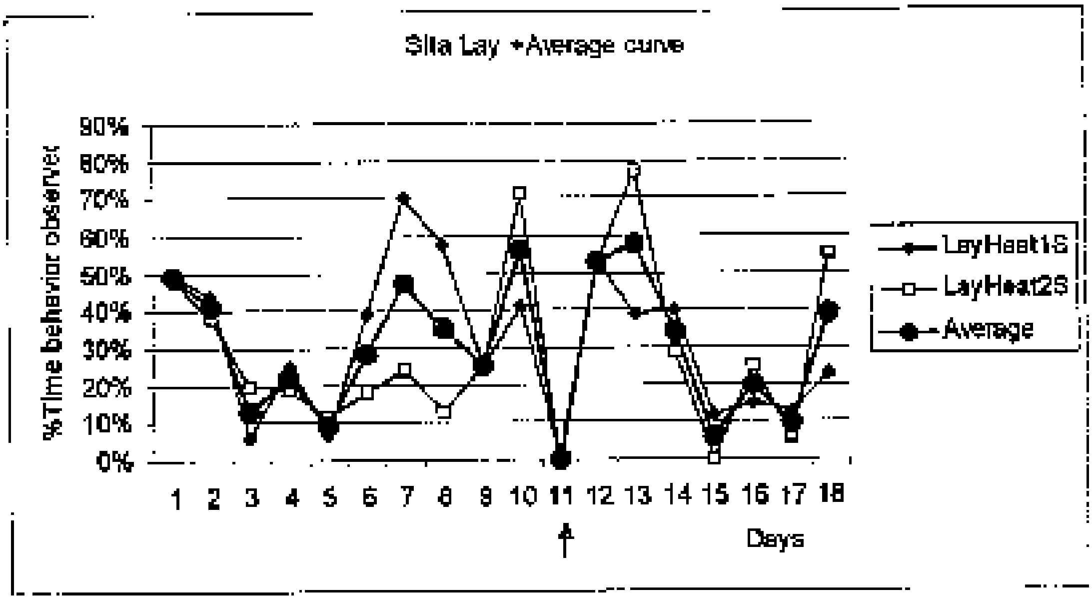


Diagram 45: Behavioral curves for Sita with peak receptivity on day 11. Data points show the amount of time Sita spent, each observation period lying and the corresponding average points. LayHeat1S: Curve of days surrounding Sita's first estrus; LayHeat2S: Curve of days surrounding Sita's second estrus. Average: Average curve of the daily data points.

The average curve (diagram 45) of these two cycles appeared to be similar before and after estrus (day 1 through 7 and days 13 through 18).

The average curve (black circle) began at 50%, decreased to 10% on day 3 and fluctuated between 10% and 20% until the fifth day, when it began another climb. On day 7, the curve reached its peak of about 47%. The next two days showed a small decline to 25%. The day prior to estrus (day 10) peaked at approx. 55%. During estrus, of course, no lying was observed, while the day after peak receptivity rose again to 55%. Day 13 increased slightly to 58%, after which the curve fell to about 5% (day 15). The following two days, the curve stayed between 10% and 20%, and climbed to 40% on the last day.

3.4.1.2 Ine

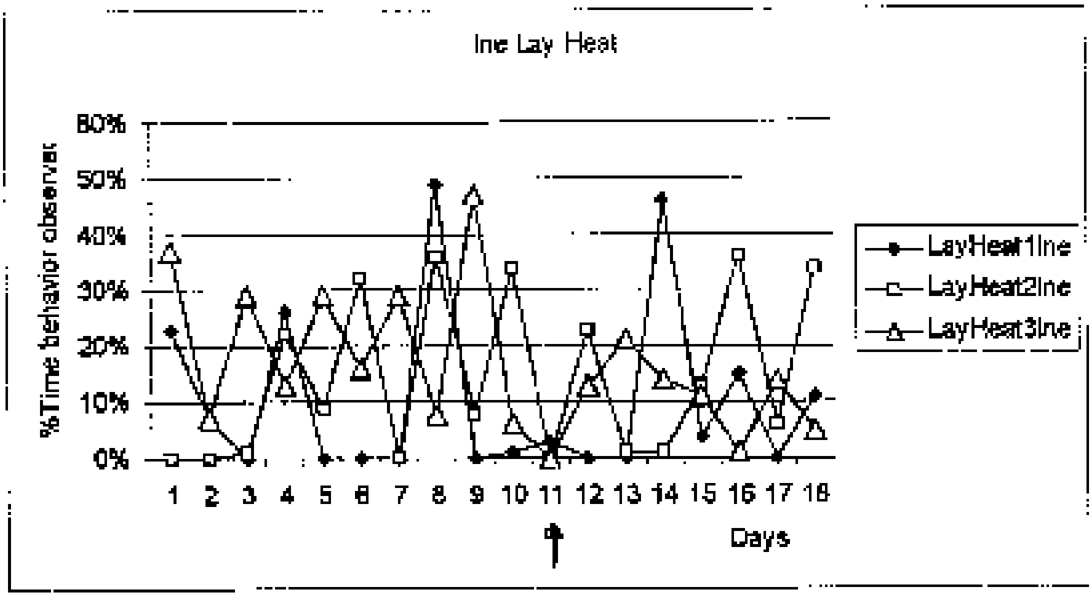


Diagram 46: Behavioral curves for Ine with peak receptivity on day 11. Data points show the amount of time Ine spent, each observation period lying. LayHeat1Ine: Curve of days surrounding Ine's first estrus; LayHeat2Ine: Curve of days surrounding Ine's second estrus; LayHeat3Ine: Curve of days surrounding Ine's third estrus.

At first glance, all three curves appear to be erratic, changing percentages from day to day (diagram 46).

The first curve (black diamond) started around 25% and dipped to 0% on the third day. The following showed a peak at 25%, after which no time spent lying. Days 7 to 14 were almost mirroring of each other, with the day peak receptivity being the mid-point. Nonetheless, from 0% on day 7, the curve peaked on the eighth day at approx. 50% and decreased again to 0% the next day. The curve stayed at ~0% until the thirteenth day, when it peaked again around 45%. Thereafter, it declined to about 5% and started fluctuating around 10% for the last few days (15-18).

The curve for the second heat cycle (white square) began at 0% for three days. After this, it fluctuated strongly from one to the next until two days after estrus. Day 4 reached about 22%, day 5 fell to ~8%, the sixth day peaked at about 32%, whereas day seven again decreased to 0%. This pattern continued with day 8 peaking at approx. 36%, day 9 dropping to 8% and the day prior to estrus peaking at 35%. As with Sita, Ine did not lay on the day of peak receptivity, during this heat cycle. The day after estrus demonstrated another peak about 24% and fell for days 13 and 14 to 0%. Afterwards, the curve started to rise again on day 15 (~12%)and peaked the next day around 36%, only to decline again on the seventeenth day (6%). The last day showed another increase to 34%

Similarly to curve 2, the last curve (white triangle) fluctuated daily between 10% and 30%until the eighth day, after starting at about 36%. The ninth day showed the high point of this curve at approx. 46%, and another decrease followed on day 10 to 5%. The of peak receptivity again showed no lying activity, whereas the day after estrus , the curve slowly began to rise again (12%) to peak at 20% on the thirteenth day. This was followed by a steady decline which reach 0% on day 16 and fluctuated the remaining days around 10%.

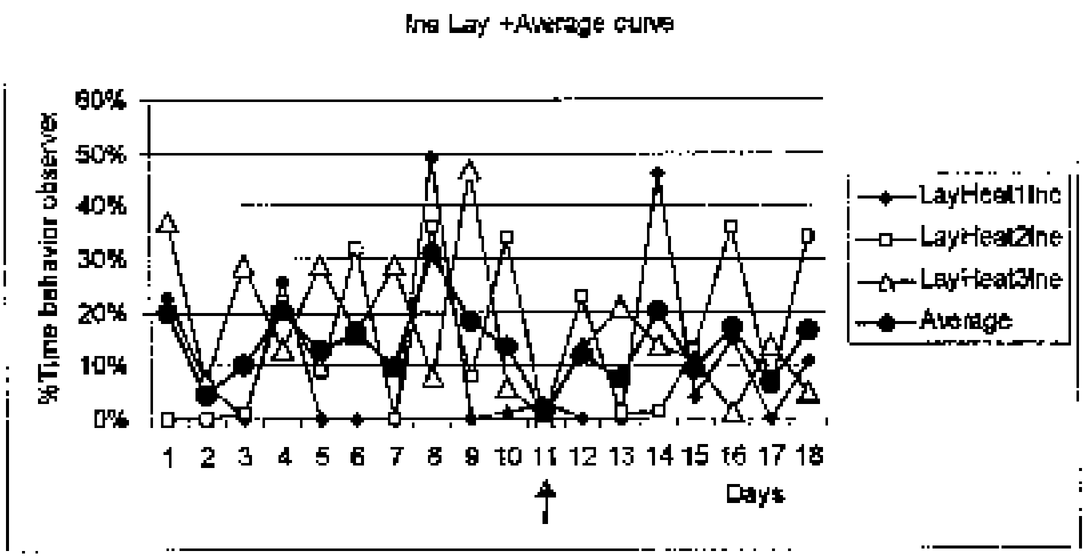


Diagram 47: Behavioral curves for Ine with peak receptivity on day 11. Data points show the amount of time Ine spent each observation period lying and the corresponding average points. LayHeat1Ine: Curve of days surrounding Ine's first estrus; LayHeat2Ine: Curve of days surrounding Ine's second estrus; LayHeat3Ine: Curve for days surrounding Ine's third estrus; Average: Average curve of the daily data points.

The interesting part of the average curve (diagram 47, black circle) was that between day 7 and 11, the day of peak receptivity. Prior to the seventh day, fluctuations could be seen between around 10% and 20%. Day 8 showed a distinct peak at approx. 30%, after which the curve steadily declined to 0% on the day of estrus. After estrus, the curve again fluctuated between 10% and 20%.

3.4.1.3 Kilaguni

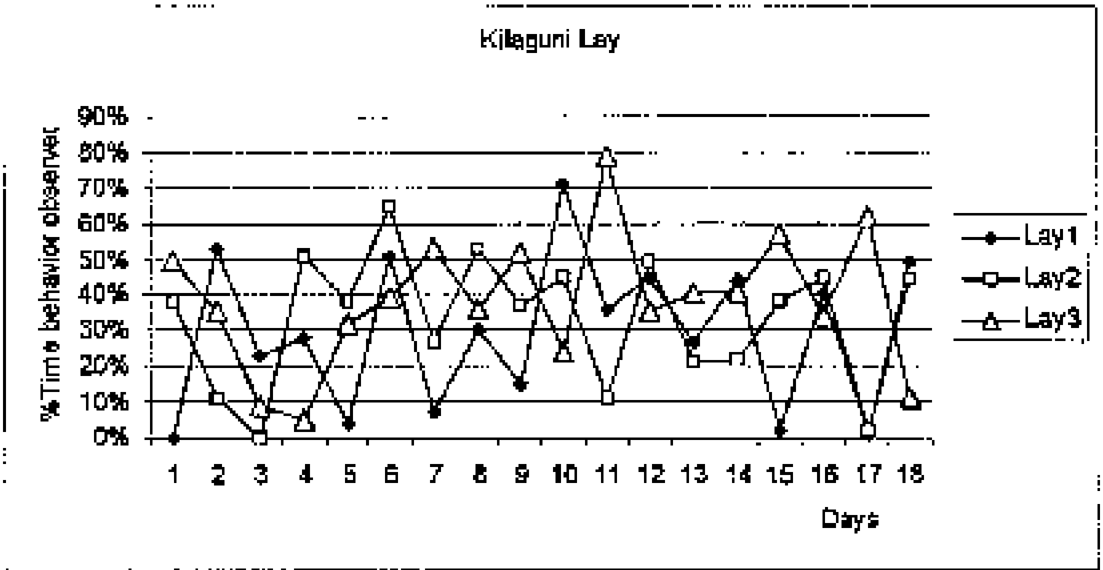


Diagram 48: Behavioral curves for Kilaguni. Data points show the amount of time Kilaguni spent, each observation period lying. Lay1: Curve of days within Kilaguni's first time-period; Lay2: Curve of days within Kilaguni's second time-period: Lay3: Curve of days within Kilaguni's third time-period.

The curves selected for Kilaguni fluctuated (diagram 48), however not daily as with Ine, and she did not show a characteristic day, on which all three curves were found around 0%. The fluctuations were severe in nature, for example curve one vacillated between 0% and 70% over the entire time-period.

The first time-period (black diamond) began at 0% and ascended to approx. 52% on the second day, then steadily fell again to ~5% on day 5, only rise to 50% on the sixth.. Day seven, the curve was situated around 10%, climbing slowly to 70% over the next three days. From days 11 to 14, the curve fluctuated between 30% and 40%. Days 15 through 18 showed a daily vacillation between 5% and 45%.

The second curve (white square) started with a decrease from about 38% to 0% on the third. The following day rose to 50%, with a slight decline to 38% on day 5, only to peak on the sixth day at 65%. From day 7 to 16 the curve generally stayed between 20% and 50%, with the only being day 11, when it dropped to 10%. Days 7 through 12 showed daily fluctuations, while days 13 to 16 a steady increase occurred from 20% to 50%. The seventeenth day showed a dramatic descent to 0%, which rose the last day to 50%.

The third time-period (white triangle) began at about 50%, and slowly fell the first few days to 5%. Leading to the seventh day, the curve steadily rose back to 50%., where it fluctuated for two more days between 35% and 50%. On day 10 the activity declined to about 25% and climbed again the following day to about 75%. Days 12 through 14 stayed around 40%. After which the started to strongly vacillate between 60% (day 15, 17) and 40% (day 16). The last day showed another decrease in activity to about 10%.

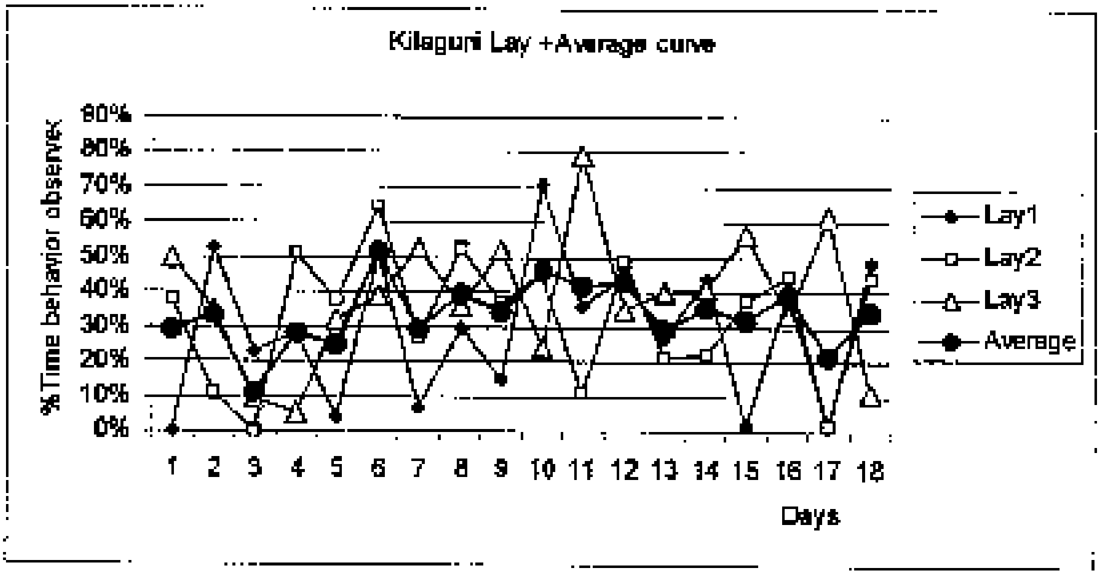


Diagram 49: Behavioral curves for Kilaguni. Data points show the amount of time Kilaguni spent, each observation period lying and the corresponding average points. Lay1: Curve of days within Kilaguni's first time-period; Lay2: Curve of days within Kilaguni's second time-period; Lay3: Curve of days within Kilaguni's third time-period; Average: Average curve of the daily data points.

Through the average curve (diagram 49), it could be seen that overall there were no large fluctuations in Kilaguni's behavior lying.

Besides two dips (day 3 at approx. 10% and day 17 at 20%) and one peak (day 6 at about 55%) the curve generally stayed between 30% and 50%.

3.4.2 Morning/Afternoon Separations

3.4.2.1 Sita

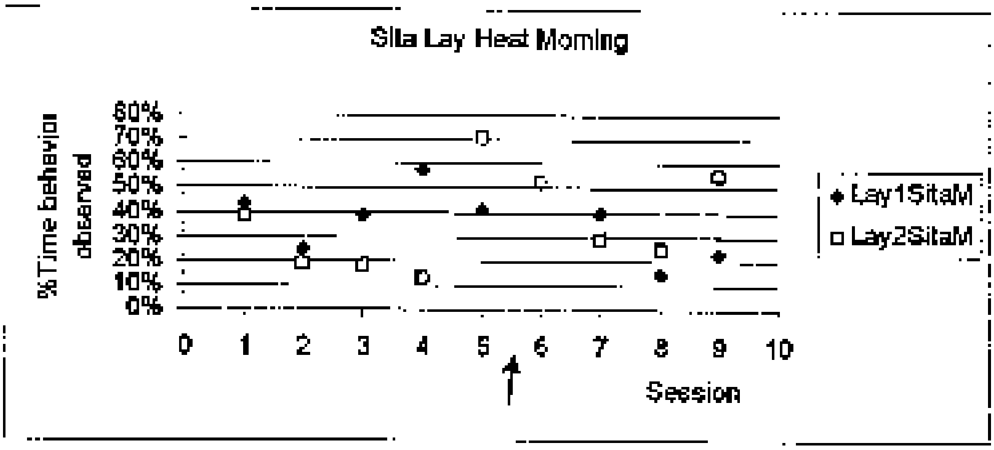


Diagram 50: Data points represent the percentage of time Sita lying on each morning of observation during the time period previously discussed. Here, estrus lies between days 5 and 6, which means peak receptivity lies on an afternoon session. Lay1SitaM: Morning observations of Sita surrounding her first estrus; Lay2SitaM: Morning observations of Sita surrounding her second estrus.

The curve of Sita's first heat cycle (black diamond) began around 45% and dropped to 25% during session 2, slowly rising to rise to approx. 60% in session 4 (diagram 50). From this point on, the curve slowly started to fall reaching 20% for the last two sessions.
The second heat cycle (white square) similarly began around 40%, but declined toward session 4 to 15%. The day before estrus (estrus being between days 5 and 6)a rise to 70%occurred. After estrus the curve again slowly decreased to 25%, rising one last time during session nine to 55%.

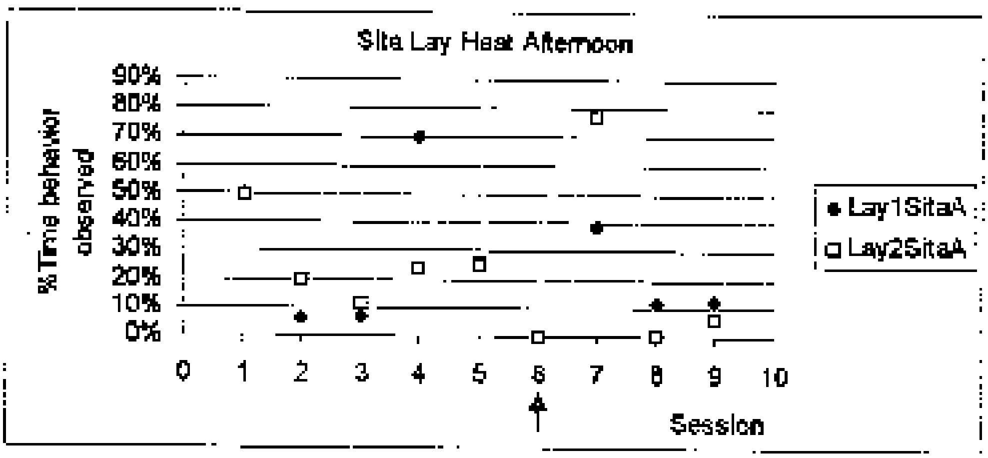


Diagram 51: Data points represent the percentage of time Sita lying on each afternoon of observation during the time period previously discussed. Here, estrus lies on day 6. Lay1SitaA: Afternoon observations of Sita surrounding her first estrus; Lay2SitaA: Afternoon observations of Sita surrounding her second estrus.

For the afternoon sessions (diagram 51), the curve of the first heat cycle (black diamond) began at 50% and fell to about 5%, at which it stayed for two days. The fourth day showed a peak at ~70%, which slowly began to decline to 0% towards the day before estrus (day 6). The day after peak receptivity showed another increase at 40%, which ended at 15% for the last two sessions.

The second curve (white square) also started at 50% and gently fell to 10% on day 3. Days 4 and 5 were steady at approx. 25% and again during estrus no lying was evident. Here the peak after estrus was greater (at 80%), but similarly to curve one it dropped sharply to end between 0% and 5% for the remaining days.

3.4.2.2 Ine

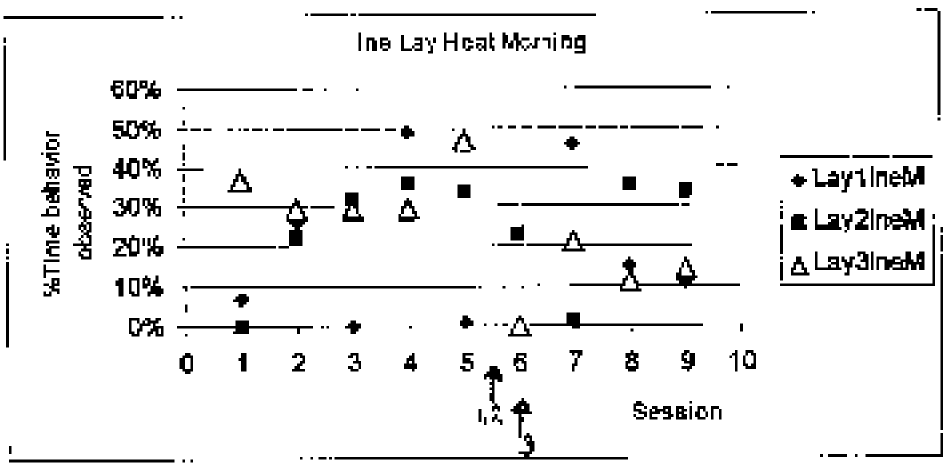


Diagram 52: Data points represent the percentage of time Ine lying on each morning of observation, during the time period previously discussed. Here, estrus lies between sessions 5 and 6 for curves 1 and 2, which means peak receptivity lies on an afternoon session. For curve 3 estrus lies in session 6. Lay1IneM: Morning observations of Ine surrounding her first estrus, Lay2IneM: Morning observations of Ine surrounding her second estrus; Lay3IneM: Morning observations of Ine surrounding her third estrus.

The first curve of the morning session (diagram 52, black diamond), on the other hand, was almost continuously increasing and then decreasing again, starting at 5%, rising to 22% and falling again to 0%. The fourth session showed a larger peak at 50%, which fell the next day almost to 0% and stayed there for the sixth session. The next peak occurred on the seventh day at 45% and the last two sessions stayed steady at about 10%.
Curve two (white square) showed a hill starting on the first morning session at 0%, rising to 38% during the fourth session, after which time it began to fall back to 0% during session 7. The last two sessions leveled out at 38%.
The third curve (white triangle) started at approx. 38%, staying steady for three sessions and then climbing to around 45% during the fifth session. Session 6 was the day of the day peak receptivity and no lying was recorded. The last three session stayed steady around 10 % and 20%.

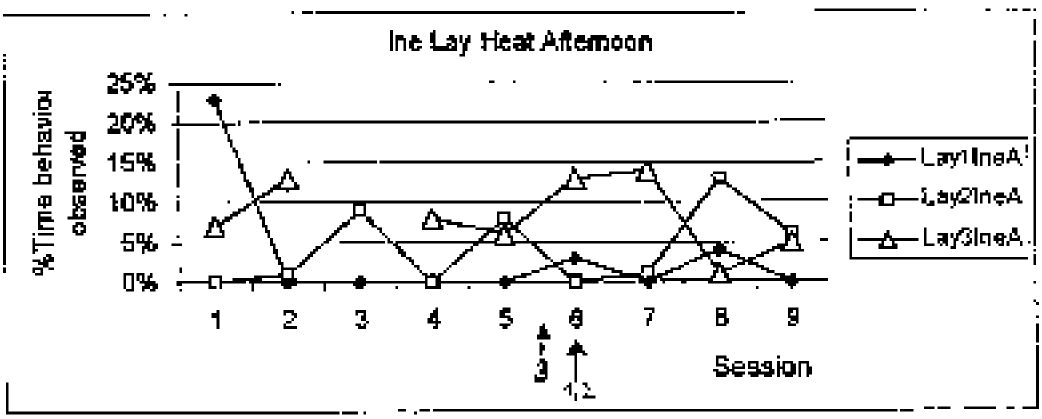


Diagram 53: Data points represent the percentage of time Ine lying on each afternoon of observation, during the time period previously discussed. Here, estrus lies between sessions 5 and 6 for curve 3, which means peak receptivity lies on a morning session. For curves, 1 and 2 estrus lies in session 6. Lay1IneA: Afternoon observations of Ine surrounding her first estrus; Lay2IneA: Afternoon observations of Ine surrounding her second estrus; Lay3IneA. Afternoon observations of Ine surrounding her third estrus.

Curves 1 and 2 showed estrus on day 6 during the afternoon sessions (diagram 53).
The first curve (black diamond) stayed between 0% and 5% during most observations, the exception being the first session (23%).
The second (white square) differed from the first in three peaks, on day 3 and 4 at approx. 10% and day 8 at ~13%. Otherwise, it too stayed around 0% and 5%.
The third curve (white triangle) differed, in that it stayed at a higher level. The first sessions showed a small increase from about 6% to approx. 13%. Sessions 4 and 5 stayed around 6% and an increase was observed during session 6, at about 13 % (estrus took place between session 5 and 6). From the height of 13% during session 7, the curve fell to between 0% and 5%, as observed with the other curves.

3.4.2.3 Kilaguni

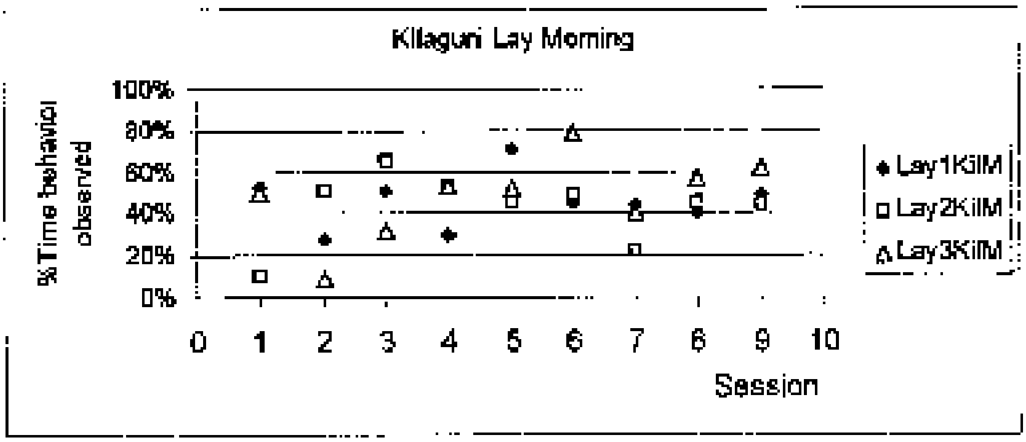


Diagram 54: Data points represent the percentage of time Kilaguni lying on each morning of observation, during the time period previously discussed. Lay1KilM: Morning observations of Kilaguni during her time-period; Lay2KilM: Morning observations of Kilaguni during her second time-period; Lay3KilM: Morning observations of Kilaguni during third time-period.

As with all of Kilaguni's other behavior patterns, lying was different for each time-period (diagram 54).

The first curve (black diamond) fluctuated between 50% and 30% from morning 1 to 4, then increased to about 70% during session 5. From session 6 onward the curve stayed steady around 40% for the remaining sessions.

The second curve (white square) showed a sloping increase from 10% to about 65% between session 1 and 3. Then it slowly declined to 50% in session 6, and, showing a slight dip in the seventh session (25%), to return to approx. 45% for the remaining sessions.

The curve for third time-period (white triangle) fell from 50% during the first session to about 10% during the second session. After second morning, a steady was observed until session 6, when it peaked at 80%. After a sharp decline to 40% the following day it increased again the last two sessions 60%.

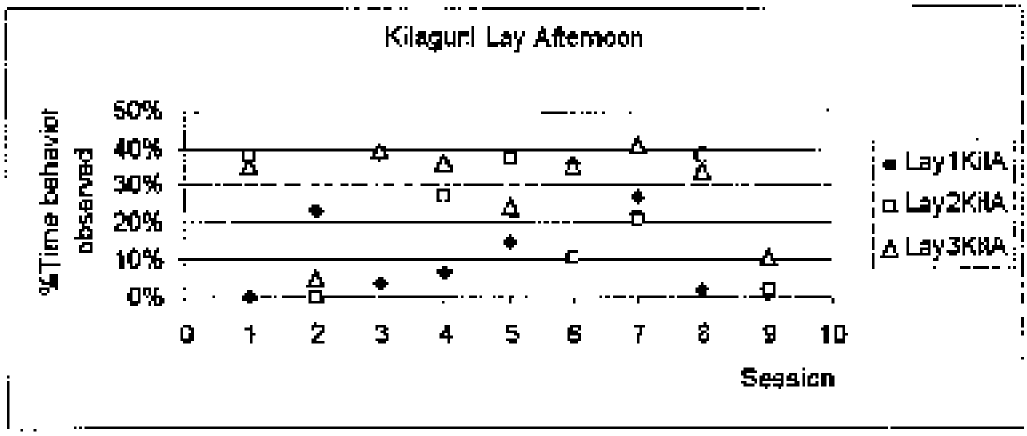


Diagram 55: Data points represent the percentage of time Kilaguni lying on each afternoon of observation during the time period previously discussed. Lay1KilA: Afternoon observations of Kilaguni during her time-period; Lay2KilA: Afternoon observations of Kilaguni during her second time-period; Lay3KilA: Afternoon observations of Kilaguni during third time-period.

During the afternoon sessions (diagram 55), Kilaguni did not lay as much she did during the morning session.

The first time-period (black diamond) started at 0% and climbed to 25% (day 2), only to decrease to 5% during session 3. From session 3 to 6, lying steadily increased to 35%, after which it slowly fell again to 0% during session 9.

The second (white square) and third curve (white triangle) began identically. During the first afternoon, both curves were around 35% and fell on the second afternoon to about 5%. The third session showed a rise in both curves to 40%, after which the similarities ended. The second time-period wavered between 30% and 40% and dropped during session 6 to 10%. From afternoon 6 to 8, lying increased again to ~40% and fell to 0% during the last session. The third curve, on the other hand, slowly declined to about 25% during session 5, then consistently increased to 40% on afternoon 7 and again steadily declined to 10% (session 9).

To summarize the results in the behavior lay:

Site: Two peaks were observed, one before estrus and one after estrus, both around 70%. On the day of estrus itself, no activity was recorded in either curve. In the morning and afternoon separation, it was evident that all curves were different, and one could not assume a dependence of this behavior on the time of day the observations were made.

Ine: Two peaks were observed before estrus (in two different curves), and one peak was observed after estrus (in the first curve). The third curve showed no peaks. All curves coincide in the fact, that on the day of peak receptivity very little to no lying was seen. In Ine's case, there was definitely a difference in the behavior shown in the morning as opposed to the afternoon. The curves for the morning sessions were usually situated between 0% and 35%, whereas the afternoon session tended to fluctuate greatly.

Kilaguni: All curves fluctuated with large amplitudes and at different percentages. This leads to the conclusion that all curves were different from each other.

3.5. Smell

3.5.1 Daily Observations and Average Curve

3.5.1.1 Sita

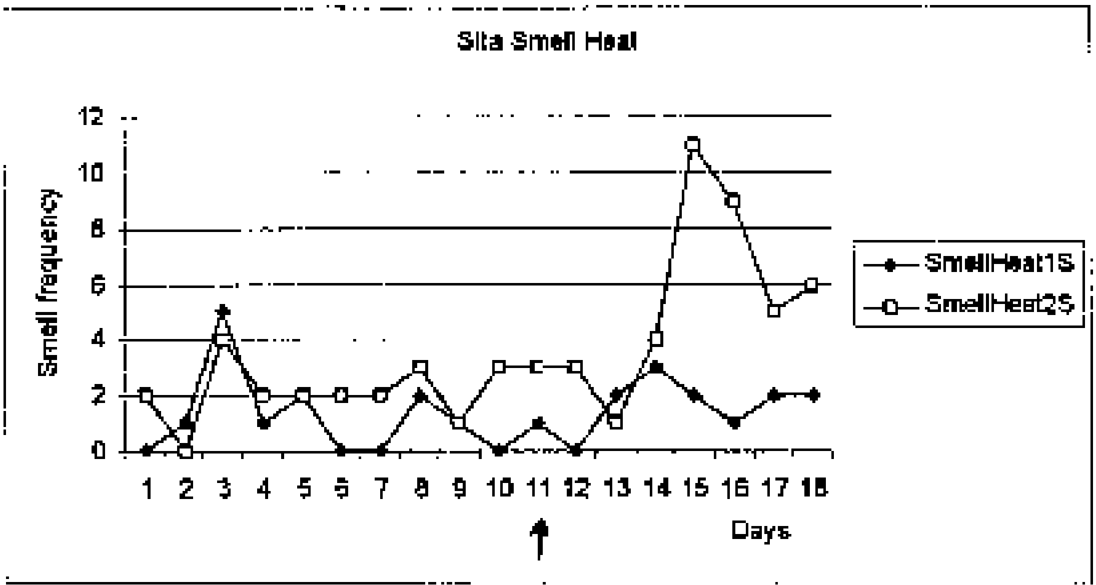


Diagram 56: Behavioral curves for Sita with peak receptivity on day 11. Data points depict how often the behavioral pattern "smell" was observed each day.
SmellHeat1S: Curve of days surrounding Sita's first estrus; SmellHeat2S: Curve of days surrounding Sita's second estrus.

Curve 1 (diagram 56, black diamond) showed an interesting peak on day 3, with a smell frequency of five for the day. The rest of the curve wavered between zero and two. Estrus did not show a heightened smelling activity. The only other time smelling did not reach over the level of two was on day 14 with a frequency of three.

The beginning of the second curve (white square) resembles the first, with heightened activity on day 3 (smell frequency of four). This curve, however, stayed between one and three for most of the observation period, even the day of peak receptivity, showed no clear difference to the previous days, staying at a level of two during the observation. Starting on the fourteenth day, a sharp peak in smelling began, and reached its zenith on day 15 at a smell frequency of eleven. The following days likewise showed a heightened activity, however, the curve slowly dropped off on day 16 (to nine) and 17 (to seven) and picked up only slightly on the next day (to eight).

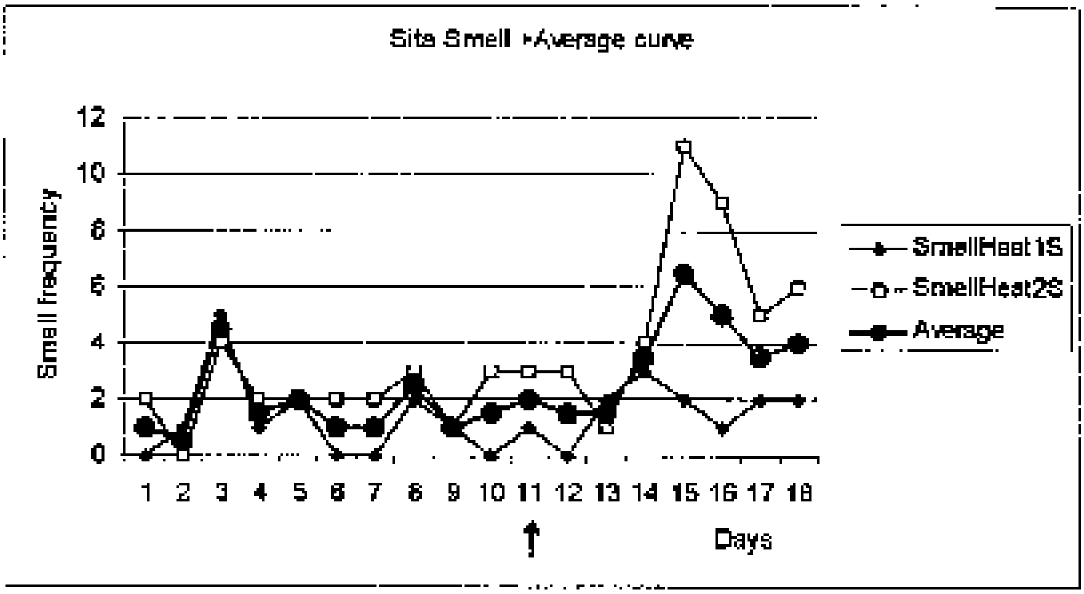


Diagram 57: Behavioral curves for Sita with peak receptivity on day 11. Data points depict how often the behavioral pattern "smell" was observed each day and the average of each days observations. SmellHeat1S: Curve of days surrounding Sita's first estrus; SmellHeat2S: Curve of days surrounding Sita's second estrus; Average: Curve of the average of each days data points.

In this instance, the average curve (diagram 57, black circle) did not clarify the situation any better than was previously discussed.

The curve began at a smell frequency of approx. one and climbed to 4.5, then fell back again to stay between zero and two until the fourteenth day. Thereupon, it started to rise towards a zenith of 6.4 on the fifteenth day, followed by a slow decrease, to end at frequency of four on day 18.

3.5.1.2 Ine

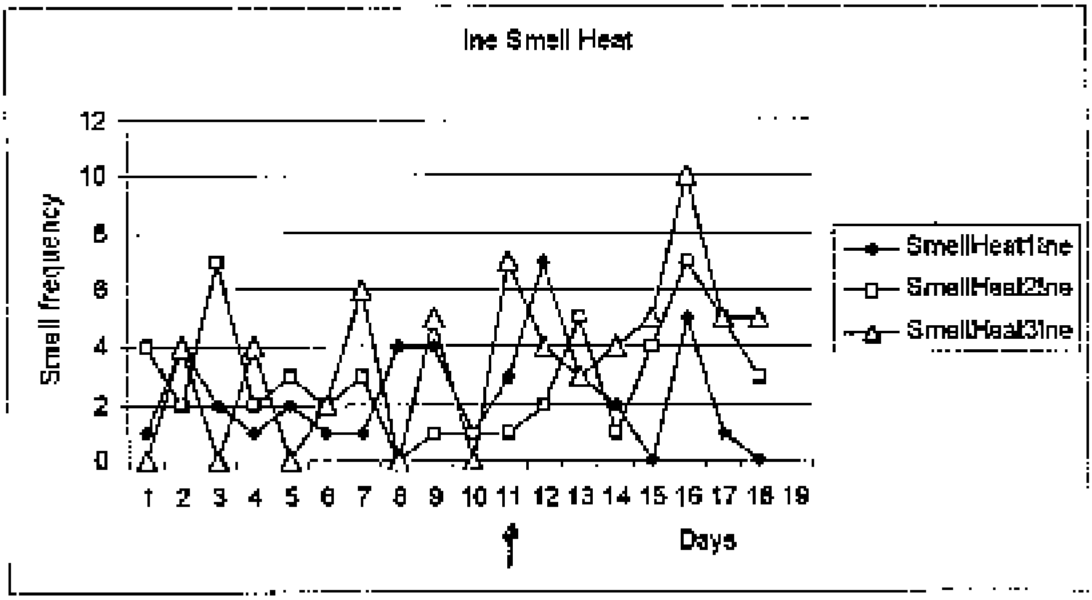


Diagram 58: Behavioral curves for Ine with peak receptivity on day 11. Data points depict how often the behavioral pattern "smell" was observed each day. SmellHeat1Ine: Curve of days surrounding Ine's first estrus; SmellHeat2Ine: Curve of days surrounding Ine's second estrus; SmellHeat3Ine: Curve of days surrounding Ine's third estrus.

For Ine, all three curves appeared distinct from the other (diagram 58).
The first curve (black diamond) started at a level of one and climbed to four the second day. After this, it fell again, to stay between one and two until day 7. Days 8 and 9 showed a smell frequency of four, which tentatively dropped on the day prior to estrus to one. The day of peak receptivity was the beginning of an increase, which reached its zenith the day after estrus at a frequency of seven. After the first peak, the curve slowly fell to zero on day 15 and rose again to peak at five on the sixteenth day. The last two days showed a renewed decrease to end at zero.
The second curve (white square)began with a drop from four to two and did not peak until day 3 at a frequency of seven. From the fourth to seventh day, smelling wavered between a frequency of two and three, and declined to zero on day 8. Between days 9 and 11, smelling stayed steady at a level of one and began to rise the day after estrus, to peak at five on the thirteenth day. This was followed by a dip to one, and another rise, which peaked at a frequency of seven on day 16. Similar to the first curve, days 17 and 18 slowly decreased, ending at a level of three.
The third curve (white triangle) was different in nature from the other two curves, in that it tended to fluctuate more. Starting at zero, the curve vacillated until day 5 between zero and

four. The sixth day the curve began to rise and peaked the following day at a smell frequency of six. After this, the curve declined again to zero on the eighth day, only to increase again to five on day 9. The day prior to estrus showed a frequency of zero, and estrus itself showed a peak at a level of seven. Estrus was followed by a small dip in the curve (day 13 at a level of three), which rose again to peak on day 16 at a frequency of ten. The seventeenth and eighteenth days stayed at five.

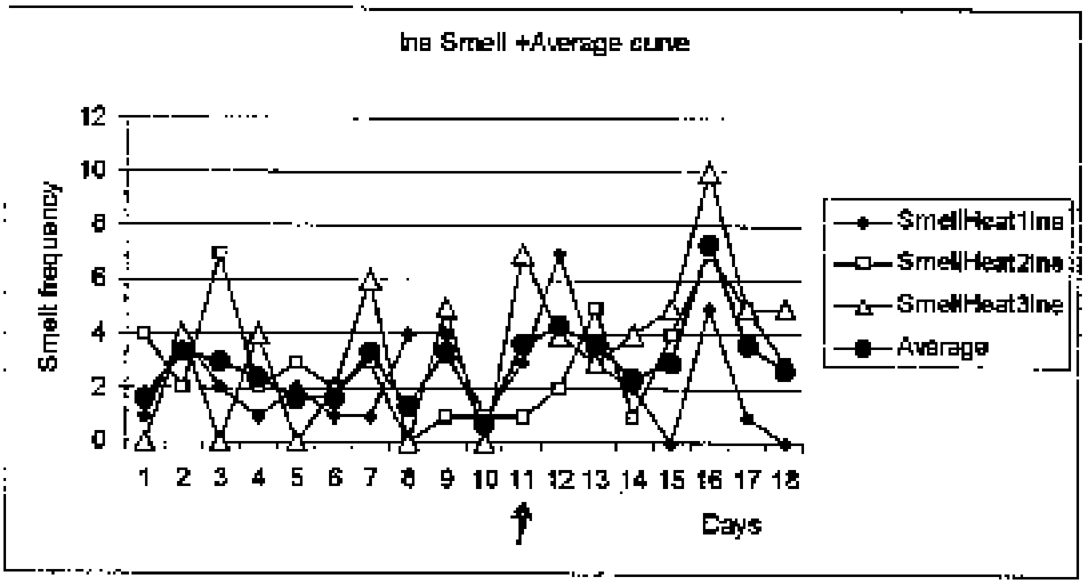


Diagram 59: Behavioral curves for Ine with peak receptivity on day 11. Data points depict how often the behavioral pattern "smell" was observed each day and the average of each days observations. SmellHeat1Ine: Curve of days surrounding Ine's first estrus; SmellHeat2Ine: Curve of days surrounding Ine's second estrus; SmellHeat3Ine: Curve of days surrounding Ine's third estrus; Average: Curve of the average of each days data points.

The average curve (diagram 59, black circle) stayed steady throughout the observation, remaining between a level of one and four from the first day to the fifteenth. Only day 16 showed a larger peak at a frequency of 7.5, which fell again during the last two days to join all other data points, between one and four.

3.5.1.3 Kilaguni

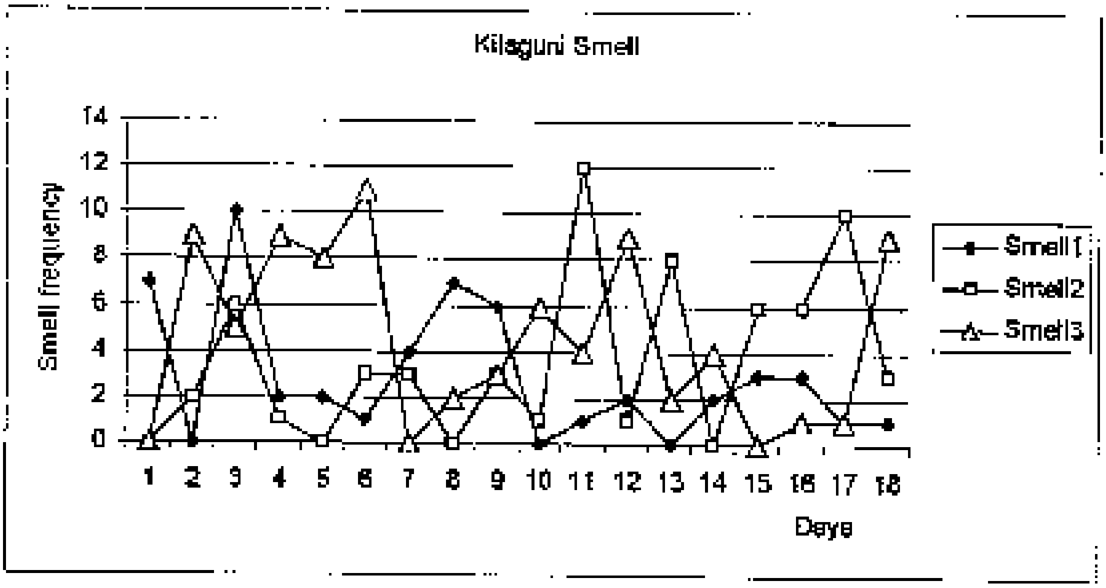


Diagram 60: Behavioral curves for Kilaguni. Data points depict how often the behavioral pattern "smell" was observed each day. Smell1: Curve of days during Kilaguni's first time-period; Smell2: Curve of days during Kilaguni's second time-period; Smell3: Curve of days during Kilaguni's third time-period.

As with the previously discussed behavior patterns, Kilaguni's curve (diagram 60) demonstrated a wide range in the data points, and each curve had no similarities to the others.

The curve for the first time-period (black diamond) began at a frequency of seven and fell to zero on day 2, only to soar to a level of ten on the third day. The next three days (4,5 and 6) stayed around one and two and the curve then began to climb and peak on the eighth day, at a frequency of seven. After this peak, the curve started to descend to zero on day 10, from which point on it stayed between zero and two. The exception being days 15 and 16, reaching a level of three.

The second curve (white square), slowly rose to a frequency of six on day 3, after which it fell to waver between zero and three until the tenth day. A sharp ascent occurred on day 11 to a frequency of twelve, which descended again to one the following day. The thirteenth day peaked at a level of eight, which was followed by a decrease to zero. Days 15 and 16 stayed steady at a level of six, after which the curve peaked again at a frequency of eight and ended the time-period at a level of three.

The last time-period (white triangle) began at a level of zero and rose to nine on the second day. Thereafter the curve fell to five on day 3, then fluctuated between eight and nine on days

4 and 5. Finally, it peaked at a frequency of eleven on the sixth day (the highest point of the curve), after which the curve returned to zero (day 7). Another slow climb ensued and reached its zenith on day 12 at a level of nine, after which it descended to two. Day 14 showed a small increase to four, which was followed by a decrease in the curve and ultimately to fluctuations between one and zero until day 17. The last day peaked again at a frequency of nine.

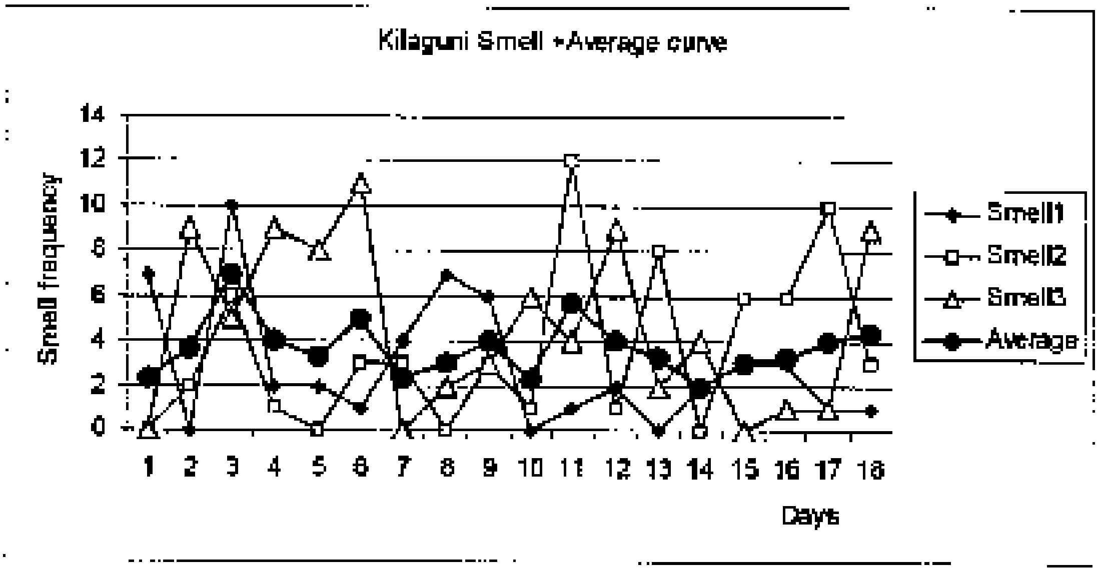


Diagram 61: Behavioral curves for Kilaguni. Data points depict how often the behavioral pattern "smell" was observed each day and the average of each days observations. Smell1: Curve of days during Kilaguni's first time-period; Smell2: Curve of days during Kilaguni's second time-period;Smell3: Curve of days during Kilaguni's third time-period; Average: Curve of the average of each days data points.

Generally, the average curve (diagram 61, black circle) stayed between a level of two and four, however occasional exceptions did occur. The third day peaked at a frequency of seven, day 6 showed a frequency of five and the eleventh day peaked at 5.5. Otherwise, the curve fluctuated in gentle waves over a period of several days.

3.5.2 Morning/Afternoon Separation

3.5.2.1 Sita

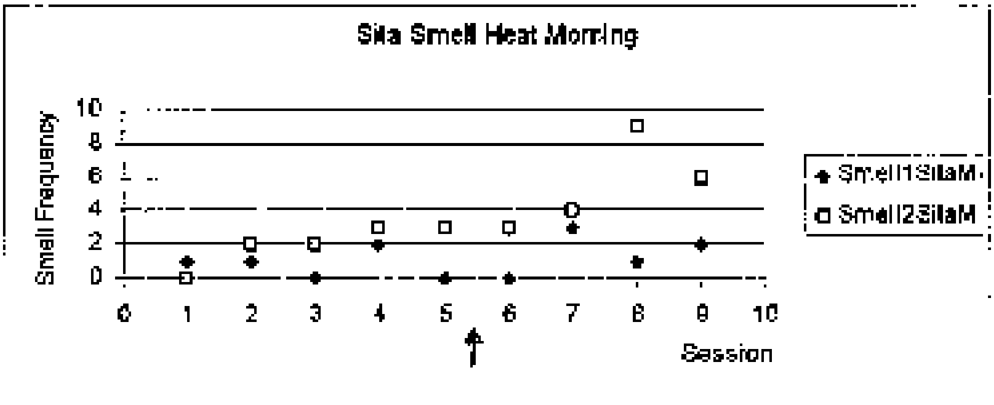


Diagram 62: Data points the frequency with which Sita was observed "smelling" each morning of observation during the time period previously discussed. Here, estrus lies between days 5 and 6, which means peak receptivity lies on an afternoon session. Smell1SitaM: Morning observations of Sita surrounding her first estrus; Smell2SitaM: Morning observations of Sita surrounding her second estrus.

In the morning sessions (diagram 62), the first curve (black diamond) stayed between zero and two, with the exception of session 7, which rose to a frequency of three.
Curve 2 (white square) started at a level of zero, then rose to two, and increased to three during session 4. It stayed at this level until session 7, at which time the curve started to climb and ultimately peaked at a frequency of nine during session eight. Leading to the ninth session the curve decreased and ended at a level of six.

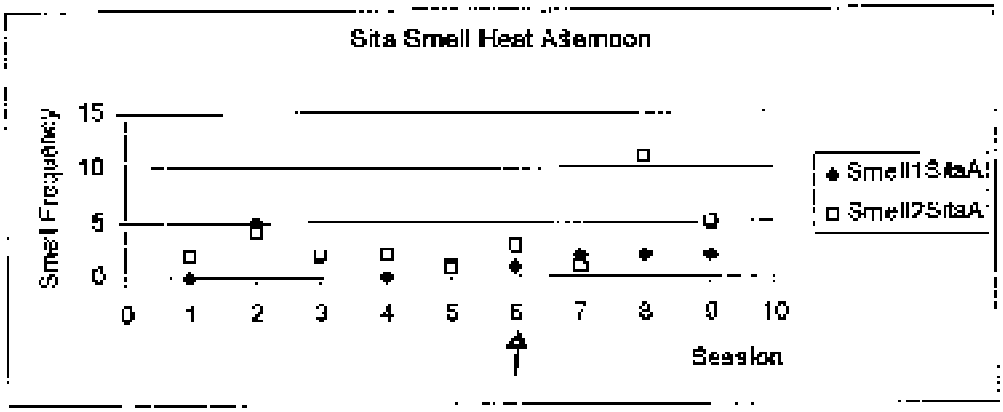


Diagram 63: Data points the frequency with which Sita was observed "smelling" each afternoon of observation, during the time period previously discussed. Here, estrus lies on day 6. Smell1SitaA: Afternoon observations of Sita surrounding her first estrus; Smell2SitaA: Afternoon observations of Sita surrounding her second estrus.

In the afternoon sessions (diagram 63), the first curve (black diamond) peaked during the second session at a frequency of five, otherwise the curve stayed between zero and two during each session.

The second curve (white square) showed a small peak during the second session, at a level of four, but otherwise stayed between one and three until session 8. At this time, the curve peaked at a frequency of eleven, after which it decreased again, to end the observation period at a level of five.

3.5.2.2 Ine

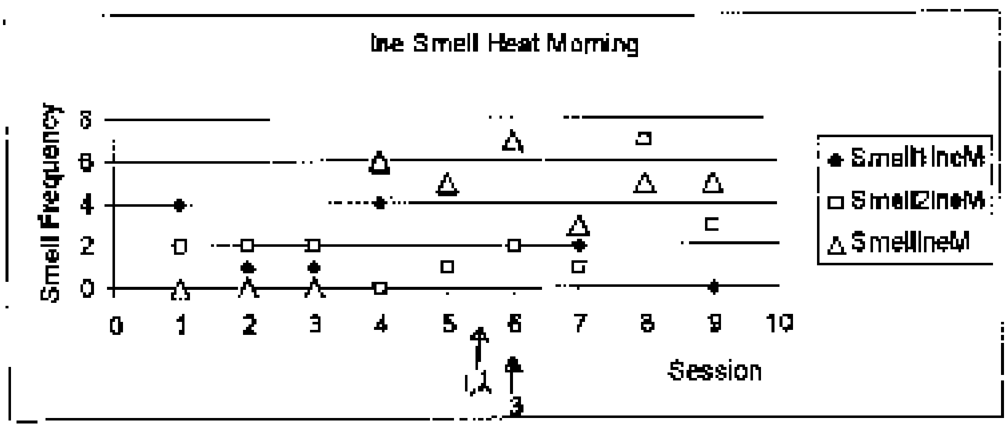


Diagram 64: Data points the frequency with which Ine was observed "smelling" each morning of observation, during the time-period previously discussed. Here, estrus lies between days 5 and 6 for curves 1 and 2, and during session 6 for curve 3. Smell1IneM: Morning observations of Ine surrounding her first estrus; Smell2IneM: Morning observations of Ine surrounding her second estrus; Smell3IneM: Morning observations of Ine surrounding her third estrus.

Ine's behavioral pattern is much more varied than Sila's was, when looking at the separation of morning (diagram 64) and afternoon (diagram 65) sessions.

The first curve (black diamond) started at a frequency of four, then dropped to one during the following two sessions. The fourth session brought a small rise to the level of four and the fifth session (the day prior to estrus) found the curve returning to the level of one. The day after estrus (session 6), a sharp increase was recorded at a frequency of seven, which decreased during the next session to a level of two. Session 8 showed another peak at five, which declined during the last session, ending the curve with no activity.

The second curve (white square) did not fluctuate as much as the first, staying at the level of two for the first three sessions. Between sessions 4 and 7, a small waver was observed, with the curve rising from zero to the level of two (session 6), and declining slightly during the seventh session to one. Again, a sharp peak was observed during session eight at a frequency of seven, which fell during the last session to a level of three.

The third curve (white triangle) began with no activity during the first three sessions, which then increased to a frequency of six during the fourth session. From here, the curve fluctuated between six and seven, which was the highest point of the curve, in session 6. The seventh session saw a decrease to a level of three, after which the last two sessions showed an increase to a frequency of five.

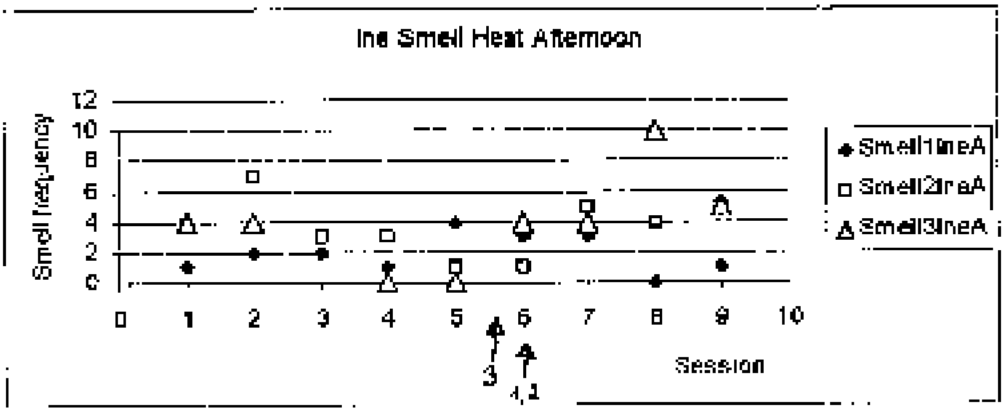


Diagram 65: Data points the frequency with which Ine was observed "smelling" each afternoon of observation, during the time period previously discussed. Here, estrus lies on between days 5 and 6 for curve 3, and on day 6 for curves 1 and 2.
Smell1IneA: Afternoon observations of Ine surrounding her first estrus; Smell2IneA: Afternoon observations of Ine surrounding her second estrus; Smell3IneA: Afternoon observations of Ine surrounding her third estrus.

In the afternoon sessions (diagram 65), the curves were not as erratic as in the morning sessions.

The first curve (black diamond) wavered between on and two for the first four sessions, then it climbed to a level of four during session 5. The curve then stayed steady at a frequency of three for two sessions, before declining to zero and one during the last sessions.

The second curve (white square) stared at a frequency of four and increased to seven during the second session. Thereafter, the curve slowly descended to a frequency of one, which it held on the day of estrus as well. Following estrus, the curve vacillated around five for the last three sessions.

The third curve (white triangle) began at a level of four the first two sessions. During sessions 4 and 5, it stayed at zero, then slowly began to rise over sessions 6 and 7, each at a level of four, to peak at a frequency of 10 during the eighth session. The last session showed another decrease and ended at a frequency of five.

3.5.2.3 Kilaguni

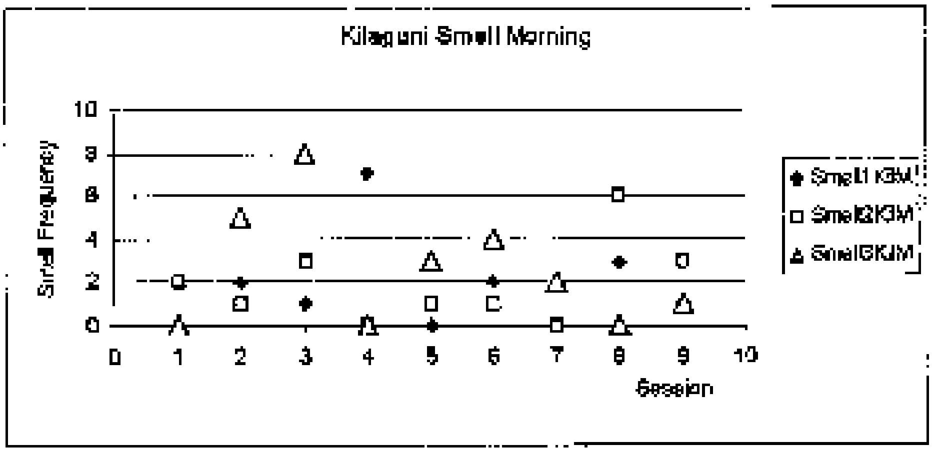


Diagram 66: Data points the frequency with which Kilaguni was observed "smelling" each morning of observation, during the time-period previously discussed.
Smell1KilM: Morning observations of Kilaguni during the first time-period;
Smell2KilM: Morning observations of Kilaguni during the second time-period;
Smell3KM: Morning observations of Kilaguni during the third time-period.

The curve of the first time-period (diagram 66, black diamond) tended to fluctuate between a level of zero and two through most of the observation period. The only exceptions to this were during session 4, when the curve peaked at a frequency of seven, and the eighth session, which reached three.

The second curve (white square) also stayed between zero and two most of the time, however during the third session it climbed to a level of three. Also session 8 and 9 were higher, peaking during the eighth session at a level of six and decreasing during session 9 to three.

The third curve (white triangle) started with no activity, but steadily rose to reach a frequency of eight during the third session. Thereafter it once more fell to zero. During session 4, the curve started to increase and peaked in the sixth session at a level of four. This was followed by a slow decline to zero (session 8), and another small rise during the last session, to end at a level of one.

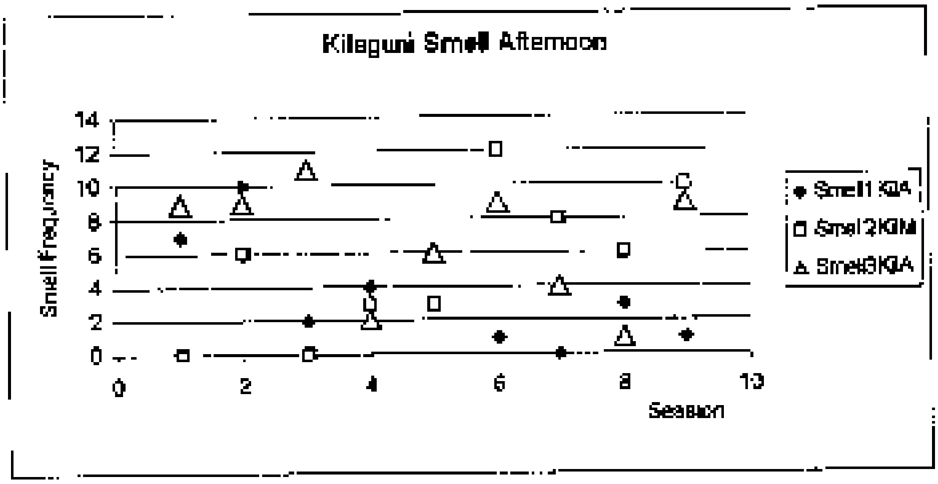


Diagram 67: Data points the frequency with which Kilaguni was observed "smelling" each afternoon of observation, during the time-period previously discussed.. Smell1KilA: Afternoon observations of Kilaguni during the first time-period; Smell2KilA: Afternoon observations of Kilaguni during the second time-period; Smell3A: Afternoon observations of Kilaguni during the third time-period.

During the afternoon sessions (diagram 67), each curve varied more and frequencies were generally higher than in the morning.

The first curve (black diamond) started at a frequency of seven and rose to ten during the second session. By the third session, the curve fell to a level of two. From there, it began a slow rise to six during session 5, only to descend again to a frequency of zero. During sessions 4 and 5, the curve stayed at the level of three, after which it climbed steeply to twelve during the sixth session. After this ascent, the curve declined to a frequency of six by the eighth session, and started to recover by the ninth session, ending at a level of 10.

The second time-period (white square) began at a level of zero, which increased to six during the second session, only to decline to zero in the following session. Sessions 4 and 5 showed the curve at a frequency of three, after which it climbed steeply to twelve during the sixth session. After this ascent, the curve declined to a frequency of six by the eighth session, and started to recover by the ninth session, ending at ten.

The third curve (white triangle), stayed steady for the first two sessions at a frequency of nine, rose slightly during the third session (to the level of eleven), and decreased rapidly to two during the fourth session. Thereafter, the curve slowly climbed to a height of nine during session 6, followed by a steady decline to a frequency of one in the eighth session. As before the last session showed an increase, this time ending at a level of nine.

To summarize the results of the behavior 'smell':

Sita: The first curve showed a peak on day three, while the second curve showed a larger peak on day 15. In the afternoon and morning separation, three of the four curves fluctuate, while the fourth curve (morning) slowly rises and peaks during session 8.

Ine: All three curves show a peak on day 16. Although they are not always the highest points of the curve, all curves showed similarities leading to and away from this peak. The separate morning and afternoon sessions generally fluctuated (each at different levels). Only the peaks on day 16 and in the third curve on the of estrus are discernible.

Kilaguni: All curves show fluctuations. Although peaks are visible in the morning and afternoon sessions, none of them coincides. Outside of these peaks, the curves fluctuate with large amplitudes.

3.6. Urinate

3.6.1 Daily Observations and Average Curve

3.6.1.1 Sita

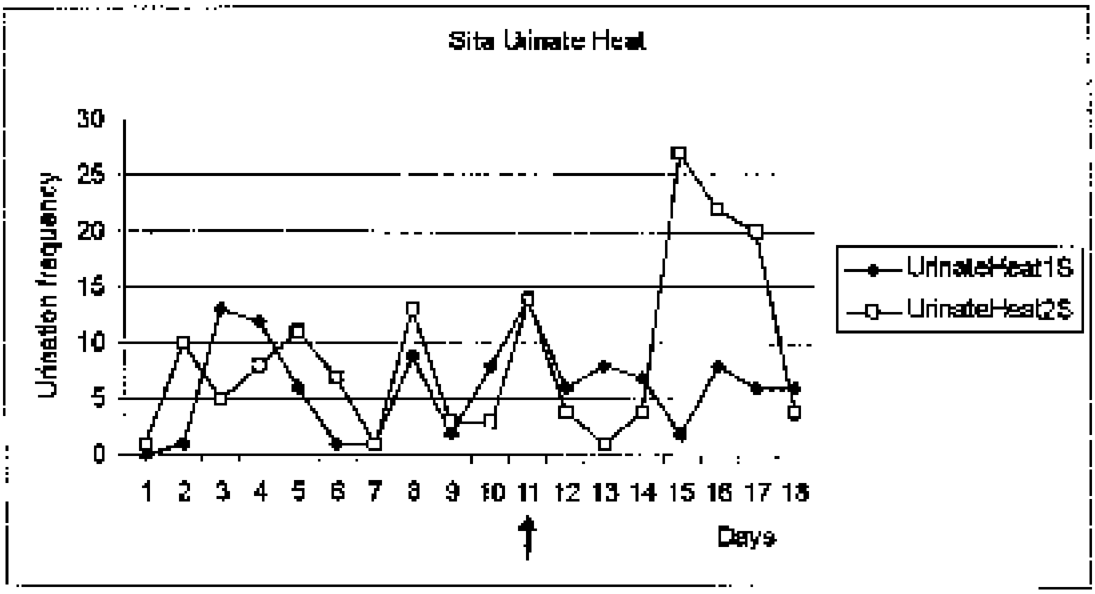


Diagram 68: Behavioral curves for Sita with peak receptivity on day 11. Data points depict how often the behavioral pattern "urinate" was observed each day. UrinateHeat1S: Curve of days surrounding Sita's first estrus; UrinateHeat2S: Curve of days surrounding Sita's second estrus.

The curve of the first heat cycle (diagram 68, black diamond) began at a frequency of zero and slowly increased to peak on day 3 to a level of thirteen. After this peak, the curve slowly decreased to reach a level of one for days 6 and 7. The eighth day showed a small peak at nine, which fell again to two the next day. The day prior to estrus a steady climb was evident, which reached its zenith on the day of peak receptivity at a frequency of fourteen (high point if the curve). After this the curve decreased to six on day 12, showed a small rise during days 13 (at a level of 8) and 14 (at a level of 7), which descended on the fifteenth day to two. The last three days stayed between a frequency of six and eight.

The second curve (white square) began with a frequency of one and rose to ten on day 2, but decreased again the following day to a level of five. After this, a steady rise was observed, that reached its zenith on the fifth day at a frequency of eleven. The curve slowly descended back to a level of one during the seventh day and peaked again the next day at a level of two. Days 9 and 10 saw the curve at a frequency of three, which was followed by another rise on the day of estrus to fourteen. After a slow drop to one on day 13, the curve rose again to its highest point on the fifteenth day at a frequency of twenty-seven. After this, the curve slowly decreased the last three days of the observation period to twenty-two, twenty and ending at a level of four.

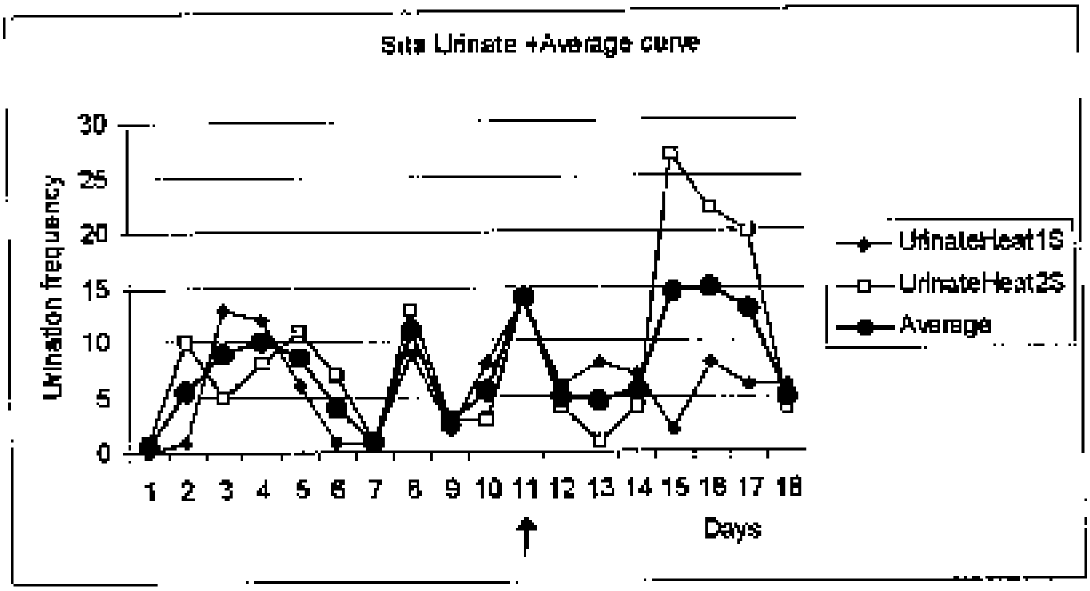


Diagram 69: Behavioral curves for Sita with peak receptivity on day 11. Data points depict how often the behavioral pattern "urinate" was observed each day and the average of each days observations. UrinateHeat1S: Curve of days surrounding Sita's first estrus; UrinateHeat2S: Curve of days surrounding Sita's second estrus; Average: Curve of the average of each days data points.

Studying the average curve (diagram 69, black circle), a small hill was apparent. It started at a level of zero on the first day, and slowly rose to ten during the fourth day, after which the curve slowly decreased again to reach a frequency of one on day 7. Furthermore, a peak was evident on day 8 at a level of eleven, as well as on the day of estrus (level of fourteen). After estrus, the curve stayed at a level of five for three days and showed another hill between the days 14 and 18. This hill began with a frequency of five, rose to fifteen on the sixteenth day, and returned to five on day 18.

3.6.1.2 Ine

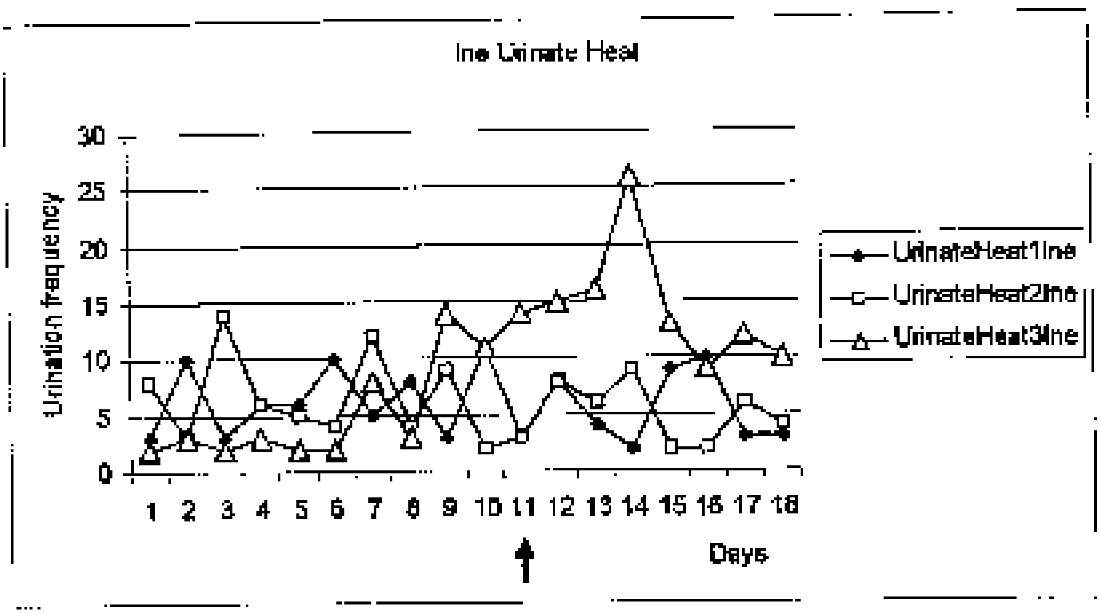


Diagram 70: Behavioral curves for Ine with peak receptivity on day 11. Data points depict how often the behavioral pattern "urinate" was observed each day. UrinateHeat1Ine: Curve of days surrounding Ine's first estrus; UrinateHeat2Ine: Curve of days surrounding Ine's second estrus; UrinateHeat3Ine: Curve of days surrounding Ine's third estrus.

For Ine's first heat cycle (diagram 70, black diamond), the curve began at a frequency of three and climbed to ten during the second day, after which it returned to three. Days 4 and 5 were steady at a frequency of six, and the curve stayed between the level of five and ten from day 4 through day 8. The ninth day showed another decline to three, which was followed by an increase to a frequency of eleven on day 10. During peak receptivity, the curve fell to a level of three, while the day after estrus it increased to eight. Following this rise, the curve declined to a level of three during the fourteenth day. This was followed by a rise to a frequency of nine and a peak of sixteen on day 10. During the last two days, the curve stayed steady at a level of three.

The second curve (white square) started with a decline from a frequency of eight to three (day 2), which turned into a peak of fourteen on day 3. Between days 4 and 6, a slow decrease could be seen from a level of six to four. The seventh day showed a peak at the frequency of twelve, at which the curve declined to four (day 8), only to climb to a level of nine on day 9. From days 10 to 13, estrus lying on day eleven, a slow rise increase form three to eight (day 12) was observed, with a slight decline on day 13 to a level of six. On the fourteenth day, a small rise to a frequency of nine occurred. During the last three days the curve stayed between a level of three (days 15 and 16) and six (day 17) ending at a level of four.

The last time-period (white triangle) fluctuated for six days between the frequency of two and three, then rose on the seventh day to a level of eight. After this, the curve decreased to three on day 8, which was followed by a small peak at a level of thirteen. From the tenth day, at a level of eleven, the curve began steady rise over four days to a frequency of sixteen. Thereafter a sharp ascent occurred on day 14 to a level of twenty-six. This was followed by a decline in the curve, which fluctuated between thirteen and nine the last four days.

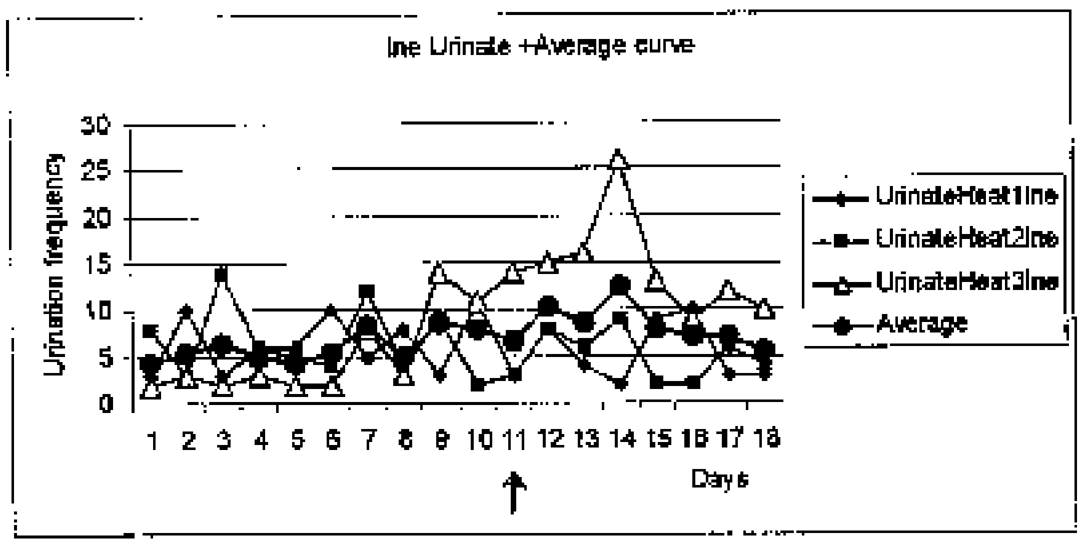


Diagram 71: Behavioral curves for Ine with peak receptivity on day 11. Data points depict how often the behavioral pattern "urinate" was observed each day and the average of each days observations. UrinateHeat1Ine: Curve of days surrounding Ine's first estrus; UrinateHeat2Ine: Curve of days surrounding Ine's second estrus; UrinateHeat3Ine: Curve of days surrounding Ine's third estrus; Average: Curve of the average of each days data points.

The average curve (diagram 71, black circle) for Ine's urination frequency was actually quite steady. For the first six days, the curve wavered between a frequency of four and seven. On the seventh day, a small peak was observed at a level of eight, which was followed by a drop to five. Days 9 through 11 showed a decrease from a frequency of nine to six. The twelfth and thirteenth days had a frequency of eleven and nine respectively, while day 14 reached the highest point of the curve at a level of thirteen. From days 15 to 18, a steady decrease set in from eight to six.

3.6.1.3 Kilaguni

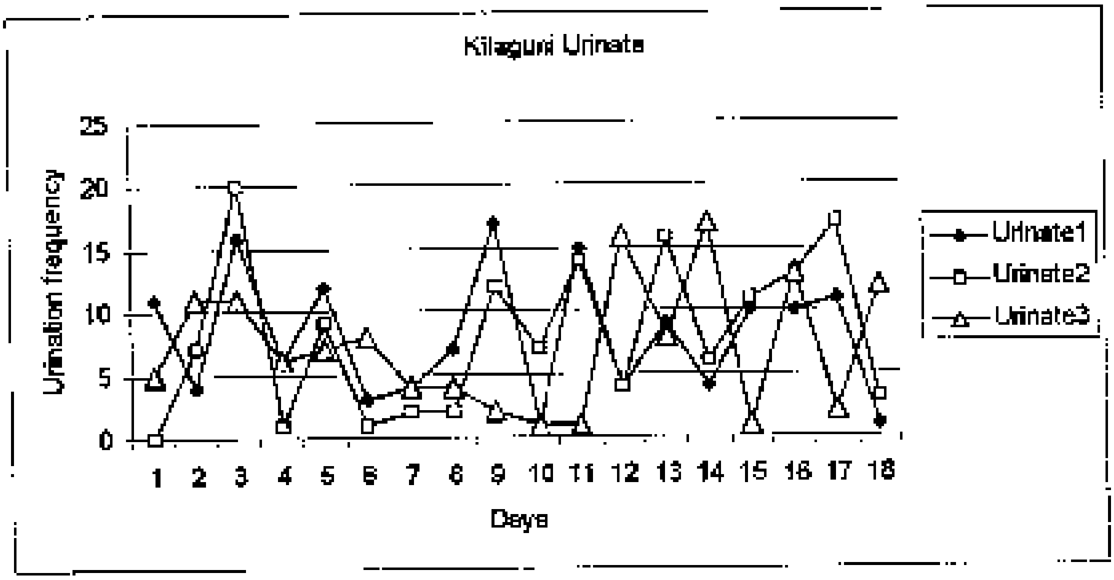


Diagram 72: Behavioral curves for Kilaguni. Data points depict how often the behavioral pattern "urinate" was observed each day. Urinate1: Curve of days during Kilaguni's first time-period; Urinate2: Curve of days during Kilaguni's second time-period; Urinate3: Curve of days during Kilaguni's third time-period.

For Kilaguni the urination curves were mostly not as regular as with the other females (diagram 72).

The first curve (black diamond) started at a frequency of eleven, which dropped to a level of four the following day, only to rise on day 3 to sixteen. After this, the curve decreased to six and increased on day 5 to a level of twelve. From the sixth to the ninth, a slow ascent was evident from a level of three to peak at seventeen, the highest point of the curve. Day 10 showed another decline to a level of one, after which an increase to a frequency of fifteen occurred the next day. From days 12 to 15, the curve fluctuated between four and ten. Leading to the seventeenth day, a rise was observed form a level of ten to eleven, which dropped during the last day to a frequency of one.

The second curve (white square) was similary erratic, starting with no activity, but peaking on the third day at a frequency of twenty. This was followed by an immediate decrease the next day to a level of one. The fifth climbed to a frequency of nine, after which the curve returned to one. The curve then stayed between a level of one and two for the next three days (6 through 8) and started vacillating again on day 9. These fluctuations showed an increasing amplidude from day to day, starting at a frequency of twelve on day 9 and falling to seven on the tenth day. On the eleventh day the curve climbed to a level of fourteen and decreased again the following day to four. Day 13 rose again to a frequency of sixteen, which dropped the next day to six. Between the days 14 and 17, a steady rise was observed from the level of six to peak at seventeen. The last day dropped to a level of three.

The last curve (white triangle) began with a small rise, from a frequency of five to eleven on days 2 and 3. Between days 4 and 6, the curve slowly rose from a level of six to eight. Starting on the seventh day and leading to the eleventh day, the curve slowly dropped from a level of four to one, after which it climbed to a peak of sixteen (day 12). This was followed by a decrease in the curve to eight, which led to the highest point of the curve, a frequency of seventeen, on day 14. The fifteenth day descended again to a level of one, and day 16 showed an ascent to thirteen. Similarly, day 17 declined to a frequency of two, which was followed by another rise on the last day at a frequency of twelve.

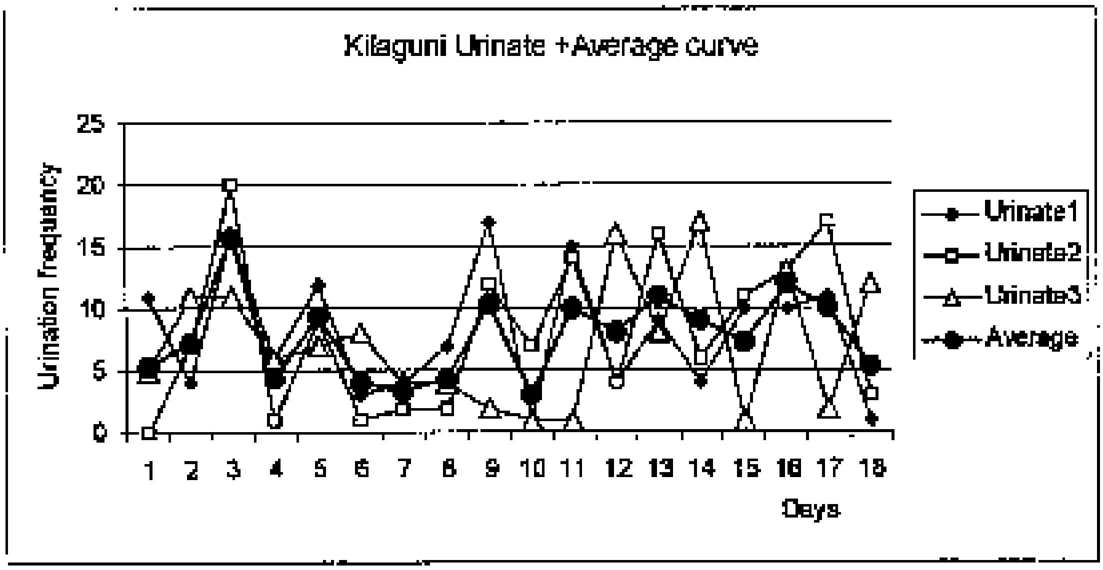


Diagram 73: Behavioral curves for Kilaguni. Data points depict how often the behavioral pattern "urinate" was observed each day and the average of each days observations. Urinate1: Curve of days during Kilaguni's first time-period; Urinate2: Curve of days during Kilaguni's second time-period; Urinate3: Curve of days during Kilaguni's third time-period; Average: Curve of the average of each days data points.

As would be expected form such dissimilar curves, the average curve was also quite erratic. It began with an increase from a frequency of six to sixteen (day 3), after which the curve vacillated between a level of four and nine until day 6. The seventh day showed a slight decrease to three. Thereafter the curve rose again to peak on day 9 at a level of eleven. The tenth day, the lowest point of the curve was reached (a frequency of three), after which the curve fluctuated between a level of seven and twelve. The last day ended with a drop to six.

3.6.2 Morning/Afternoon Separation

3.6.2.1 Sita

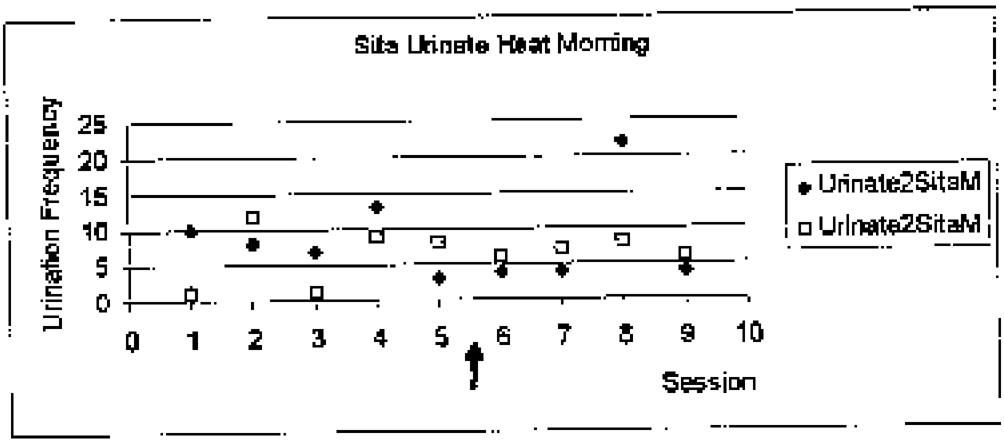


Diagram 74: Data points the frequency with which Sita was observed "urinate" each morning of observation, during the time period previously discussed. Here, estrus lies between days 5 and 6, which means peak receptivity lies on an afternoon session. Urinate1SitaM: Morning observations of Sita surrounding her first estrus; Urinate2SitaM: Morning observations of Sita surrounding her second estrus.

During the morning session (diagram 74), the first curve (black diamond) slowly decreased from a level of ten to seven during the third session. Session 4 showed a small peak at a frequency of thirteen, which was followed by a decrease to three. Sessions 6 and 7 stayed steady at a frequency of four, before the curve leapt to a zenith of twenty-two during session 8. In the ninth session, the curve returned to a level of four.

The second curve (white square) started at a level of one and increased to twelve during the second session. After this peak, the curve wavered for the remaining sessions between six and nine.

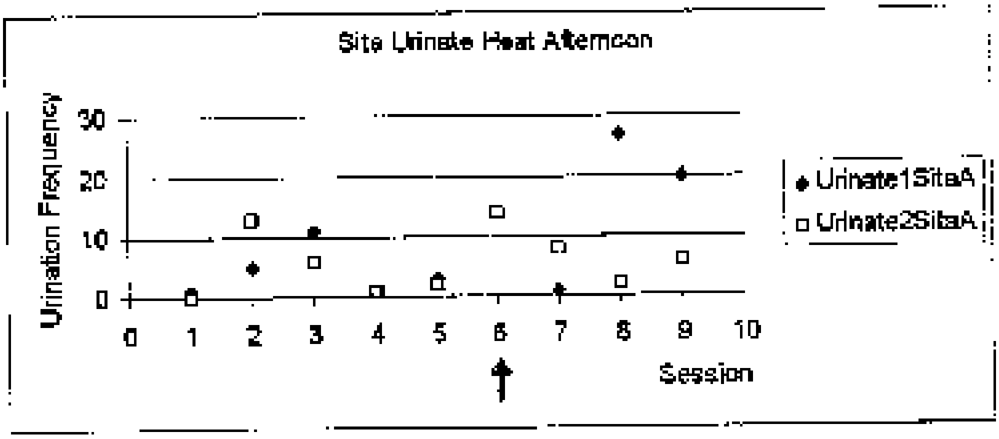


Diagram 75: Data points the frequency with which Sita was observed "urinating" each afternoon of observation, during the time period previously discussed. Here, estrus lies on day 6. Urinate1SitaA: Afternoon observations of Sita surrounding her first estrus, Urinate2SitaA: Afternoon observations of Sita surrounding her second estrus

The afternoon curves (diagram 75) showed a little more variation, with curve 1 (black diamond) starting at a level on one and steadily climbing to eleven during session three. This was followed by a dip in the curve during sessions 4 (a level of one) and 5 (a level of three), and another peak in the sixth session (estrus) at a frequency of fourteen. Session 7 declined again to one, only to peak the next session at a level of twenty-seven. The last session showed only a slight decrease to twenty.

The second curve (white square) began without activity and climbed in session 2 to a level 13. After this, the curve dipped for three sessions from a level six to one and back to a level of two. This started a peak during session 6 (estrus) at the frequency of fourteen. After this peak, the curve slowly decreased to a level of two during session 8 and began a new climb in the last session ending at a frequency six.

3.6.2.2 Ine

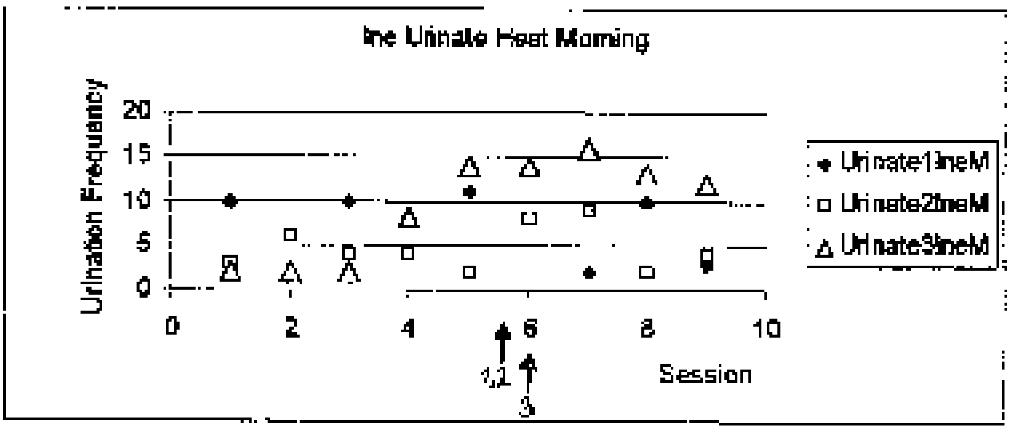


Diagram 76: Data points the frequency with which Ine was observed "urinating" each morning of observation, during the time-period previously discussed. Here, estrus lies between days 5 and 6 for curves 1 and 2, and during session 6 for curve 3. Urinate1IneM: Morning observations of Ine surrounding her first estrus; Urinate2IneM: Morning observations of Ine surrounding her second estrus; Urinate3IneM: Morning observations of Ine surrounding her third estrus.

For Ine's morning sessions (diagram 76), the first curve (black diamond) stayed between the frequency of five and ten for most of the sessions. Only session 7 and 9 deviated, dropping to a level of two and three respectively.

The second curve (white square) fluctuated between the frequencies of three and six for most of the sessions, deviating only in session 6 and 7, where the curve rose to a frequency of eight and nine respectively.

The last curve (white triangle) stayed at a frequency of two for the first three sessions. Then it climbed steadily to a level of fourteen in the fifth session and lightly wavered from session 5 to 9 between the frequencies of twelve and sixteen.

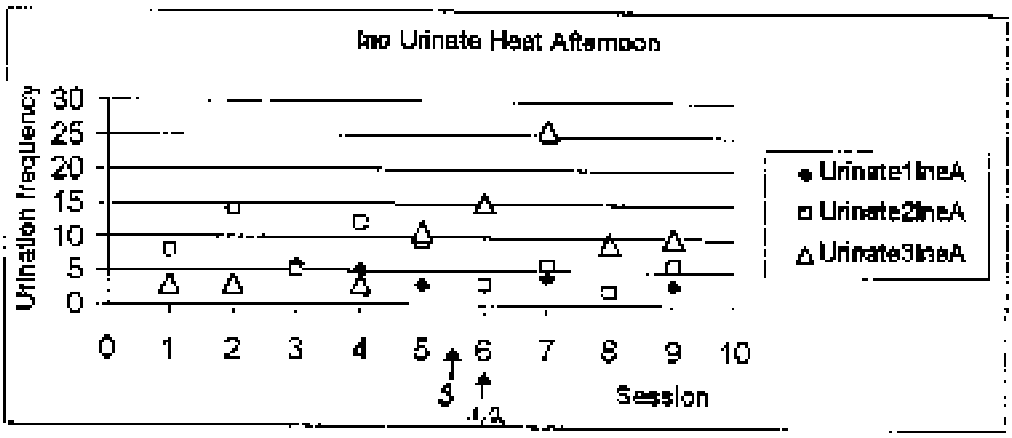


Diagram 77: Data points show the frequency with which Ine was observed "urinating" each afternoon of observation, during the time period previously discussed. Here, estrus lies on between days 5 and 6 for curve 3, and on day 6 for curves 1 and 2.
Urinate1IneA: Afternoon observations of Ine surrounding her first estrus;
Urinate2IneA: Afternoon observations of Ine surrounding her second estrus;
Urinate3IneA: Afternoon observations of Ine surrounding her third estrus.

During the afternoon sessions (diagram 77), curve 1 (black diamond) stayed between the frequencies of two and nine in all sessions. It started at a level of two and rose to seven during session3. Then the curve decreased again to a level of two on the day of estrus, and showed its highest point during session 8 at a frequency of nine.
The second curve (white square) fluctuated slightly more, beginning at a level of nine and rising during the second session to fourteen and declining again during session 3 to a frequency of five. The fourth session showed another small increase to a level of eleven, after which the curve declined to a frequency of two during session 6. The remaining sessions fluctuated between one and three.
The last curve (white triangle) began at a low level of two during sessions 1, 2 and 4. For session 5, an increase was noted, which ultimately led to a peak during session 7 of a twenty-six. The remaining sessions stayed steady at about a level of nine.

3.6.2.3 Kilaguni

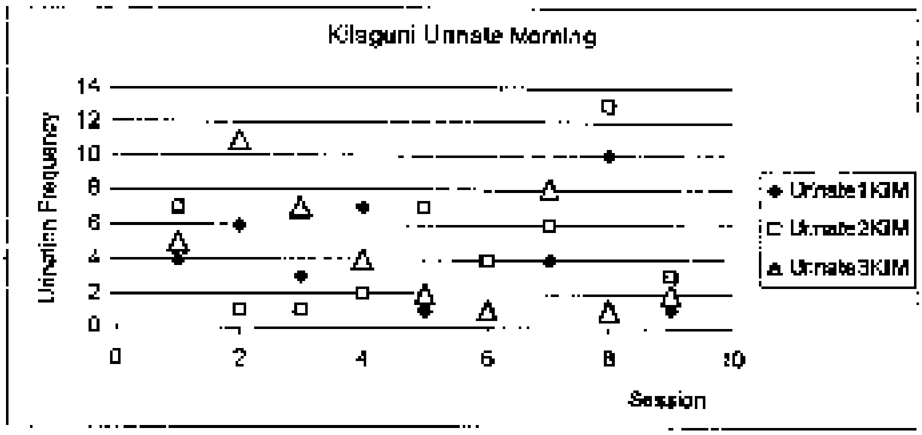


Diagram 78: Data points the frequency with which Kilaguni was observed "urinating" each morning of observation, during the time-period previously discussed.. Urinate1KiIM: Morning observations of Kilaguni during the first time-period; Urinate2KiIM: Morning observations of Kilaguni during the second time-period; Urinate3M: Morning observations of Kilaguni during the third time-period.

Kilaguni's morning sessions (diagram 78) began with curve 1 (black diamond) at a level of four, which led to a small peak the following session at a frequency of six. Session 3 showed a decrease to three, after which another peak occurred during the fourth session (at a level of seven). Session 5 declined to a frequency of one, and steady rise followed, which led to the highest point of the curve during session 8 at a frequency of ten. The last session showed a decline to one.

The second curve (white square) started with a descent from a level seen to one. The sixth session dropped to four only to lead to an ascent to the highest point of the curve in session 8 at a level of thirteen. Again the last session fell to a level of three.

The last curve (white triangle) began with a rise from a frequency of five to eleven during session2, followed by a slow decline to one in session 6. The curve peaked again in the seventh at a level of eight, which decline to one and two during the last sessions.

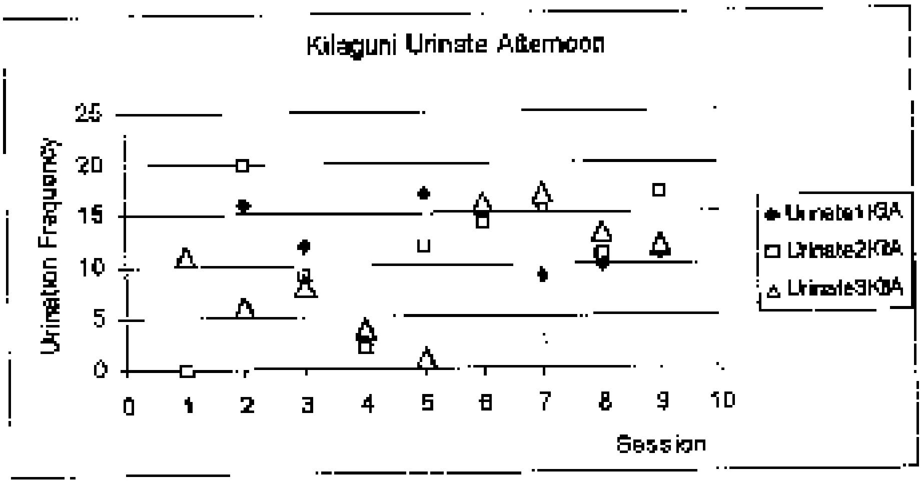


Diagram 79: Data points the frequency with which Kilaguni was observed "urinating" each afternoon of observation, during the time-period previously discussed.. Urinate1KilA: Afternoon observations of Kilaguni during the first time-period; Urinate2KilA: Afternoon observations of Kilaguni during the second time-period; Urinate3A: Afternoon observations of Kilaguni during the third time-period.

The first time-period (diagram 79, black diamond) of the afternoon sessions, began with a small hill, starting at a frequency of eleven, rising to sixteen during the second session, and declining again to four during the fourth session. The highest point of the curve was reached in session 5 at frequency of seventeen, which was followed by a small decline to a level of nine in the seventh session. Sessions 8 and 9 showed a slight increase to the frequencies ten and eleven respectively.

The second curve (white square) started with a sharp increase from a level of zero, to twenty in the second session. Leading to the fourth session was a slow decline, ending at a level of four. This was succeeded by a steady increase to a frequency of sixteen in the seventh session, a dip to eleven in session 8 and ending, with a climb to a level of seventeen, in the last session.

The third curve (white triangle) started at a level of eleven and decreased to one during the fifth session. After this, it increased to a frequency of sixteen in session six, rose slightly to seventeen during the seventh session, after which it began to decline, ending at a level of twelve.

To summarize the results of the behavior 'urinate':

Sita: There were large fluctuations, with a peak at estrus in curve 1, however curve 2 showed an even larger peak on day 15. Morning and afternoon separation indicates this behavior is shown most often in the afternoon, since the amplitudes of the fluctuations are greater.

Ine: Two peaks were visible in curve 2 on days 3 and 7, whereas the first curve only fluctuated wildly and no peaks were evident. The third curve showed a peak on day 14. In this separation of morning and afternoon sessions, urination appears to be more frequent during the morning, while the afternoon generally stays steady at a lower level.

Kitaguni: All of Kitaguni's curves tend to fluctuate strongly, with higher frequencies in the afternoon than in the morning.

3.7. Rub

3.7.1 Daily Observations and Average Curve

3.7.1.1 Sita

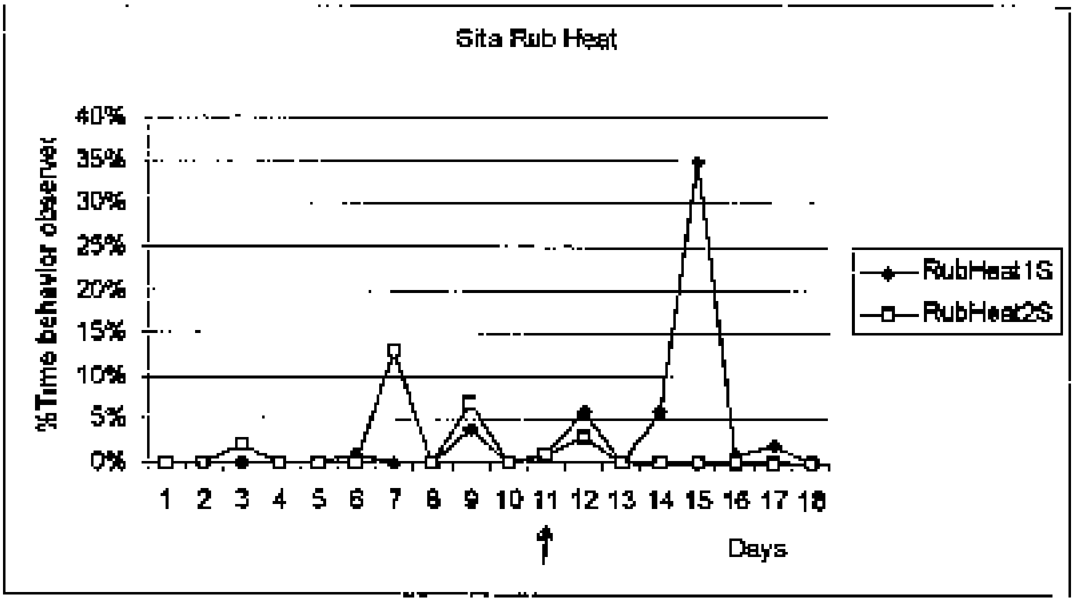


Diagram 80: Behavioral curves for Sita with peak receptivity on day 11. Data points depict how often the behavioral pattern "rub" was observed each day.
RubHeat1S: Curve of days surrounding Sita's first estrus; RubHeat2S: Curve of days surrounding Sita's second estrus.

Concerning the behavior of rubbing her horn, Sita did not show this behavior very often.
For the first heat cycle (black diamond), no activity was observed until the sixth day, on which she rubbed her horn about 1 % of the observation period. The next activity was seen on day 9 at 4% and day 12 (the day after estrus) at 6%. Between the days 13 (0%0 and 16 (0%), a peak developed, which reached its zenith at 35% on day 15. The last day to show any activity was day 17 at 2%.
The second curve (white square) showed 2% activity on day 3 and 13% on days 7 and 9. The last two days that rubbing activity was observed were the eleventh and twelfth at 1% and 2% respectively. For the rest of the days, no rubbing was observed.
Due to this lack of activity, the rest of the curves (average, and morning/afternoon separation curves) will not be discussed, but can be found in the appendix.

3.7.1.2 Ine

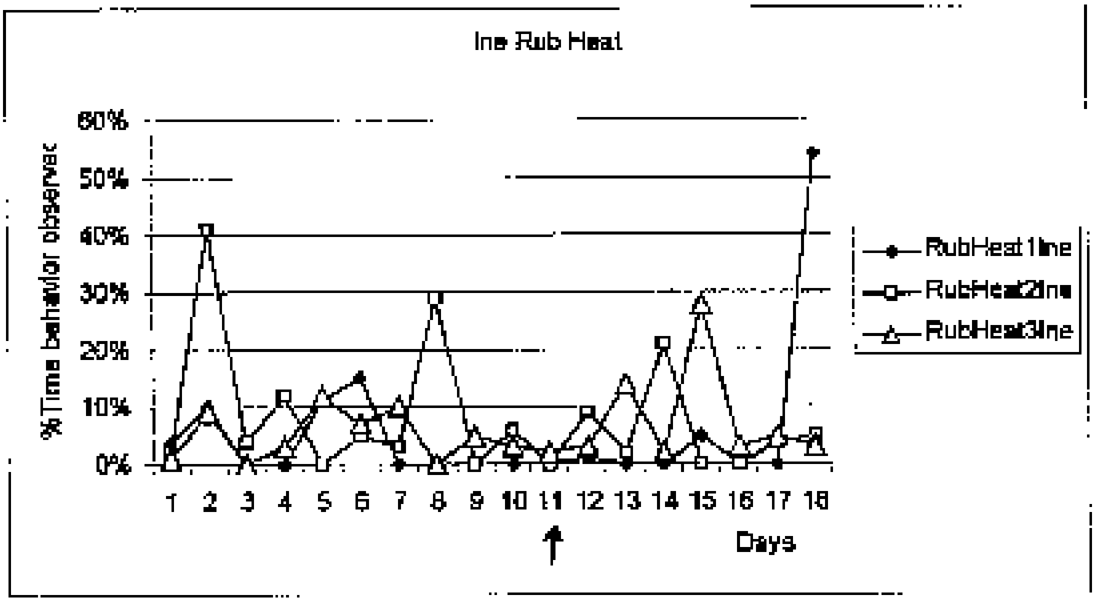


Diagram 81: Behavioral curves for Ine with peak receptivity on day 11. Data points depict how often the behavioral pattern "rub" was observed each day. RubHeat1Ine: Curve of days surrounding Ine's first estrus; RubHeat2Ine: Curve of days surrounding Ine's second estrus; RubHeat3Ine: Curve of days surrounding Ine's third estrus.

Ine showed a slightly higher amount of activity then Sita did.

During the first heat cycle (black diamond), the first day showed 4% activity, that rose to 10% on the second day. On days 3 and 4, no rubbing activity was observed. On the fifth day, the curve began to rise (11%) and peaked the following day at 15%. After this, no activity was observed from day 7 to 10. The day of estrus showed an increase to 1%, which fell back to 0%. for two days after estrus. The fifteenth day showed a small peak at 5%, which decreased again to 0% for days 16 and 17. The last day a sharp climb to approx. 55% was recorded.

The second curve (white square) began at 3% and immediately climbed to 41% the following day. After this, it fell again to 4% only to rise to 12% on day 4. The fifth day showed no activity, after which the curve climbed to 5% on day 6 and decreased slightly to 3% the next day. The eighth day another peak occurred at 29% followed by fluctuations between 0% and 10% until day 13. No activity was recorded during estrus. The fourteenth day, the curve rose again to 21% and returned to 0% on days 15 and 16, after which a small rise occurred on the seventeenth day at 4% and the eighteenth day at 5%.

The last curve (white triangle) began at 1% and increased to 9% on day 2, only to drop to 0% on the third day. This was followed by a slow rise to 11% on day 5, with a small dip in the curve the next day at 8% and another rise to 10% on day 7. Again no activity was observed on day 8, but the curve stayed around 2% to 4% from days 9 through 12. The thirteenth day exhibited another peak at 13%, which decreased to 2% on day 14. The curve climbed to 26% on day 15, falling again the next day to 2% and staying steady between 2% and 3% the remaining days.

With all this variety in the curves, the average curve should be discussed.

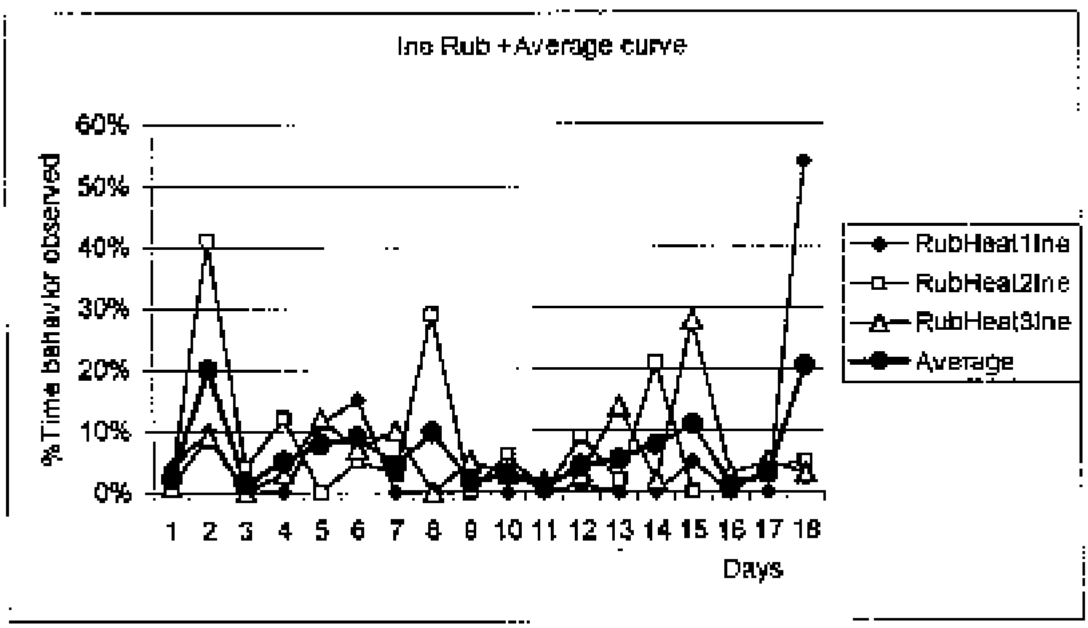


Diagram 82: Behavioral curves for Ine with peak receptivity on day 11. Data points depict how often the behavioral pattern "rub" was observed each day and the average of each days observations. RubHeat1Ine: Curve of days surrounding Ine's first estrus; RubHeat2Ine: Curve of days surrounding Ine's second estrus; RubHeat3Ine: Curve of days surrounding Ine's third estrus; Average: Curve of the average of each days data points.

Overall, the average curve (black circle) fluctuated between 1% and 11% throughout the observation period, however it did show two peaks. The first peak occurred on the second day at 20% and the second peak occurred on the last day at 21%.

3.7.1.3 Kilaguni

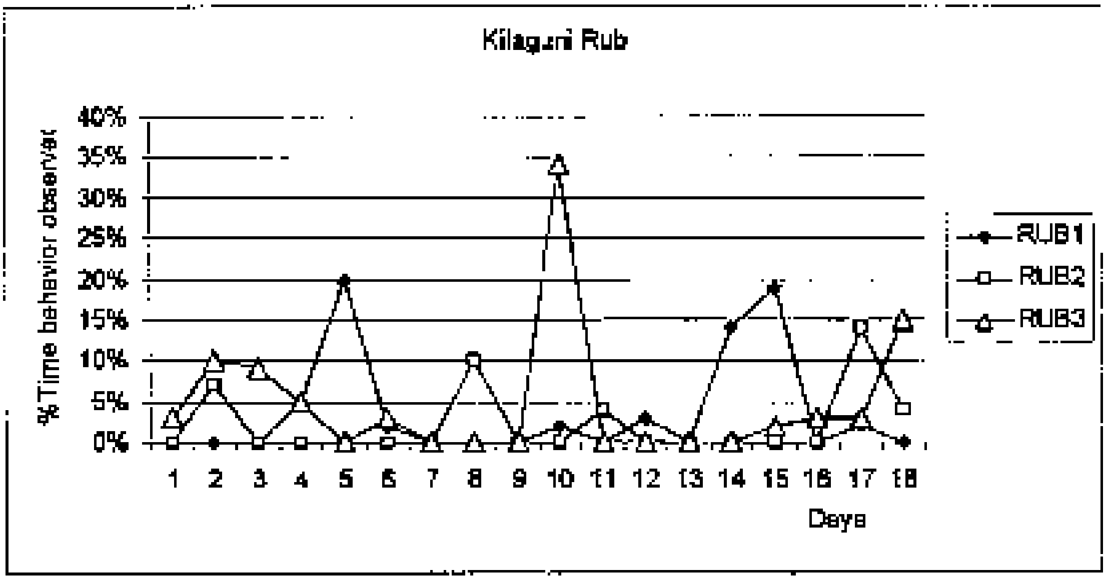


Diagram 83: Behavioral curves for Kilaguni. Data points depict how often the behavioral pattern "rub" was observed each day. RUB1: Curve of days during Kilaguni's first time-period; RUB2: Curve of days during Kilaguni's second time-period; RUB3: Curve of days during Kilaguni's third time-period.

Kilaguni also showed more activity than Sita, however not as much as Ine.

The first time-period (black diamond) stayed at 0% for the first three sessions. Then, the curve slowly began to rise and peaked at 20% on day 5. The sixth day fell again to 2% and from days 7 to 9, no rubbing was observed. Days 10 and 12 showed small peaks of 2% and 3% respectively, while days 11 and 13 registered no activity. The fourteenth and fifteenth days showed another increase with day 14 at 14% and day 15 at 19% activity. After this peak, the curve fell to 0% rising only slightly on day 17 to 2%.

The second curve (white square) exhibited very little activity, with only four peaks. The first peak occurred on day 2 at 7%, the second peak on the eighth day at 10%, the third peak on day 11 at 4% and the last peak occurred on the seventeenth day at 14%. The rest of the curve showed no activity, with the exception of the last day, which rose to 4%.

Curve three (white triangle) began at 3% and rose to 9% on day 2 and slowly began to decrease, until it reached 0% on day 5. The next day showed another small peak at 3%, after which no activity occurred until the tenth day. On this day, the curve soared to 34% and dropped back to 0% on day 11. From day 11 to day 14, no activity was recorded. Starting with the fifteenth day the curve again started to climb and eventually peaked on day 18 at 15%.

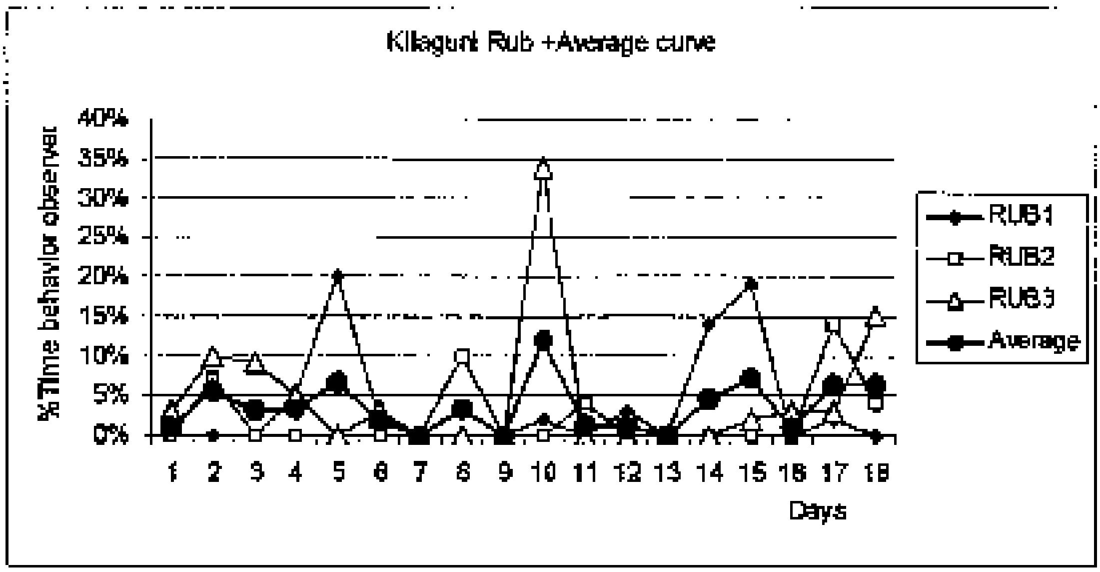


Diagram 84: Behavioral curves for Kilaguni. Data points depict how often the behavioral pattern "rub" was observed each day and the average of each days observations. RUB1: Curve of days during Kilaguni's first time-period; RUB2: Curve of days during Kilaguni's second time-period; RUB3: Curve of days during Kilaguni's third time-period; Average: Curve of the average of each days data points.

Since the average curve showed activity for most of the days in question, it will be discussed as well.

For seventeen out of eighteen days, the average curve (diagram 84, black circle) fluctuated between 0% and 6%. Only on day 10 did a small peak of 12% occur to disturb the series.

Since Ine showed the most activity concerning rubbing, her curves will be split into morning and afternoon sessions.

3.7.2 Morning/Afternoon Separation

3.7.2.1 Ine

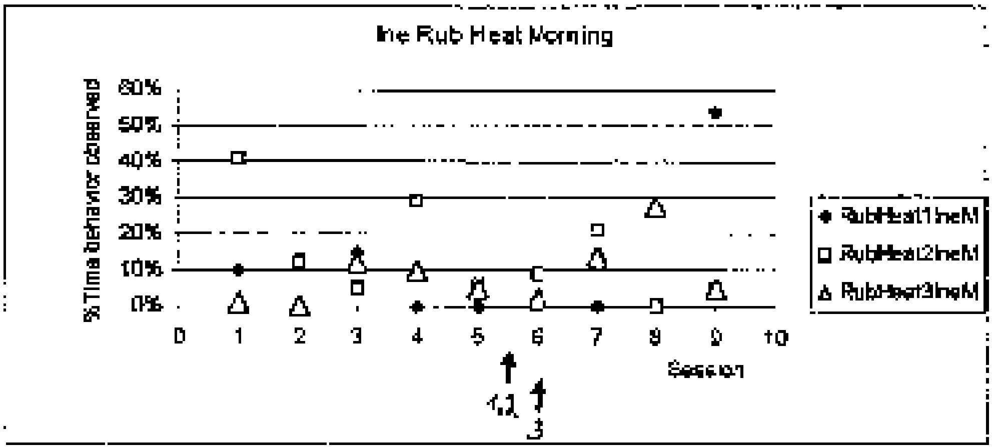


Diagram 85: Data points the frequency with which Ine was observed "rubbing" each morning of observation, during the time-period previously discussed. Here, estrus lies between days 5 and 6 for curves 1 and 2, and during session 6 for curve 3. Rub1IneM: Morning observations of Ine surrounding her first estrus; Rub2IneM: Morning observations of Ine surrounding her second estrus; Rub3IneM: Morning observations of Ine surrounding her third estrus.

The first curve (black diamond) of the morning session (diagram 85) showed three sessions of activity: session 1 at 10%, session 3 at 15% and session 9 at 55%.
The second curve (white square) began at 41% and decreased to 5% during session 3. This was followed by a peak at 29% in the fourth session, after which the curve again declined to 6%. Thereafter, the curve slowly rose to 21% during session 7. During session 8, no activity occurred and the last session ended at 5%.
The third curve (white triangle) started at 1% and dropped to 0% the following session, only to peak at 12% during session 3. After this, the curve steadily decreased to 2% in session 6 and began another increase to peak at 28% during the eighth session. The last session ended again at 5%.

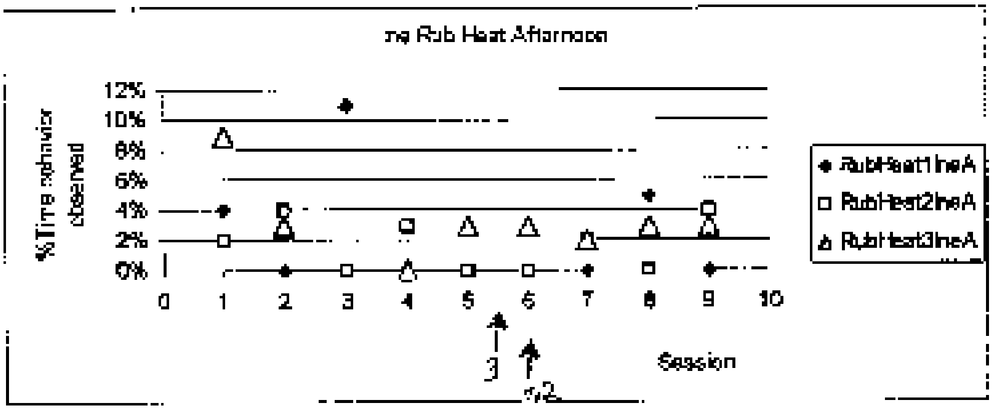


Diagram 86: Data points the frequency with which Ine was observed "rubbing" each morning of observation, during the time-period previously discussed. Here, estrus lies between days 5 and 6 for curve 3, and during session 6 for curves 1 and 2. Rub1IneA: Afternoon observations of Ine surrounding her first estrus; Rub2IneA: Afternoon observations of Ine surrounding her second estrus; Rub3IneA: Afternoon observations of Ine surrounding her third estrus.

The first curve (black diamond) of the afternoon sessions (diagram 86), did not show much activity. The first day started at 4%, then the curve fell to 0% the second day and peaked at 11% during the third session. After this, the curve stayed at 0% until session 8, when it rose to 5%, only to decline again to 0% during the last session.

The second curve (white square), began at 2% and rose slightly during the next session to 4%, only to show no activity during session 3. The next increase occurred in session 4 (3%), but again the curve declined to 0% and stayed there until the last session, when it climbed to 4%.

The third heat cycle (white triangle) showed a decrease from 9% to 3% during sessions 1 and 2. During the fourth session no activity was observed, however the curve rose in session 5 to waver between 2% and 3% for the remaining sessions.

3.7.2.2 Kilaguni

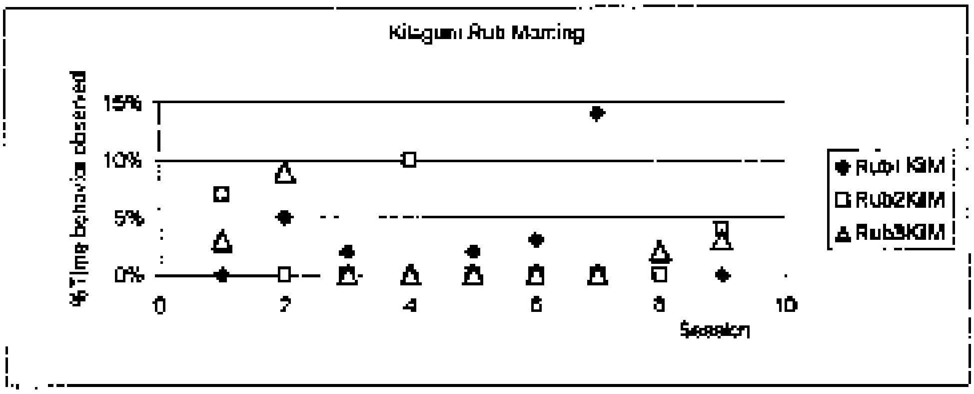


Diagram 87: Data points the frequency with which Kilaguni was observed "rubbing" each morning of observation, during the time-period previously discussed.
Rub1KilM: Morning observations of Kilaguni during her first time-period.
Rub2KilM: Morning observations of Kilaguni during her second time-period.
Rub3KilM: Morning observations of Kilaguni during her third time-period.

For Kilaguni, the first time-period (diagram 87, black diamond) revealed the most activity, beginning at 0% and rising to 5% during session 2. Thereafter, the curve decline to 0% in session 4, only to increase again and finally peak at 14% in the seventh session. The last two sessions no activity was observed.
The second curve (white square) exhibited activity during the first session (7%), which dropped to 0% for the following two days. In session 4, the curve increased to 10%, but returned to 0% in session 5, and during the next morning session the curve climbed to 4%.
The third time-period (white triangle) showed activity during the first two sessions, at 3% and 9% respectively, and the last two sessions at 2% and 3%.

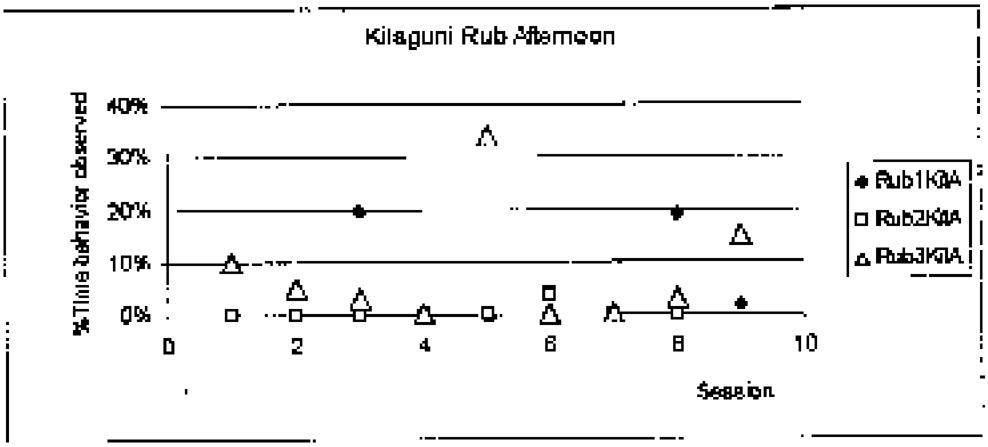


Diagram 88: Data points the frequency with which Kilaguni was observed "rubbing" each afternoon of observation, during the time-period previously discussed. Rub1KilA: Afternoon observations of Kilaguni during her first time-period; Rub2KilA: Afternoon observations of Kilaguni during her second time-period; Rub3KilA: Afternoon observations of Kilaguni during her third time-period.

During the afternoon sessions (diagram 88), the first time-period (black diamond) showed activity only in three sessions: the third session at 20%, the eighth session at 19% and the last session at 3%.

Similarly, the second curve (white square) only exhibited activity during two sessions: session 6 at 4%, and session 9 at 14%.

During the last time-period (white triangle), the most amount of activity was recorded, with the curve slowly declining from 10% to 0% during the first four sessions. The fifth session peaked at 33%, after which the curve again fell to 0% for two afternoons. During session 8, the curve began to climb (2%) and ended at 15% in the last session.

To summarize the results of the behavior 'rub':

Sita: A peak was observed in both curves on the days 9 and 12, however the largest peak was seen during the first heat cycle on day 15.

Ine: Three large peaks were present, one per heat cycle, however each peak occurred on different days. Therefore, no conclusions can be drawn as to its relevance to estrus. From the morning and afternoon separation, it is evident that this behavior was seen most often in the morning.

Kilaguni: Most of the time, rubbing took up less than 10% of the observation time. Three peaks were evident overall: two peaks at 20% (days 5 and 15) during the first time-period, and one peak at about 35% (on day 10) in the third time period. The time spent rubbing was evenly distributed between mornings and afternoons.

3.8 Defecate

3.8.1 Daily Observations and Average Curve

3.8.1.1 Sita

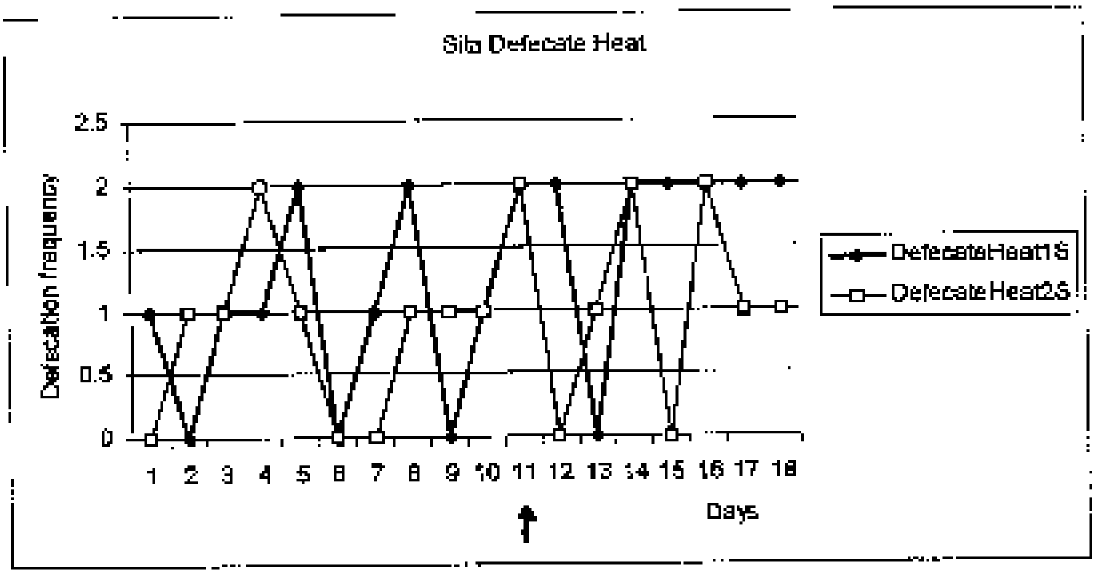


Diagram 89: Behavioral curves for Sita with peak receptivity on day 11. Data points depict how often the behavioral pattern "defecate" was observed each day. DefecateHeat1S: Curve of days surrounding Sita's first estrus; DefecateHeat2S: Curve of days surrounding Sita's second estrus.

During the first heat cycle, defecation occurred most often, once a day, before estrus (days 1, 3, 4, 7 and 10), while on three days no defecation was observed (days 2, 6 and 9). Only twice did it occur with a frequency of two (days 5 and 8). Form the point of estrus onward (day 11 through 18), defecation took palce twice a day, with the exception of day thirteen, on which no defecation was observed.

In the second heat cycle, as in the first, before the day of peak receptivity, defecation occurred most frequently once a day (days 2, 3, 5, 8, 9 and 10). The occasions, when no defecation took place were the days 1, 6 and 7. Only once did it reach a level of two, on day 4. Again, estrus reached a frequency of two. During this heat cycle, this level was reached only three times, including estrus (days 11, 14 and 15). Just as often once a day was recorded (days 13, 17 and 18), and no defecation was observed on the days 12 and 15.

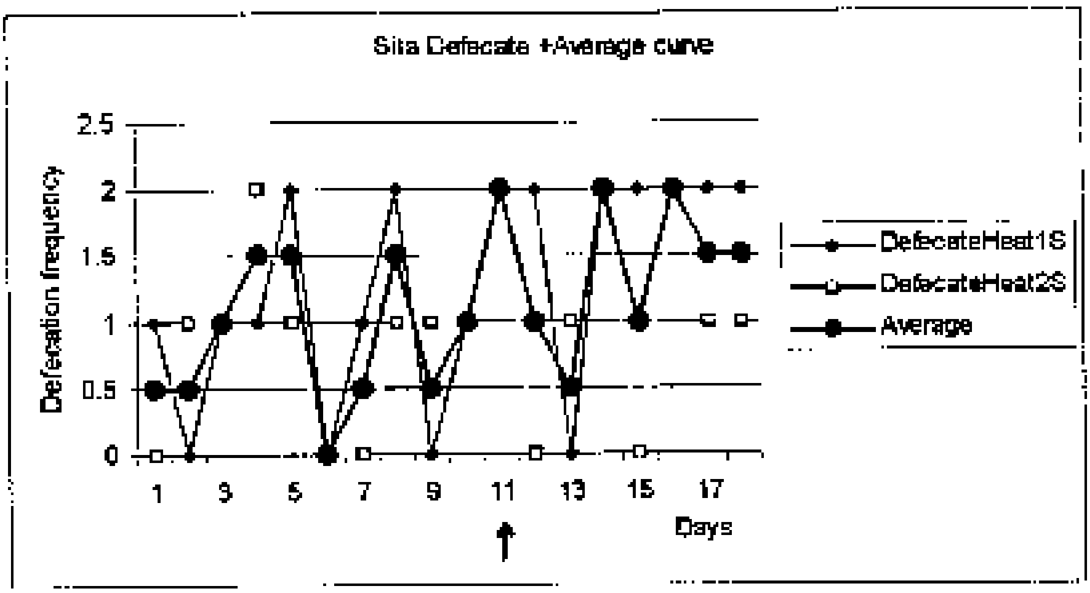


Diagram 90: Behavioral curves for Sita with peak receptivity on day 11. Data points depict how often the behavioral pattern "defecate" was observed each day and the average of each days observations. DefecateHeat1S Curve of days surrounding Sita's first estrus; DefecateHeat2S: Curve of days surrounding Sita's second estrus; Average: Curve of the average of each days data points.

With the average curve (diagram 90, black circle) the observations made previously are more visible. The curve began at a level of 0.5, increased after two days to 1.5 and dropped on day 6 to zero. After this, it rose to peak at 1.5 on day 8. The ninth day showed another decline to 0.5, which was followed by a rise to a level of one on day 10. This in turn led to a peak, on the day of peak receptivity, at a frequency of two. After another descent to a level of 0.5 on day 13, the curve began to fluctuate between one and two.

3.8.1.2 Ine

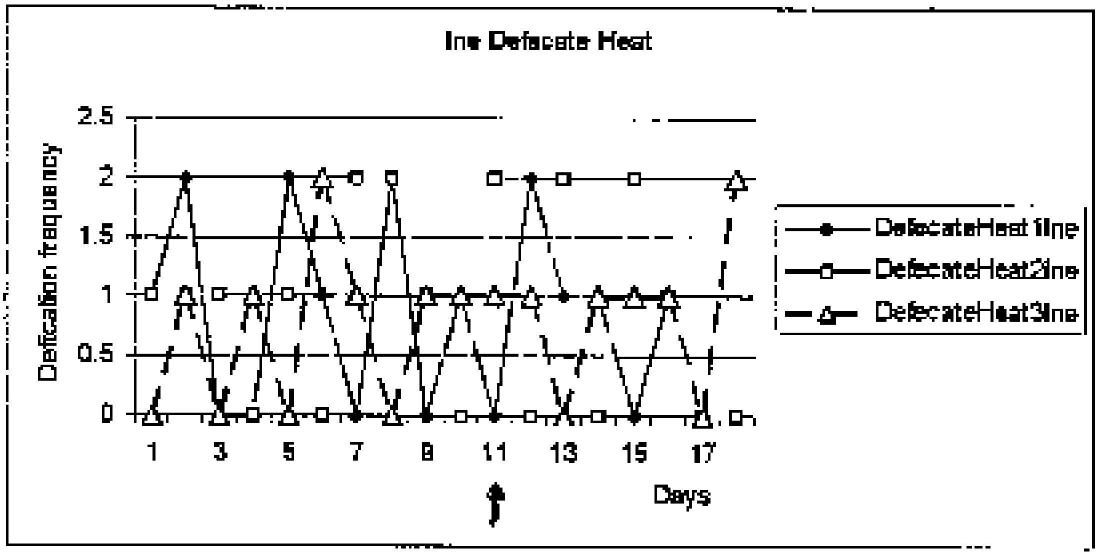


Diagram 91: Behavioral curves for Ine with peak receptivity on day 11. Data points depict how often the behavioral pattern "defecate" was observed each day. DefecateHeat1Ine: Curve of days surrounding Ine's first estrus; DefecateHeat2Ine: Curve of days surrounding Ine's second estrus; DefecateHeat3Ine: Curve of days surrounding Ine's third estrus.

During Ine's first heat cycle (diagram 91, black diamond), defecation at a frequency of two, was reached three times, on the days 2, 5 and 8 before estrus, and once after estrus (day 12). Most often, the first curve showed no activity, as on the days 3, 4, 7 and 9, before the day of peak receptivity, and on the days 11, 15, 17 and 18, after estrus. Defecating once, occurred six times throughout the observation: thrice before estrus (days 1,6 and 10), and thrice after estrus (days 13, 14 and 16).

The second curve showed a defecation of once, five times before the day of peak receptivity (days 1 through3, 5 and 9), while after estrus it occurred only on day 16. A defecation frequency of two was reached prior to estrus, twice on days 7 and 8, and after estrus three times, on days 11 (estrus), 13 and 15. Overall, no defecation was most frequently observed, occurring seven times throughout the observation (days 4, 6, 10, 12, 14, 17 and 18), few of these days being after estrus.

The third curve was most often found at a level of one, being evenly distributed before and after estrus. After this the level of zero was most frequent, occurring four times before estrus and two after. The curve reached a frequency of two only twice (once before estrus and once after).

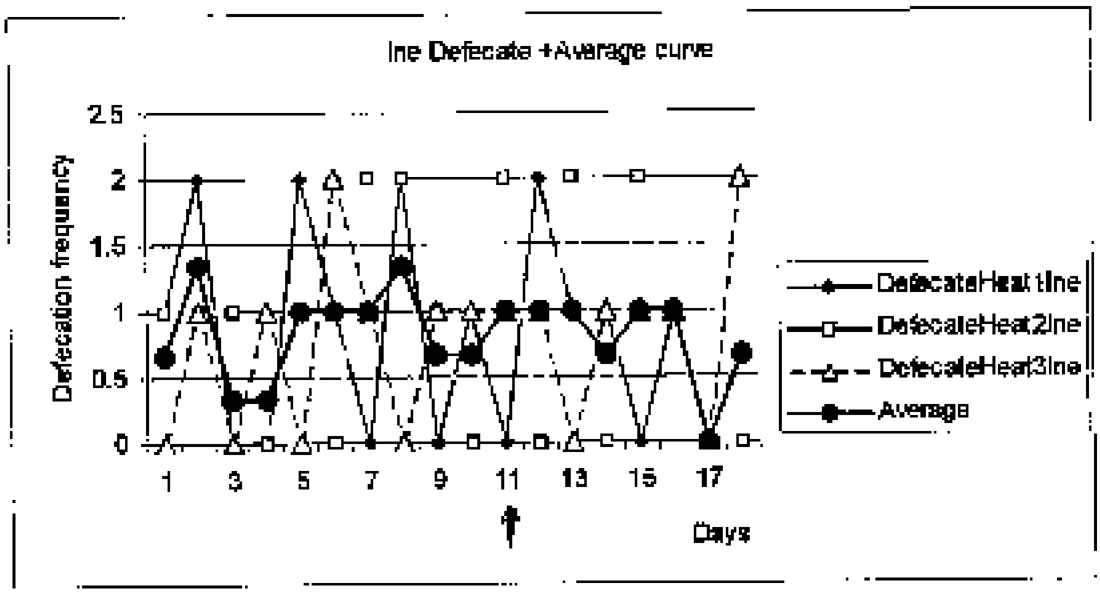


Diagram 92: Behavioral curves for Ine with peak receptivity on day 11. Data points depict how often the behavioral pattern "defecate" was observed each day and the average of each days observations. DefecateHeat1Ine: Curve of days surrounding Ine's first estrus; DefecateHeat2Ine: Curve of days surrounding Ine's second estrus; DefecateHeat3Ine: Curve of days surrounding Ine's third estrus; Average: Curve of the average of each days data points.

In Ine's case, the average curve did not show an increased frequency after estrus as opposed to before estrus. What it does demonstrate, is a higher variability before estrus, fluctuating between approx. 0.4 and 1.4, before estrus, while after peak receptivity the curve stayed between 0.7 and one for most days. The exception was day 17, when the curve decreased to a level of zero.

3.8.1.3 Kilaguni

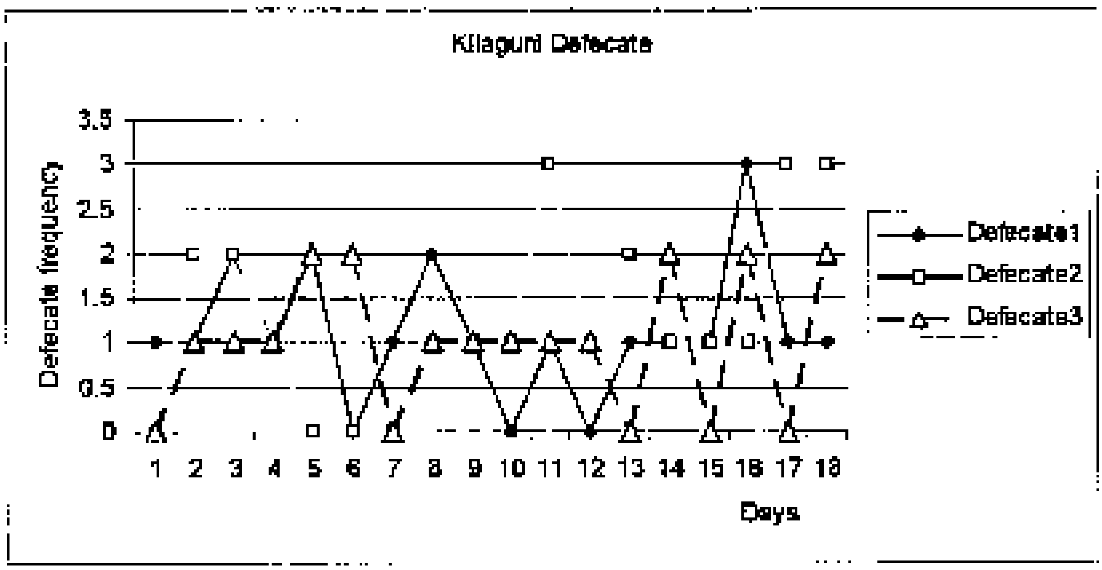


Diagram 93: Behavioral curves for Kilaguni. Data points depict how often the behavioral pattern "defecate" was observed each day. Defecate1: Curve of days during Kilaguni's first time-period; Defecate2: Curve of days during Kilaguni's second time-period; Defecate3: Curve of days during Kilaguni's third time-period.

Kilaguni's curves (diagram 93) showed much variety, not only between the curve, but also within each curve.

The first time-period (black diamond), began at a level of one for two days, which then increased to two during day 3. After this, the curve decreased to reach a frequency of zero for the fifth and sixth days. On day 7, the curve began another increase, peaking at two on day 8, which was followed by a decline to zero on the tenth day. Daily fluctuations occurred from day 10 to 13 between zero and one, after which the curve stayed at a level of zero until the last day, with the exception of a peak on day 16.

The second curve did not fluctuate as much as the first did, starting at a level of zero and climbing to two for days two and three. This was followed by a decline to zero, which was observed on days 5 through 7. Days 8 to 10 showed a level of one, after which the curve peaked at three on day 11, but returned to a frequency of one the next day. The thirteenth day showed another small peak at a level of two, however, the curve returned to stay at a frequency of one for the days 14, 15 and 16. The last two days showed another peak ending at a level of three.

The last curve showed little variation in the beginning, starting at zero and rising to one for the days 2 to 4. The fifth and sixth days peaked at a level of three, which was followed by no defecation activity on day 7. A frequency of one was held on the days 8 through 12, after which the curve declined to zero and began a daily fluctuation between zero and two, ending on day 18 with a frequency of two.

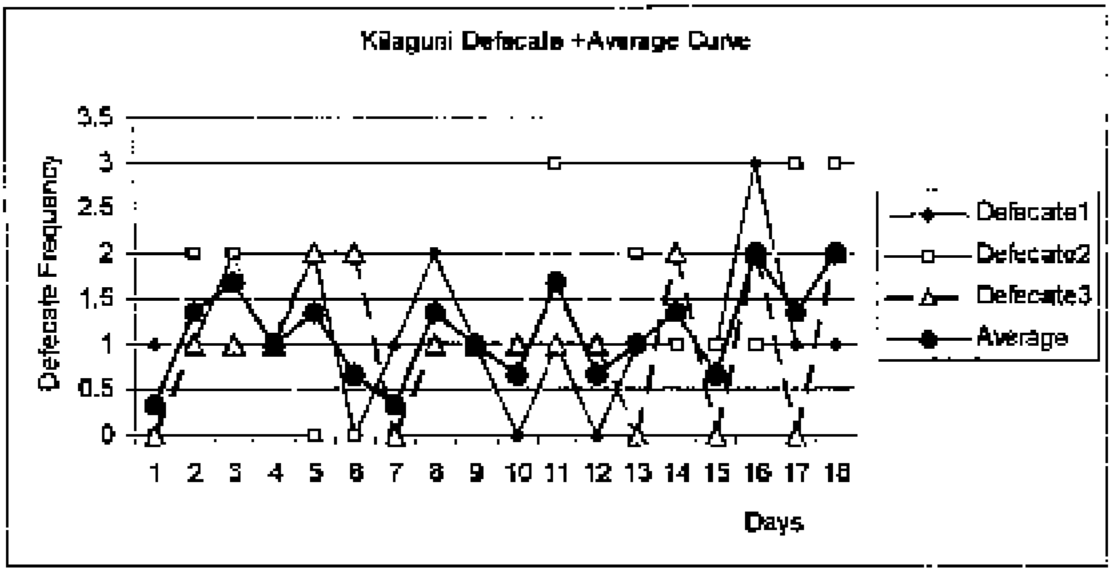


Diagram 94: Behavioral curves for Kilaguni. Data points depict how often the behavioral pattern "defecate" was observed each day and the average of each days observations. Defecate1: Curve of days during Kilaguni's first time-period; Decfecate2: Curve of days during Kilaguni's second time-period; Defecate3: Curve of days during Kilaguni's third time-period; Average: Curve of the average of each days data points.

The average curve (diagram 95, black circle), fluctuated between 0.5 and 1.5 for most until day 15. Only the days of the observation period did the curve increase to fluctuate between 1.5 and 2.0.

3.8.2 Morning/ Afternoon Separation:

3.8.2.1 Sita

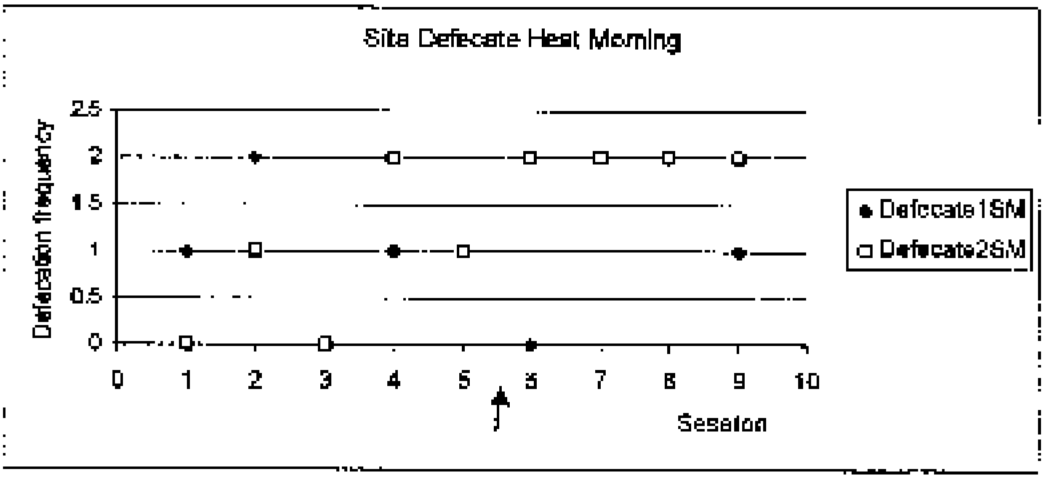


Diagram 95: Data points the frequency with which Sita was observed "defecating" each morning of observation, during the time period previously discussed. Here, estrus lies between days 5 and 6, which means peak receptivity lies on an afternoon session. Defecate1SitaM: Morning observations of Sita surrounding her first estrus; Defecate2SitaM: Morning observations of Sita surrounding her second estrus.

In the morning sessions (diagram 95), the first curve (black diamond) started at a level of one and climbed to a frequency of two. After this, it dropped to zero during session 3, but climbed to a level of one for sessions 4 and 5. The day following estrus (day 7), showed no activity, however the curve did climb to a level of two for the seventh and eighth sessions. The last session ended at a frequency of one.
The second curve (white square), began with a fluctuation between zero and one until session 4, when it increased to a level of two. Beside a dip in session 5 to a frequency of one, the curve remained at a level of two for the remaining sessions.

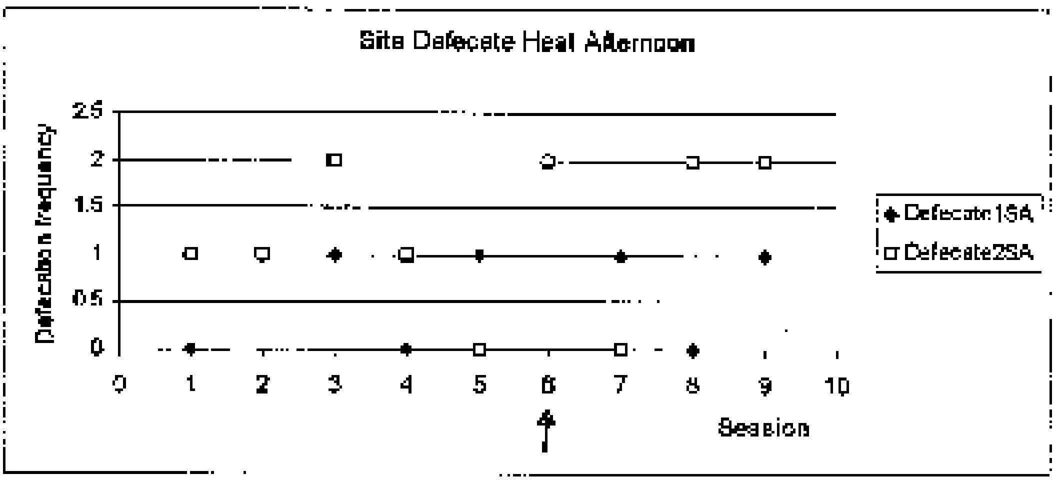


Diagram 96: Data points the frequency with which Sita was observed "defecating" each afternoon of observation, during the time period previously discussed. Here, estrus lies on day 6. Defecate1SitaA: Afternoon observations of Sita surrounding her first estrus; Defecate2SitaA. Afternoon observations of Sita surrounding her second estrus.

In the afternoon session (diagram 96), the first curve (black diamond) began at a level of zero and rose to a frequency of two until session 4. At this time, the curve again fell to zero, only to begin an ascent the following day, which ended on the day of peak receptivity, at a frequency of two. After estrus, the curve declined, ending at zero during session 8, but increased the last day to a level of nine.

The second curve (white square) began steady at a frequency of one, however, it then increased to two during session 3. Leading to session5, the curve decreased to zero, only to peak in the following session (estrus) at a level of two. Session 7 showed no defecation, whereas sessions 8 and 9 ended at frequency of two.

3.8.2.2 Ine

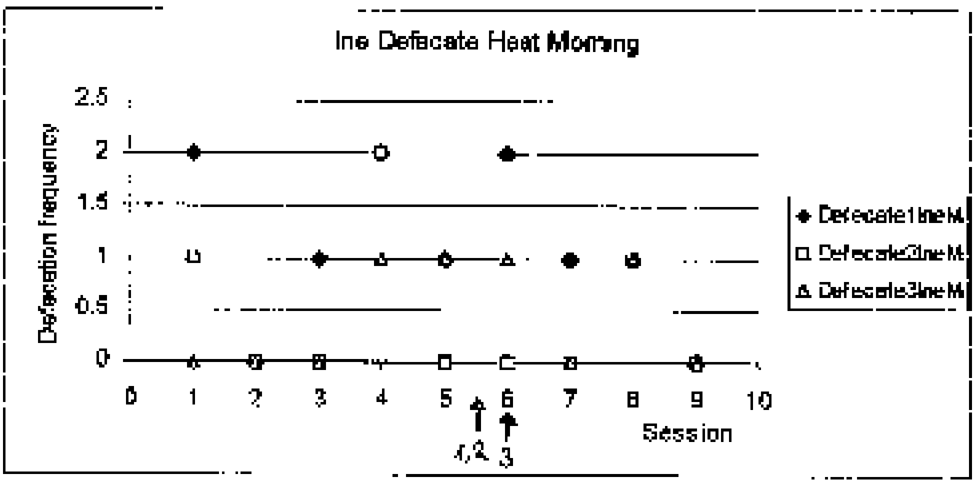


Diagram 97: Data points the frequency with which Ine was observed "defecating" each morning of observation, during the time-period previously discussed. Here, estrus lies between days 5 and 6 for curves 1 and 2, and during session 6 for curve 3.
Defecate1IneM: Morning observations of Ine surrounding her first estrus;
Defecate2IneM: Morning observations of Ine surrounding her second estrus;
Defecate3IneM: Morning observations of Ine surrounding her third estrus.

During the morning sessions (diagram 97), the first curve (black diamond) started at a level of two, and decreased to zero during the second session. This was followed by an increase, which peaked during session 4 at a frequency of two. From days 4 to 7, the curve fluctuated daily between a level of two and one. Session 8 stayed at the same level as the seventh session (a level of one) and the last session showed no activity.

The second curve (white square) began similar to the first curve, starting at a level of one and falling to zero in the second session. In this heat cycle, session three did not increase, but stayed at a level of zero. Session 4 showed a climb to a level of two, which declined the followed session to stay at zero until session8, when it peaked again at one. The last session again showed no activity.

The last curve (white triangle) stayed steady at a level of zero during sessions 1 through 3, then it climbed to a frequency of one for sessions 4 to 6. After this, it fluctuated between zero and one for the remaining sessions.

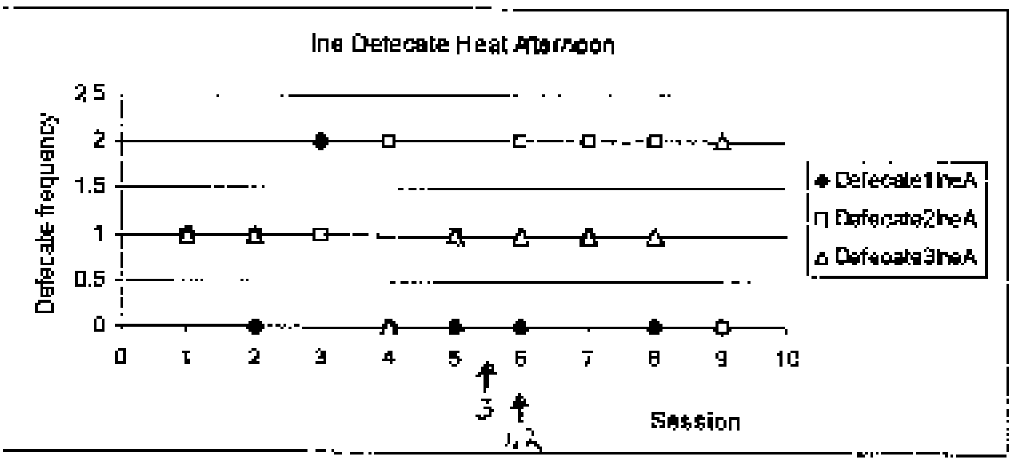


Diagram 98. Data points the frequency with which Ine was observed "defecating" each afternoon of observation, during the time period previously discussed. Here, estrus lies on between days 5 and 6 for curve 3, and on day 6 for curves 1 and 2.
Defecate1IneA: Afternoon observations of Ine surrounding her first estrus;
Defecate2IneA: Afternoon observations of Ine surrounding her second estrus;
Defecate3IneA: Afternoon observations of Ine surrounding her third estrus.

The first curve (diagram 98, black diamond), began with a decline from a frequency of one to a level of zero during session 2. The third session increased to a level of two, however, the curve returned to zero the next day and stayed there until session 7, when it climbed to a level of one. Sessions 8 and 9 showed no defecation.

The second curve (white square) stayed between one and two for all but the last session, when it dropped to zero. However, the curve did not fluctuate between these two levels, instead it stayed steady at a frequency of one for the first three sessions. Then it increased to two during session three, returned to one in the fifth session and stayed steady at a frequency of one during sessions 5 through 8.

The third curve (white triangle) started steady at a level of one in the first two sessions. The fourth session did not show any activity, but the curve increased to a level of one during session 5. The curve stayed at this level for four sessions (5 to 8), while the last session increased to a level of two.

3.8.2.3 Kilaguni

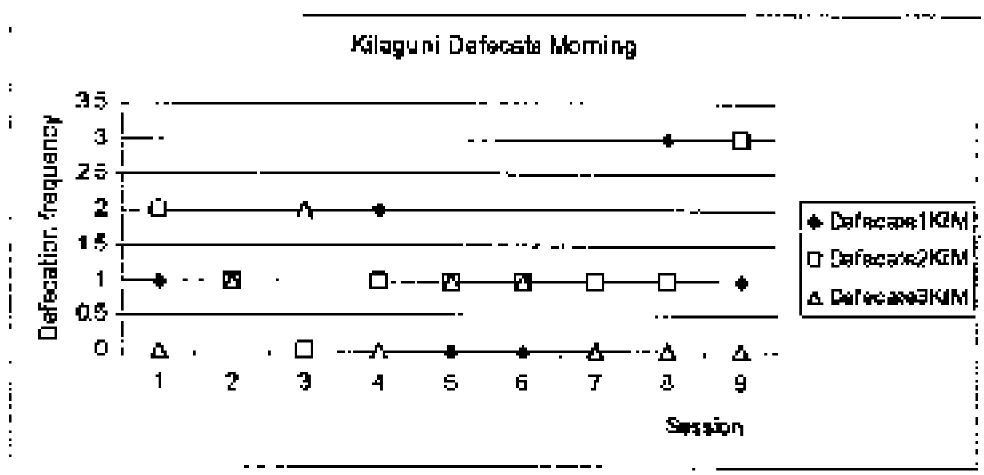


Diagram 99: Data points the frequency with which Kilaguni was observed "defecating" each morning of observation, during the time-period previously discussed. Defecate1KilM: Morning observations of Kilaguni during the first time-period; Defecate2KilM: Morning observations of Kilaguni during the second time-period; Defecate3M: Morning observations of Kilaguni during the third time-period.

The first curve (diagram 99, black diamond) stayed at a level of one during sessions 1 and 2. The third session showed no activity, whereas the fourth session peaked at a frequency of two. During sessions 5 and 6 no activity was observed, while the curve started to rise the following day and peaked at a level of three in session 8. However, the curve decreased again during the lat session, ending at a level of one.

The second curve (white square), began with a decrease from a level of two to zero during session 3. From sessions 4 to 8 the curve stayed at a frequency of one and climbed to three during the last session.

The third curve (white triangle), increased from zero to a frequency of two in session 3. The fourth session decreased to zero, while sessions 5 and 6 showed a level of one. The remaining sessions ended the observation with no defecation observed.

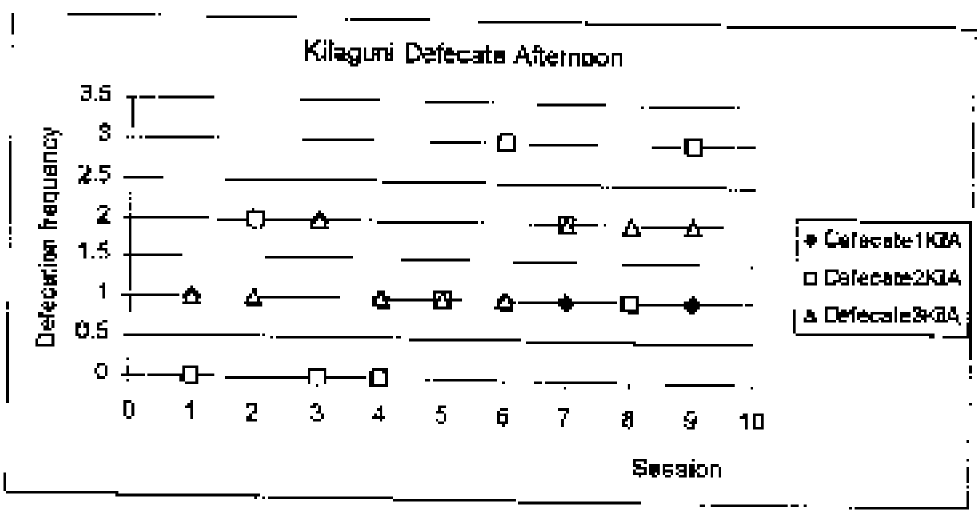


Diagram 100: Data points the frequency with which Kilaguni was observed "defecating" each afternoon of observation, during the time-period previously discussed.. Defecate1KilA: Afternoon observations of Kilaguni during the first time-period; Defecate2KilA: Afternoon observations of Kilaguni during the second time-period; Defecate3A: Afternoon observations of Kilaguni during the third time-period.

In the afternoon sessions (diagram 100), the first curve (black diamond) started at a level of one and rose to two for sessions 2 and 3. After this, the curve fell to a frequency of one and stayed at this level for the remaining sessions.

The second curve (white square) rose from zero to a level of two, but returned to zero during session 4. The fifth and sixth sessions reached the frequency of one, and the remaining sessions ended the curve at a level of zero.

The third curve (white triangle) stayed at frequency of one for the first two sessions, then rose to two during session three. After this, the curve returned to a level of one for session 3 through 8. The remaining session ended at a frequency of two.

To summarize the results of the behavior defecate:

Sita: A higher defecation frequency was observed after estrus, than before, with the day of peak receptivity showing a level of two in both curves. Most defecation took place during the morning sessions.

Ine: No connection between estrus and defecation could be found. No defecation and a level of one were almost evenly balanced, with the higher frequency of two almost being an exception. In the morning and afternoon separation, most curves tended to fluctuate wildly without indication of estrus. However., it must be noted, that a defecation frequency was found in the afternoon sessions.

Kilaguni: The most obvious fact that appeared was that Kilaguni defecated more, sometimes even three time during an observation period. The separation between morning and afternoon session showed an even distribution between the two.

3.9. Alert

3.9.1. Daily observations and Average Curve

3.9.1.1 Sita

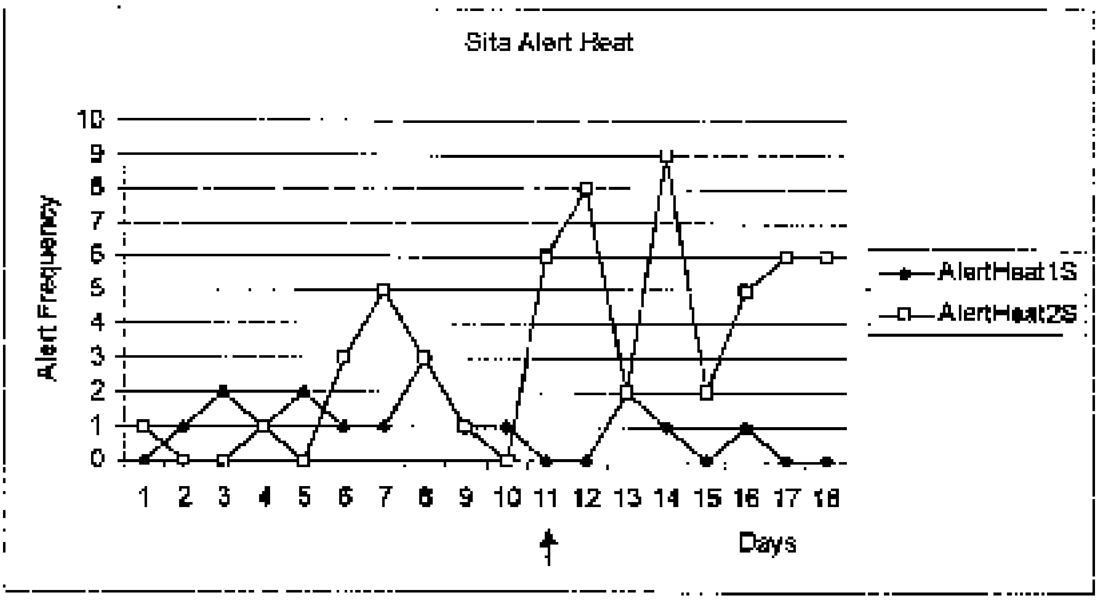


Diagram 101: Behavioral curves for Sita with peak receptivity on day 11. Data points depict how often the behavioral pattern "alert" was observed each day.
AlertHeat1S: Curve of days surrounding Sita's first estrus, AlertHeat2S: Curve of days surrounding Sita's second estrus.

During the first heat cycle (diagram 101, black diamond), this behavior was not shown by Sita very often. The curve began with no activity and slowly increased to a level of two by day 3. After this peak was reached, the curve fluctuated between a frequency of one and two until day 7. The eighth day showed a small peak at a level three, which fell again to a frequency of two the following day. The curve stayed at this level on day 10, but decreased to zero on the days 11 and 12. The thirteenth day rose to reach a level of two, however, the curve declined the next day and began fluctuating between one and zero for the remaining days.
The second curve (white square) was more varied than the first, however it too began at a low level, fluctuating between zero and a level of one, until day 5. This was followed by a peak on day seven, which reached a frequency of seven, after which the curve descended to zero on day 10. The next peak occurred on the twelfth day, after the day of estrus, to reach its zenith at a level of eight, only to decline the next day to a frequency of two. The highest point of the curve was observed on day 14 at a level of nine, which did not last, and the curve returned to

two the following day. The sixteenth showed another climb (to a level of five), which peaked at a frequency of 6 on day 17 and stayed steady during the last day.

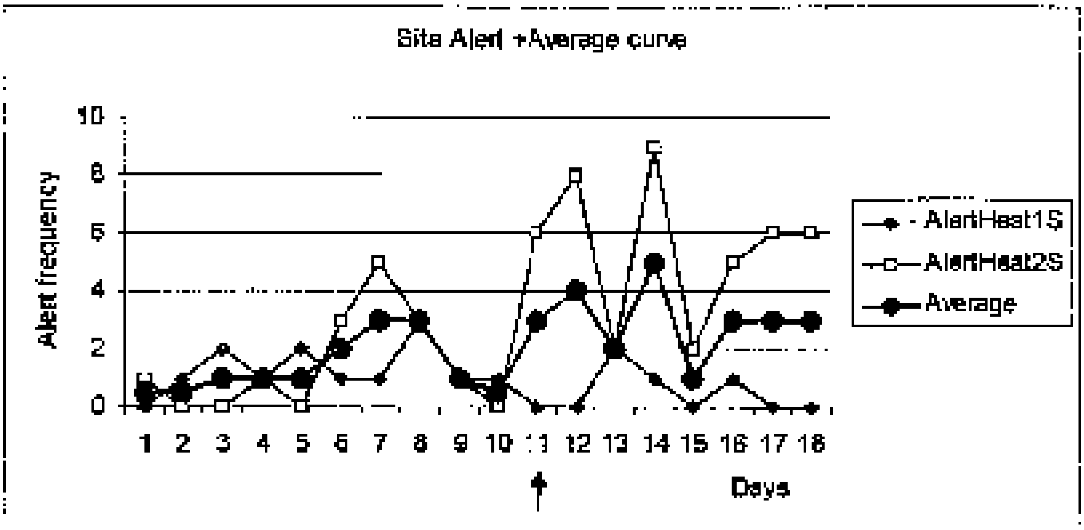


Diagram 102: Behavioral curves for Sita with peak receptivity on day 11. Data points depict how often the behavioral pattern "alert" was observed each day and the average of each days observations. AlertHeat1S: Curve of days surrounding Sita's first estrus; AlertHeat2Sita: Curve of days surrounding Sita's second estrus; Average: Curve of the average of each days data points.

The average curve (diagram 102, black circle) showed an increase over several days (day 1 to 6), which finally peaked on day 7 at a frequency of about three and stayed at this level the next day. Days 9 and 10 demonstrated a lower level (about one), however, the curve began to rise on the day of estrus and momentarily peaked on day 12 at a frequency of four. On the thirteenth day the curve declined slightly (to two), which did not last, because it ascended the following day to reach its highest point at a frequency of five. A dip in the curve, to a level of one, occurred on day 15, which rebounded to end the observation at a level of three for the remaining days.

3.9.1.2 Ine

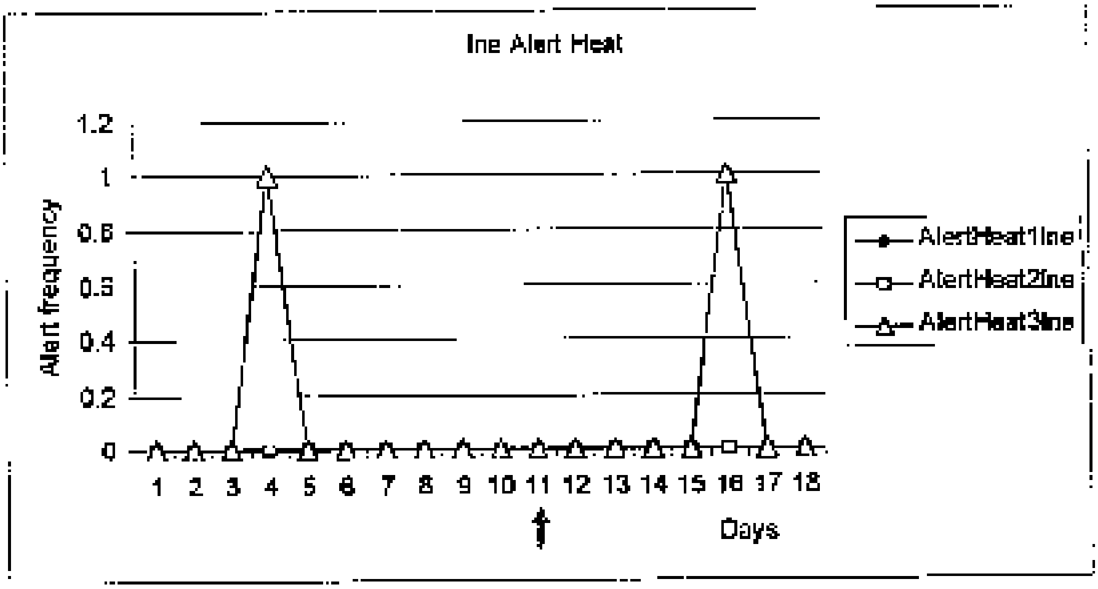


Diagram 103: Behavioral curves for Ine with peak receptivity on day 11. Data points depict how often the behavioral pattern "alert" was observed each day. AlertHeat1Ine: Curve of days surrounding Ine's first estrus; AlertHeat2Ine: Curve of days surrounding Ine's second estrus; AlertHeat3Ine: Curve of days surrounding Ine's third estrus.

As can be clearly seen, Ine showed this behavior only twice, each time during the third heat cycle (diagram 103, white triangle). The first time was on day 4, and the second time on day 16.

Due to this lack of behavior shown, the average curve and the morning/afternoon seperation need not be discussed. However, the curves will be placed in the appendix.

3.9.1.3 Kilaguni

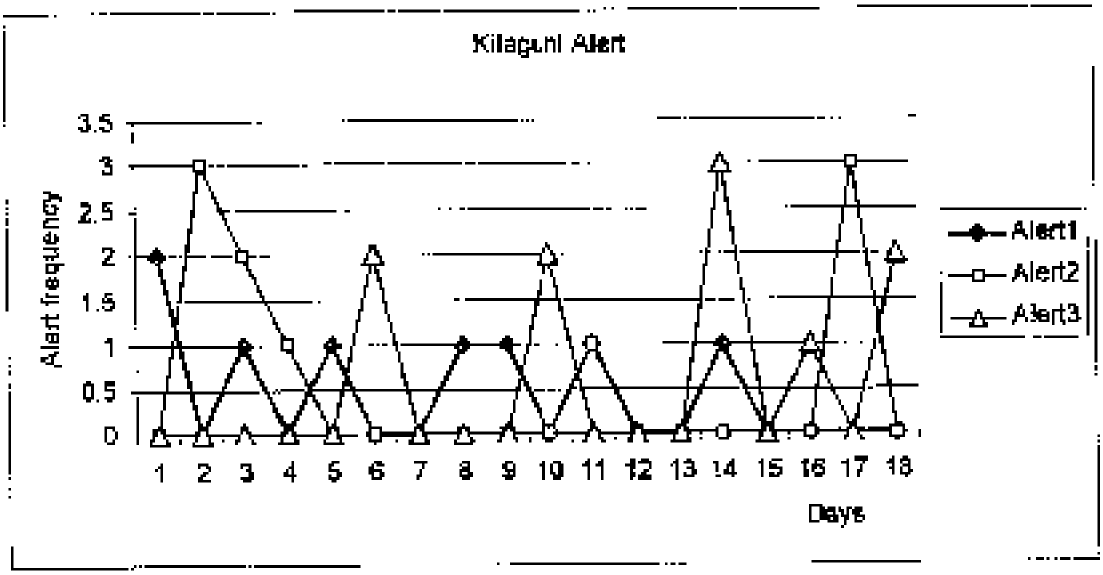


Diagram 104: Behavioral curves for Kilaguni. Data points depict how often the behavioral pattern "alert" was observed each day. Alert1: Curve of days during Kilaguni's first time-period; Alert2: Curve of days during Kilaguni's second time-period; Alert3: Curve of days during Kilaguni's third time-period.

This behavior was not shown much more by Kilaguni as it was by Ine. The first curve (diagram 104, black diamond) started with the highest point of the curve, at a level of two, and from began to fluctuate between o and one for the rest of the time-period.

The second curve (white square) began with a peak on day 2 at a frequency of three, after which it slowly decreased to zero at which point it stayed for most of the second time-period. Only days eleven and 17 showed this behavior again, reaching a frequency of one and three respectively.

The third curve (white triangle) showed three peaks at a level of two (on days 6, 10 and 18), and one peak at one on day 16.

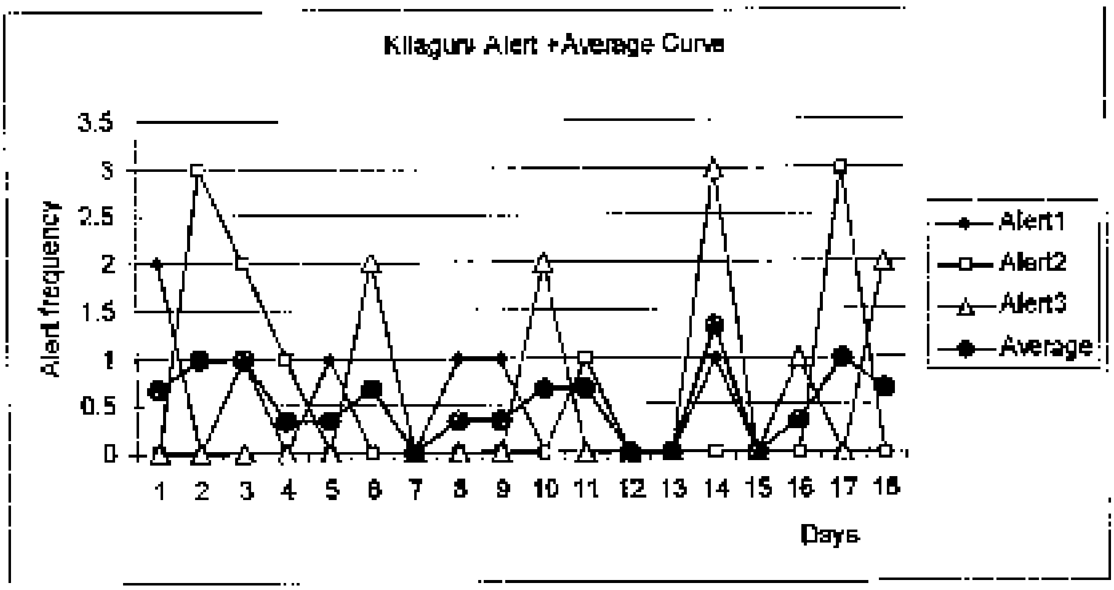


Diagram 105: Behavioral curves for Kilaguni. Data points depict how often the behavioral pattern "alert" was observed each day and the average of each days observations. Alert1: Curve of days during Kilaguni's first time-period; Alert2: Curve of days during Kilaguni's second time-period; Alert3: Curve of days during Kilaguni's third time-period; Average: Curve of the average of each days data points.

The average curve (diagram 105, black circle) demonstrated that although this behavior appeared to have occurred frequently, this was not the case. The average wavered throughout the period between no activity and a frequency of one, with one exception, day 14, when it peaked at about a frequency of 1.4.

Due to this low level of behavior the morning/afternoon separation will not be discussed, but will be included in the appendix.

3.9.2 Morning/Afternoon Separation

3.9.2.1 Sita

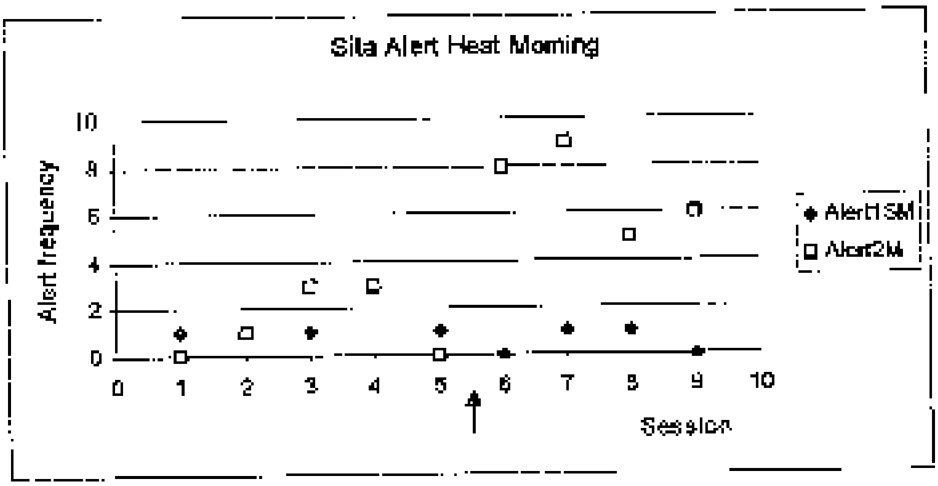


Diagram 106: Data points the frequency with which Sita was observed at "alert" each morning of observation, during the time-period previously discussed. Here, estrus lies between days 5 and 6, which means that estrus occurred during an afternoon session. Alert1SM: Morning observations of Sita surrounding her first estrus. Alert2SM: Morning observations of Sita surrounding her second estrus.

During the morning sessions (diagram 106), this behavior was observed more often in Sita, than in the afternoon (diagram 107)

The first curve (black diamond) began steady at a frequency of one until session 4, when it increased to a level of three. Leading to the session after estrus (session 6), the curve declined to zero. During sessions 7 and 8 the curve reached a level of one, while no activity was observed during the last session.

The second curve (white square) began with a rise from no activity to a level of three during sessions 3 and 4. The fifth session showed no activity, while the day after estrus an ascent to a frequency of eight (session 6) and ultimately to a level of nine occurred. Session 8 showed a small decrease to five, and the last session ended at a frequency of six.

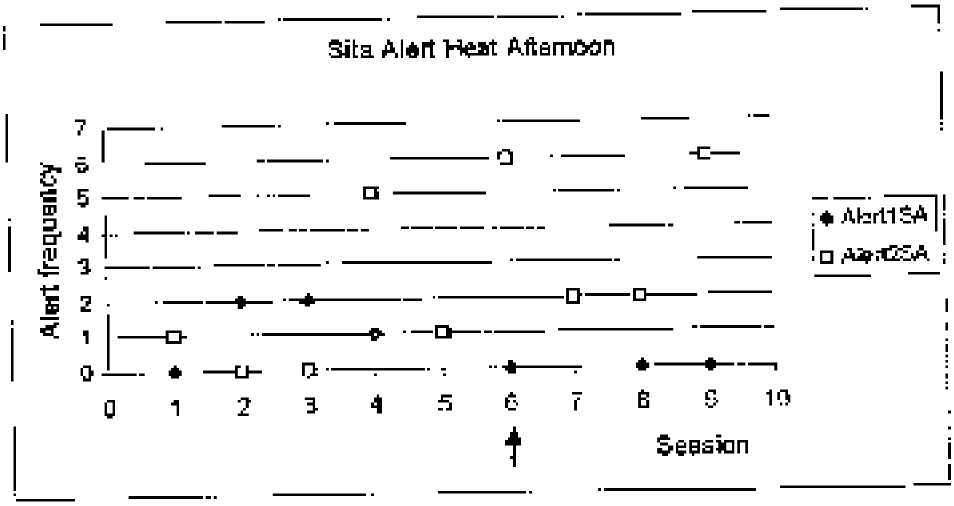


Diagram 107: Data points the frequency with which Sita was observed at "alert" each morning of observation, during the time-period previously discussed. Here, estrus lies during session 6. Alert1SA: Afternoon observations of Sita surrounding her first estrus; Alert2SA: Afternoon observations of Sita surrounding her second estrus;

Similar to the first curve during the morning sessions (diagram 106), the first curve during the afternoon session (diagram 107, black diamond) stayed between zero and a level of two. In the first session, no activity was observed. This led to a level of two during sessions 2 and 3, and decreased to one during session 4 and 5. The sixth session showed no activity, while the seventh session increased to a frequency of two. The remaining sessions showed no activity. The second curve (white square) began at a level of one during the first session, which decreased to zero during session 2 and 3. The fourth session climbed to a level of five, while the fifth session showed a dip in the curve at a frequency of one. On the day of peak receptivity, the curve peaked to a level of six, which was followed by a frequency of two during sessions 7 and 8. The last session increased again to end at a level of six.

To summarize the results of the behavior 'alert':

Sita: Of all three females, she showed this behavior the most. During the first heat cycle the behavior was steady throughout without obvious peaks. The second heat cycle showed three peaks, each one higher than the last. The two largest peaks were on days 12 (day after estrus), and 14. No difference could be seen between morning and afternoon sessions.

Ine: Only showed this behavior twice in 54 days. Each occurrence was during the third heat cycle on days 4 and 16.

Kilaguni: Behavior was observed slightly more than in Ine. Two large peaks were recorded during the first time-period on days 3 and 17, and one during the second time-period on days 6 and 7.

3.10 Restless

3.10.1 Daily Observations and Average Curve

3.10.1.1 Sita

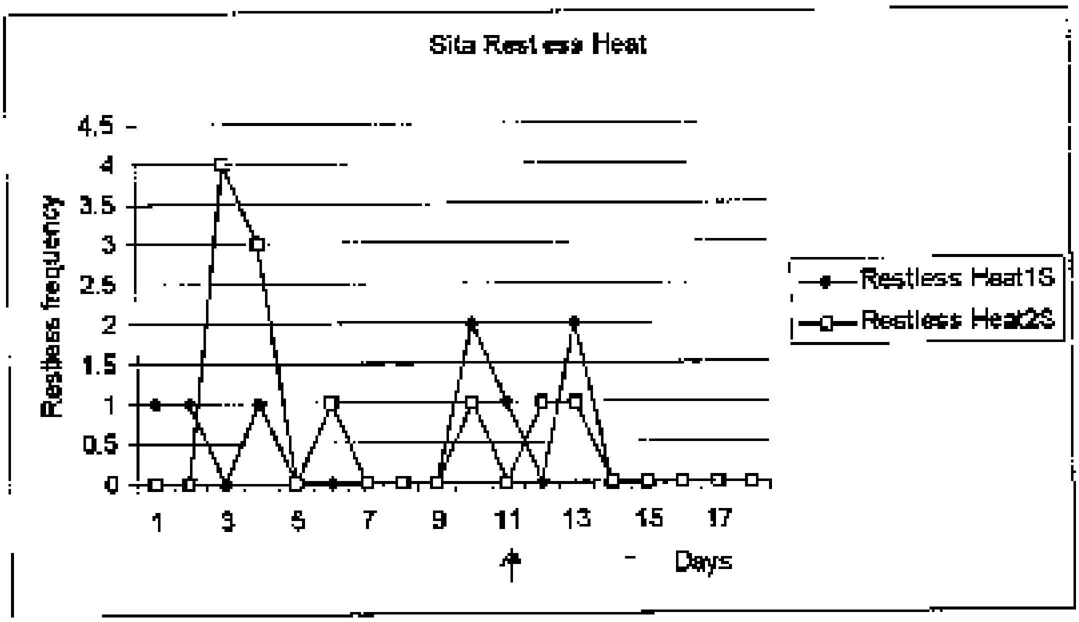


Diagram 108: Behavioral curves for Sita with peak receptivity on day 11. Data points depict how often the behavioral pattern "restless" was observed each day. RestlessHeat1S: Curve of days surrounding Sita's first estrus; RestlessHeat2S: Curve of days surrounding Sita's second estrus.

This was a behavior, which was not observed very often.

The first curve (diagram 108, black diamond) began at a level of one for the first two days, then started to fluctuate between zero and one from day 3 to 5. Days 5 through 9 all showed no activity, while the tenth day climbed to frequency of two. After this, the curve slowly decreased to return to zero on day twelve and peak again on the thirteenth day. The remaining five days (14 to 18) showed no activity.

In the second heat cycle (white square), during days one and two, no activity was observed. The third day peaked at a level of four, which declined again to reach zero on day 5. From this point on, the curve stayed between zero and one, showing activity on days 6, 10, 12 and 13.

3.10.1.2 Ine

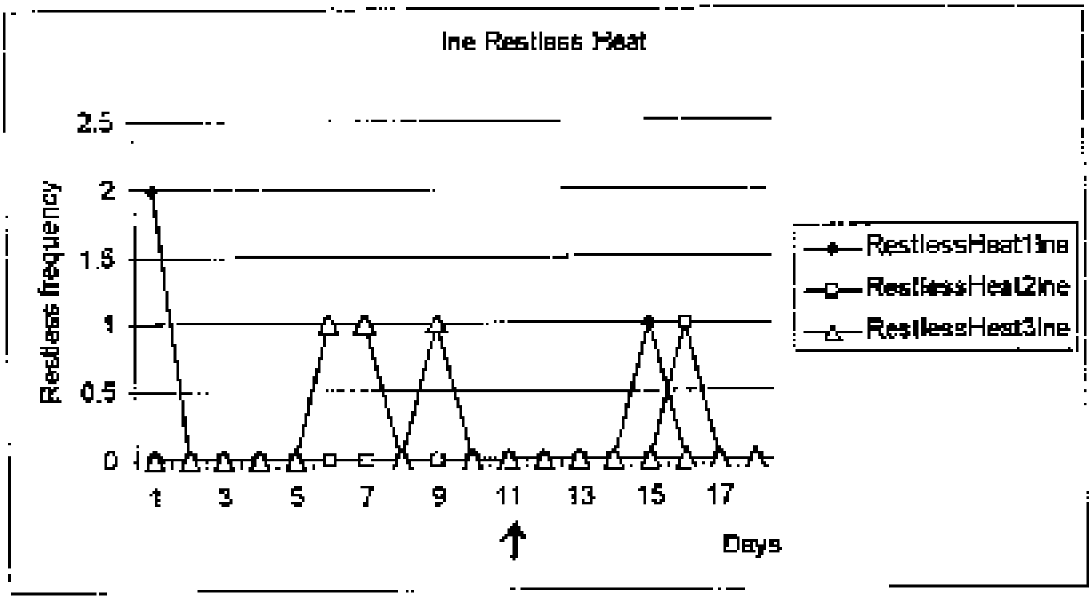


Diagram 109: Behavioral curves for Ine with peak receptivity on day 11. Data points depict how often the behavioral pattern "restless" was observed each day. RestlessHeat1Ine: Curve of days surrounding Ine's first estrus; RestlessHeat2Ine: Curve of days surrounding Ine's second estrus; RestlessHeat3Ine: Curve of days surrounding Ine's third estrus.

As with Sita, this behavior was rarely observed in Ine.

During the first the heat cycle (diagram 109, black diamond), it was observed twice on day 1 and once and day 15. During the second heat cycle (white square), it was observed once on day 16 and in the last curve (white triangle), it reached a frequency of one on the sixth day, seventh and ninth.

No average curve or morning/ afternoon separation curve will be discussed, due to the frequency of behavior observed (refer to appendix).

3.10.1.3 Kilaguni

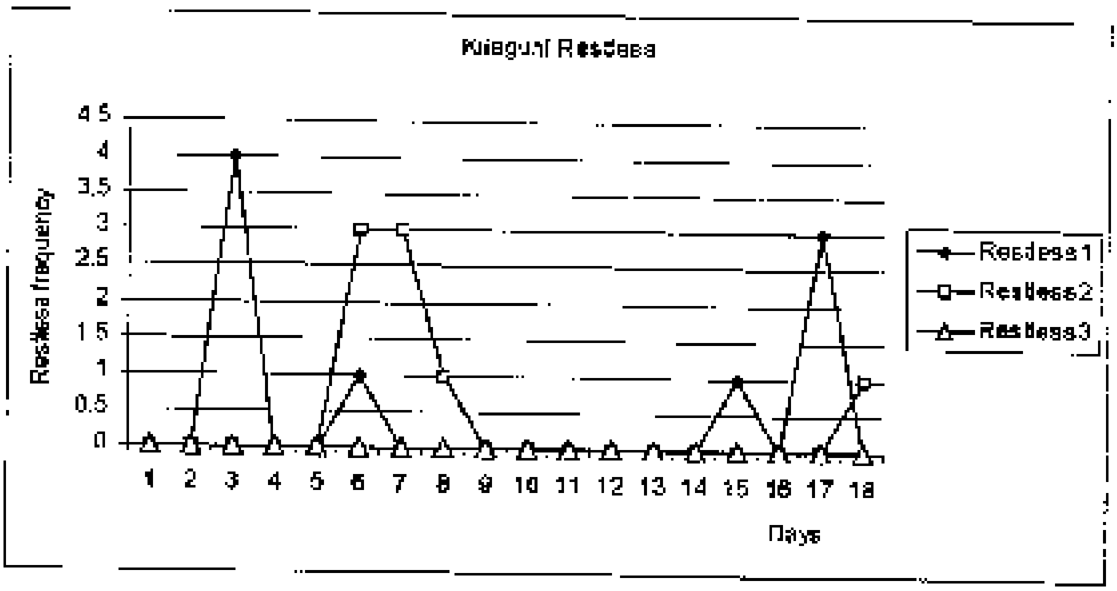


Diagram 110: Behavioral curves for Kilaguni. Data points depict how often the behavioral pattern "restless" was observed each day. Restless1: Curve of days during Kilaguni's first time-period; Restless2: Curve of days during Kilaguni's second time-period; Restless3: Curve of days during Kilaguni's third time-period.

Likewise, this behavior was not observed often in Kilaguni.

During the first time-period (diagram 110, black diamond) day three showed a frequency of four, day 6 reached a level of one as did the fifteenth day. The last peak was reached on day 17 at a level of three.

In the second curve (white square), this behavior was observed on days 6 and 7 at a level of three, which was followed by a decline to one on day 8. Only the last day showed another rise to one, while on all other days no activity was observed.

During the third time (white triangle) period this behavior did not occur.

To summarize the results of the behavior restless:

Site: Two small peaks were observed in the first heat cycle on days 10 and 13 and one large peak was seen on day 3 during the second heat cycle. The rest of the observation period was situated between zero and one.

Ine: Rarely was this behavior observed. Only during the first heat cycle, did the behavior reach above a level of one. No connection to estrus is plausible.

Kilaguni: Two peaks reached above a frequency of one in the first time-period (days 3 and 17) and two during the second time-period (day 6 and 7).

4. DISCUSSION

1. Hypothesis: *Time spent pacing increases steadily up to peak receptivity and falls off gradually following estrus.*

This hypothesis must be refuted as it stands.

Of all the heat cycles observed, only Ine's third heat cycle demonstrated an increase in pacing leading to estrus. All other curves fluctuated more or less strongly. Pacing after estrus also can not be said to decrease in any of the curves. Most continued fluctuating in the same manner as before estrus. The curve that had shown an increase in pacing prior to estrus leveled off after estrus at a percentage not far below the estral peak. The only other noteworthy pattern was a peak shown by Sita during her second heat cycle on day 15.

Kilaguni did not show any gradual increases or decreases in any of her curves, concerning this behavior.

2. Hypothesis: *Just prior to estrus, small peaks in standing are evident.*

In Sita's case, no evidence was given in her curves to warrant this hypothesis. Both curves stayed steady at a moderately high level, showing no peaks worth note before estrus. The only obvious peak occurred on day 16, well after estrus, and this only during the first heat cycle.

Unlike Sita, Ine showed a peak in this behavior on the day prior to estrus during the first two heat cycles. Each peak was approx. 20% above the previous highest point, located on day 7, after which the curve showed a sharp decline. The third curve gradually increased until day 7, after which it stayed steady at a much lower level, thus this could be seen as a small peak before estrus. Based on this, there may be a possible positive to this hypothesis in Ine's case, since 2/3rds of the curves showed a large peak before estrus and all curves showed a small peak on day 7. However, since this smaller peak is four days prior to estrus more samples would have to be taken to confirm this premise.

Kilaguni's behavior pattern demonstrated gradual fluctuations in two curves. Curves 1 and 2 might be comparable to Ine's curves, however none of the observed peaks occurred on the same day, so they may be a random occurrence.

3. Hypothesis: *There were small peaks in eating following estrus.*

This hypothesis must be firmly rejected, at least in the case of these females.
For both females in this study, feeding fluctuated on an almost daily basis. Therefore, no peaks could be determined after estrus, that were different from those prior to estrus.

When examining the separated sessions, it became apparent, that feeding was, in itself, quite steady. If anything, the curves declined after estrus, and any peaks that appeared in the curves, occurred before estrus. This leads to the observation that feeding levels before estrus were higher than after estrus.

For Kilaguni eating was steady throughout the observation, fluctuating between 0% and 30% consistently. No portion of the observed curve could be said to be at a higher level than any other, such as could be seen in the pre-estral feeding patterns of the other females.

4. Hypothesis: *During receptivity, the female spends less to no time lying down.*

This hypothesis was confirmed by both females, which showed little to no lying on the day of estrus. However, it must be noted, that in Ine's case, little to no lying was observed on a few other days as well.
The only days Sita did not lay were the day of estrus during both heat cycles, and on day 15 in the second heat cycle.

Kilaguni's behavior pattern was situated between these two examples. More days than two days were observed when no lying took place, however, not as many occurred as Ine demonstrated.

5. Hypothesis: *The behavior smell should increase with the approach of estrus.*

Again, this hypothesis must be rejected. Both females showed no increase in smelling leading to estrus. The peak in most heat cycles occurred well after estrus. For Ine this peak was on day 16 and for Sita on day 15.

Kilaguni's behavior pattern fluctuated wildly in every curve throughout the observation period, with at least three peaks. None of the curves showed a peak on the same day. No similarities between Kilaguni's curves and those of the other females could be found.

6. Hypothesis: *The urination frequency should increase with the approach of estrus.*

No definite peak could be determined on the day of estrus for either of the females, and the frequency did not increase leading to estrus. The only obvious peak in Sita's behavior pattern occurred on day 15 in the second heat cycle.
Similarly, Ine's curves did not increase towards estrus, and the only obvious peak in the curve occurred on day 14 of the third heat cycle.

Kilaguni showed a higher rate of urination than the other female, however no peaks over a frequency of twenty occurred during the observation, as they were seen for Ine and Sita.

7. Hypothesis: *With the approach of estrus, rubbing should increase.*

In both females, this behavior did not occur very often.
For Sita, this behavior was observed less than 10% for most of the observation time. Only on two occasions did it reach above this level: on day 15 in the first heat cycle and on day 7 of the second heat cycle. Thus, no increase leading to estrus could be determined.

None of Ine's heat cycles showed a rise in rubbing leading to estrus, in fact, on and around the day of estrus rubbing stayed below 10 %.

Similar to the other females, rubbing was observed less than 10% during all time-periods. For Kilaguni rubbing took place on days when lying was almost non-existent. This connection was not observed in the other females.

8. Hypothesis: *Defecation should increase around the day of estrus.*

In Sita's case, an increase was evident starting on the day of estrus until the end of the observation period. This occurred in both heat cycles.

This observation could not be confirmed for Ine. Throughout the observation period, defecation was steady with a frequency of zero and a level of one being the norm. A frequency of two, as with Sita, was only rarely observed. Thus, no connection to estrus could be made.

Kilaguni showed a higher rate of defecation than the other females, similar to her higher frequency of urination.

9. Hypothesis: *The behavior pattern 'alert' should increase with the approach of estrus.*

This hypothesis can not be confirmed as it stands, at least with the females observed in this study, since only Sita showed this behavior with any regularity.
Even in Sita this behavior showed only remarkable levels of occurrence in the second heat cycle, when it ultimately peaked on day 15, well after estrus. The first heat cycle stayed steady at a low frequency and could not be connected to the approach of estrus.

Ine showed this behavior only twice in the entire observation period, and each occurrence was during the third heat cycle (on days 4 and 16).

Kilaguni showed this behavior slightly more often than Ine, however not in any kind of pattern that could be determined, such as a steady rise to a certain day.

In summary, most of the hypotheses discussed must be either rejected or revised. Of the hypotheses put forward by L.J. Mills, only the hypothesis concerning the behavior 'lay' was confirmed by both females during both heat cycles. The other hypotheses were either validated by one female alone (i.e. stand), by one female during one heat cycle (i.e. pace), or were refuted.

Mills based her estral cycles upon the behavior of the male; such as on the interest he exhibited towards the female. Aided by the males behavior, the approach of estrus was assumed and with the repeated mounting of the male, the day of estrus was concluded. Due to the youth and inexperience of the both animals, mounting may not have occurred exactly on the day of estrus, but instead a few days thereafter.
Observations made on the male during this study would suggest that the male's interest in the female is not always a sure sign of estrus.
Prior to Ine's second estrus, the male showed an interest in her for six days, which would be consistent with other observations (Adcock, Emslie; 1997). However, in this case, the male

lost interest two days prior to estrus as was determine by analysis. During the third heat cycle his interest began four days prior to estrus and lasted until two days thereafter. Within fourteen days his interest was again aroused, however the female showed no appeal for his advances. No estrus was recorded at this time, however it could have taken place shortly after the study had ended.

Overall, Sita confirmed the hypotheses that no laying occurs during estrus, and that defecation increases around the day of estrus. On the other hand, Ine confirmed the hypotheses that (small) peaks arise in standing just prior to estrus, and as with Sita, that little to no lying occurs on the day of peak receptivity. Lastly, she showed an increase in pacing during one heat cycle, which peaked on the day of estrus and decreased again thereafter.

From the results of Sita's first and Ine's first and second heat cycles, it would appear that no generalizations can be made in the behavior patterns of female Black Rhinos.
Contradicting this assumption are Sita's second heat cycle and Ine's third heat cycle, which displayed similar behavior patterns.
Although no peaks were observed on the day of estrus itself, both Sita and Ine demonstrated considerable peaks fours days (+/- one day) after estrus in several behavioral elements. These peaks occurred for Sita on day 15 in the behavioral elements of pacing, smelling and urinating. Additionally, no lying was observed on this day as well. The behavior alert peaked on the previous day.
In Ine, most of these peaks did not occur on the fourth day after estrus, but instead on the sixteenth day. This included the behavior elements pacing (second peak; only slightly lower than the estral peak), smell and alert, and no lying took place on this day. The behavior element 'Urinate' showed its peak on day 14.

Since the day of estrus was determined in this study by the beginning of a rise in the progesterone concentrations in the fecal samples, it can be argued that the observed lag between behavior peaks and estrus, is due to the fact, that the discharge of ova does not occur until a few days after progesterone leve s begin to rise (Brooks, 1970).
This could further explain the differences between the observed estrus in Mills study versus the estrus determined by analysis in this study.

The peaks in urination and, in Sita's case, defecation can be explained as side effects of the search for a male. In the wild, an increased urination and defecation rate would increase the chances a female has at finding a male, or rather in a male finding her.
Males that come upon a dung pile can asses the status of the female that left this 'calling card' behind, and follow her trail (Meister, 1997). Similar behavior has been observed in the

Indian Rhinoceros. Females in estrus will leave urine trails or defecate on communal dung piles, which dominant males will smell and begin to follow her trail. (Laurie, 1997)
Similarly, the behavioral element 'smell' can be explained. Most often this behavior was observed at dung piles. Frequent smelling of dung piles can be explained by observations made in the wild that these represent a point at which animals pick up the scent of recent visitors to the region. In a female that is searching for a mate, dung piles would be natural stops in her wanderings to discover if a male had recently passed through the area. Thus, her search efforts would not be aimless.

This search for a mate also explains the peaks observed in pacing, when one keeps in mind that home ranges of the female Black Rhino tend to be about 14.9 km^2 for the female and 15.6 km^2 (Hillman-Smith, Groves; 1994). In many species of large mammals (e.g. kangaroos, wallabies, elephants etc.), females roam over greater distances during estrus. This increases the probability of meeting a mate.

The behavior element 'alert' can be considered a sign of heightened vigilance, similar to that observed in other herbivores. Both are characterized by head raising, forward pointing of the ears, and a general appearance of tension in the animal. This behavior can not be explained in the rhinoceros by a risk of predation, since the adult animals are not preyed upon by natural enemies to a significant degree (Adcock, Emslie; 1997; Estes,19). Considering the usual habitat preferences of the Black Rhinoceros, this often includes many bushes and shrubs (Hillman-Smith, Groves; 1994) this could be another sign of partner search.

The hypothesis that feeding should peak after estrus could not be confirmed in this study. Both females spent more time feeding before estrus than after. Biologically speaking this would make sense. Through increasing the intake of food, the females increased the energy available to them during and after estrus. This energy will be needed by the female later during courtship and especially when mating is successful, for the nourishment of the fetus. Courtship among rhinoceroses can be quite severe if not exhausting. Before the female will allow the male to approach her from the rear, oftentimes hours or days of combat and/or chases have preceded this. Although fights usually are not that serious in Black rhinos, fatalities have been known to occur (Adcock, Emslie; 1997).
This increased rate in eating did not manifest itself the same in both females. Ine tended to eat at a higher percentage per day than Sila. This could be due to the presence of a competitor for food in Ine's case, in the form of her 3-year-old daughter. It could be a result of the age or weight difference between these females. Ine is a slightly larger animal, being quite tall and she is five years older than Sila.

The increase in eating is an explanation for Ine's repeated low levels of lying before estrus. The time she did not spend lying, she most often spent eating. Due to the lack of competition for food, Sita could spend less time eating. Therefore, the only times during the observation, when Sita spent no time lying, occurred during estrus and on day 15.

Originally, this study was designed to utilize a new statistical method developed by Ello and Würz (1989), the "Programpaket für die nicht-parametrische und parametrische uni- und bivariate Zeitreihenanalyse". This program was to help in assessing the repetitive nature of the observed behavior and correlate this to the estrus of the female. Lacking the exact progesterone concentrations of the females' cycles, the estrus curves could not be established. Thus, this program could not be utilized.

This program was used in a similar study in gorillas by E. Pfeffer (1995), in which a pair of gorillas was observed in the Saarbrücken Zoo. The activity of the female was observed as well as the behavior shown by the male towards the female and vice versa, since these are social animals. Additionally, fecal and urine samples were taken to determine the females estral cycle. In this study, only one behavior pattern showed a correlation between behavior elements and the estral cycle.

A similar study was conducted by Rodden et al. on the Maned Wolf (*Chrysocyon brachyurus*). Through observation of about 26 pairs for seven breeding seasons, certain behavior elements were found that helped to identify reproductive behavior and, more importantly, indications of successful breeding. Typifying breeding pairs was an increase in affiliative behavior during breeding season, while pairs that were not successful showed minimal variation throughout the breeding season.

This study successfully demonstrated that it is possible to determine the estral condition of a female mammal by observing the behavior patterns she exhibits.

Conclusions:

Although only two curves of the females coincide in the behaviors 'pace', 'smell', 'lay', 'urinate' and 'alert', this gives a starting point for further studies. These should aim at determining if the guidelines given here can establish a females reproductive cycle. By pinpointing the average reproductive cycle of a female based on the behavioral peaks in 'pace', 'urinate, 'lay', 'smell' and 'alert', and subtracting three to six days, one should be able to distinguish the actual time of estrus.

If this is successful, breeding programs will no longer have to rely on costly hormone level analyses or guesswork when bringing the male and female together to mate. Furthermore, other methods such as embryo-transfers or artificial; will have a higher chance of success.

5. Zusammenfassung:

Das Spitzmaulnashorn (*Diceros bicornis*) ist mit eines der bedrohtesten Tierarten Afrikas. Schätzungsweise leben heute ca 2000 Individuen noch in freier Wildbahn. Durch Wilderei hat sich, über die letzten 30 Jahre, eine einst weit ausgedehnte Population, in viele kleine Gruppen zergliedert. Durch diese Umstände, haben es sich die heutigen Zoos zur Aufgabe gemacht, durch Zuchtprogramme das Überleben dieser Tierart mitzusichern.

Spitzmaulnashörner sind in der freien Wildbahn Einzelgänger und leben oft in buschigen Habitaten. Die Weibchen durchstreifen Home ranges, die im Durchschnitt 14.9 km^2 betragen, und die der Männchen liegen bei etwa 15.6 km^2. Die Home ranges der Weibchen überlappen zu einem gewissen Anteil.
Nur dominante Bullen verteidigen gegenüber anderen dominanten Bullen ein Revier. Subdominante Bullen werden im Revier geduldet, solange sie dem dominanten Bullen bekannt sind.

Zu Kämpfen kommt es meist zwischen dominanten Bullen, aber auch zwischen Männchen und Weibchen bei der Paarung. Das Weibchen duldet die Annäherung eines Bullen nur, wenn sie im Oestrus ist. Je nach Individuen, kann es auch zu sehr heftigen Kämpfen kommen, eventuell zu Verletzungen oder gar zu Todesfällen.

Aus diesem Grund werden die Tiere in den meisten Zoos heute einzeln im Gehege gehalten. Da Hormonanalysen anhand von Blut-, Urin-, oder Fecalproben mit Kosten verbunden sind, erfolgt zur Zeit oft die Paarung fast nach dem Zufallsprinzip. Die Paare werden meist zusammengelassen, wenn das Männchen beginnt ein gewisses Interesse für das Weibchen zu entwickeln. Dies funktioniert natürlich nur, wenn die Individuen in benachbarten Stallungen hausen.

Basierend auf einer Studie von L.J. Mills (1995), sollte hier überprüft werden, ob man anhand des sich verändernden Verhaltens des Weibchens, dessen oestrischen Zustand festlegen kann.
Dazu wurden drei Weibchen im Berliner Zoologischen Garten über jeweils 94 aufeinanderfolgenden Tagen beobachtet. Zwei dieser Weibchen zeigten einen oestrischen Zyklus, während das Dritte, aufgrund einer vor kurzem erfolgten Geburt, keinen Zyklus zeigte.

Beobachtet wurden verschiedene Aktivitäten, wie z.B. 'Stehen' (stand), 'Liegen' (lay), 'Schnuppern' (smell), 'Urinieren' (urinate), 'Freßen' (eat) und 'Gehen' (pace) usw. Die Daten

wurden pro Tag vier Stunden nach der Scan-sampling Methode aufgenommen, wobei alle zwei Tage zwischen morgens und nachmittags alterniert wurde.
Durch Kotanalyse wurde anhand der ProgesteronKonzentration. der Tag des Oestrus bestimmt.
Eines der Weibchen zeigte zwei Zyklen, das andere drei Zyklen. Zum Vergleich der Tiere wurden um den Tag des Zyklus herum 17 Tage ausgewählt und die resultierenden Verhaltenskurven verglichen. Es lagen 10 Tage vor dem Oestrus und sieben Tage danach. Dementsprechend gab es für eines der Weibchen zwei Verhaltenskurven, und für das andere drei. Die Tage für die Verhaltenskurven des letzten Weibchens (ohne Zyklus), wurden so ausgewählt, daß sie denen des Weibchens mit drei Zyklen entsprachen. Durch die geringe Anzahl von Verhaltenskurven jedes Weibchens, wurden diese anhand beschreibender Statistik ausgewehrtet.

Es zeigte sich, daß beide Weibchen in einer Verhaltensweise in allen Zyklen übereinstimmten. Und zwar wurde am Tag des Zyklus fast kein "Liege"-Verhalten beobachtet. Ansonsten zeigte sich kein Verhalten, daß vor dem Oestrus auf diesen zrückschließen ließ. Nach dem Oestrus stimmten sie in einem Zykius jedoch in mehreren Verhaltensweisen überein. In den Verhaltensweisen 'Gehen', 'Liegen', 'Schnuppern', 'Alert' und 'Urinieren' zeigen sie Höhepunkte in ihren Verhaltenskurven vier Tage (+/- 1 Tag) nach dem Oestrus.

Somit läßt sich zwar nicht direkt aus dem Verhalten das herannahen des Oestrus schließen, jedoch könnte man anhand dieser Gipfel, die durchschnittliche Zykluslänge bestimmen. Demnach, könnte man ungefähr errechnen wann der Oestrus stattfinden müßte, und könnte zumindest das Männchen zur rechten Zeit mit dem Weibchen zusammenbringen.
Weitere Untersuchung wären angebracht, und zwar müßte eine längere Studie angelegt werden in der alle Bedingungen für die Zeitreihenanalyse von Mörz (1989) enthalten sind. Dies bedeutet eine gute und vor allem vollständige Kotanalyse, wobei idealerweise tägliche Proben entnommen werden, und viele oestrische Weibchen untersucht werden.

6. LITERATURE

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7. APPENDIX

7.1 Sita and Ine Combination Curves and Median Curves:

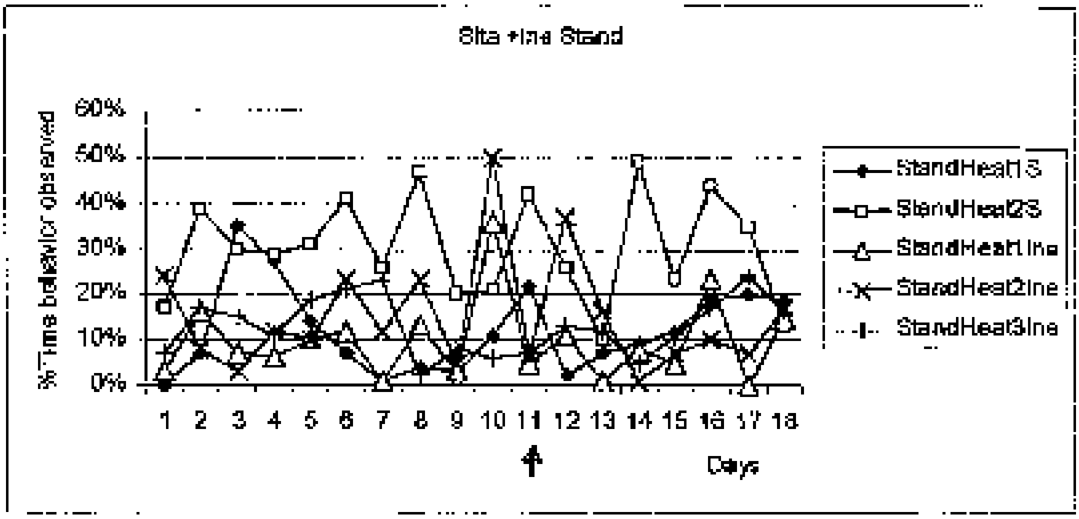

Diagram A1: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period standing was recorded. StandHeat1S: Curve of days surrounding Sita's first estrus; StandHeat2S: Curve of days surrounding Sita's second estrus; StandHeat1Ine: Curve of days surrounding Ine's first estrus, StandHeat2Ine. Curve of days surrounding Ine's second estrus: StandHeat3Ine: Curve of days surrounding Ine's third estrus.

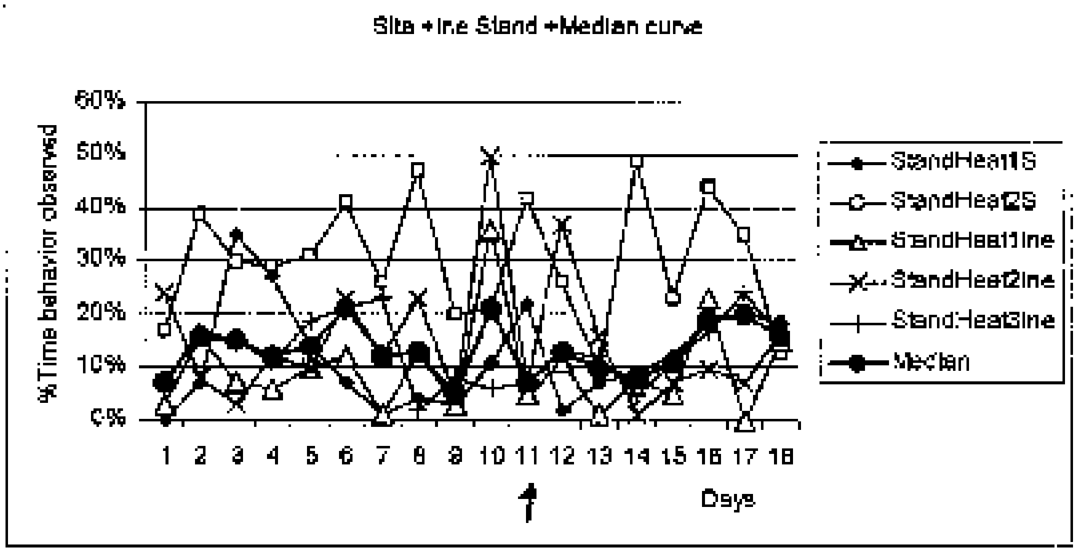

Diagram A2: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period standing was recorded. StandHeat1S: Curve of days surrounding Sita's first estrus; StandHeat2S: Curve of days surrounding Sita's second estrus; StandHeat1Ine: Curve of days surrounding Ine's first estrus; StandHeat2Ine: Curve of days surrounding Ine's second estrus; StandHeat3Ine: Curve of days surrounding Ine's third estrus; Median: Median curve of daily data points.

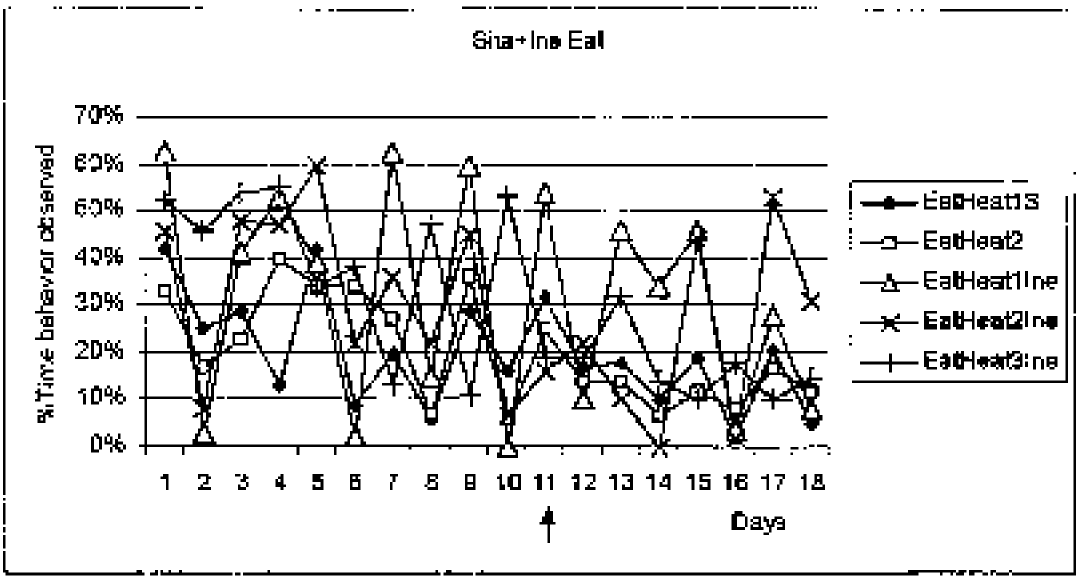

Diagram A3: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period eating was recorded. EatHeat1S: Curve of days surrounding Sita's first estrus; EatHeat2S: Curve of days surrounding Sita's second estrus; EatHeat1Ine: Curve of days surrounding Ine's first estrus; EatHeat2Ine: Curve of days surrounding Ine's second estrus; EatHeat3Ine: Curve of days surrounding Ine's third estrus.

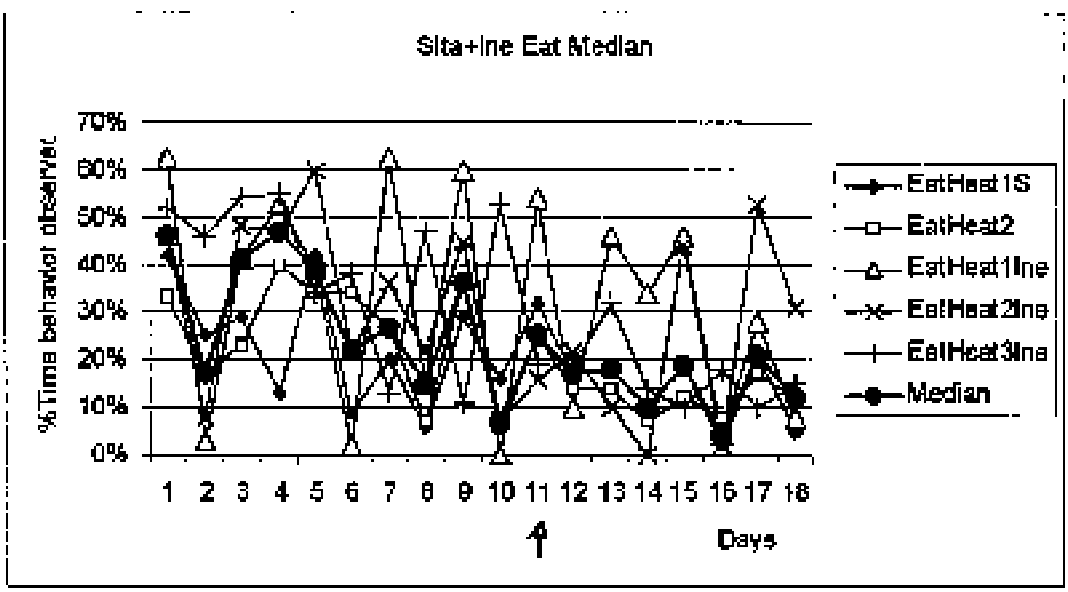

Diagram A4: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period eating was recorded. EatHeat1S: Curve of days surrounding Sita's first estrus; EatHeat2S: Curve of days surrounding Sita's second estrus; EatHeat1Ine: Curve of days surrounding Ine's first estrus; EatHeat2Ine: Curve of days surrounding Ine's second estrus; EatHeat3Ine: Curve of days surrounding Ine's third estrus; Median: Median curve of daily data points.

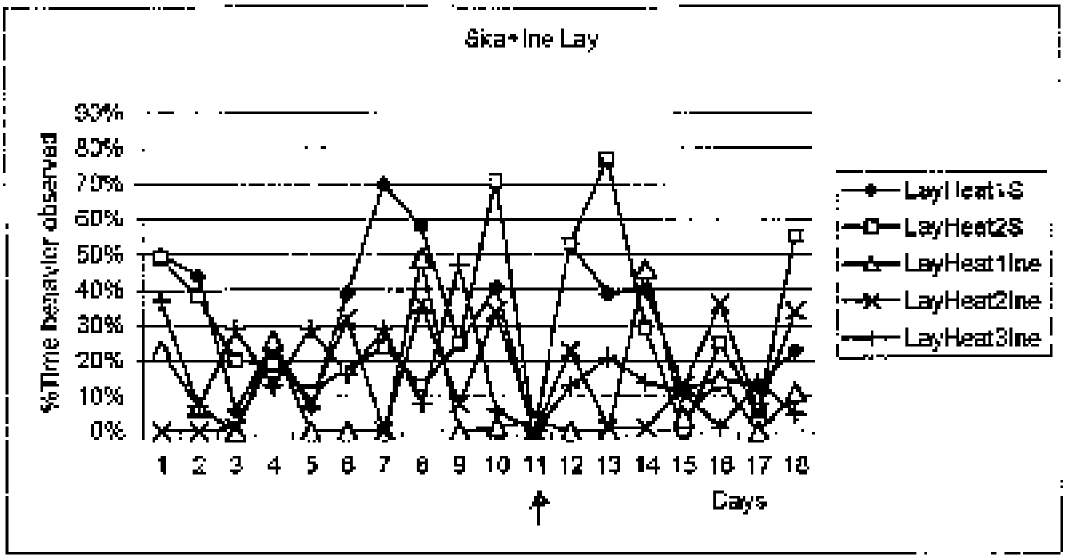

Diagram A5: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period lying was recorded. LayHeat1S: Curve of days surrounding Sita's first estrus; LayHeat2S: Curve of days surrounding Sita's second estrus; LayHeat1Ine: Curve of days surrounding Ine's first estrus; LayHeat2Ine: Curve of days surrounding Ine's second estrus; LayHeat3Ine: Curve of days surrounding Ine's third estrus.

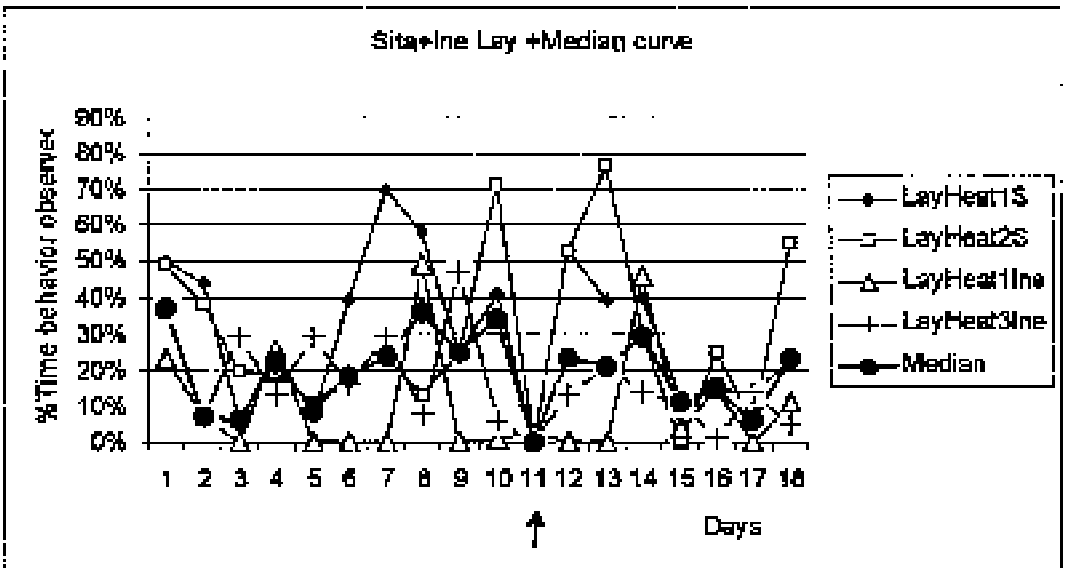

Diagram A6: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period lying was recorded. LayHeat1S: Curve of days surrounding Sita's first estrus; LayHeat2S Curve of days surrounding Sita's second estrus; LayHeat1Ine: Curve of days surrounding Ine's first estrus; LayHeat2Ine: Curve of days surrounding Ine's second estrus; LayHeat3Ine; Curve of days surrounding Ine's third estrus; Median: Median curve of daily data points.

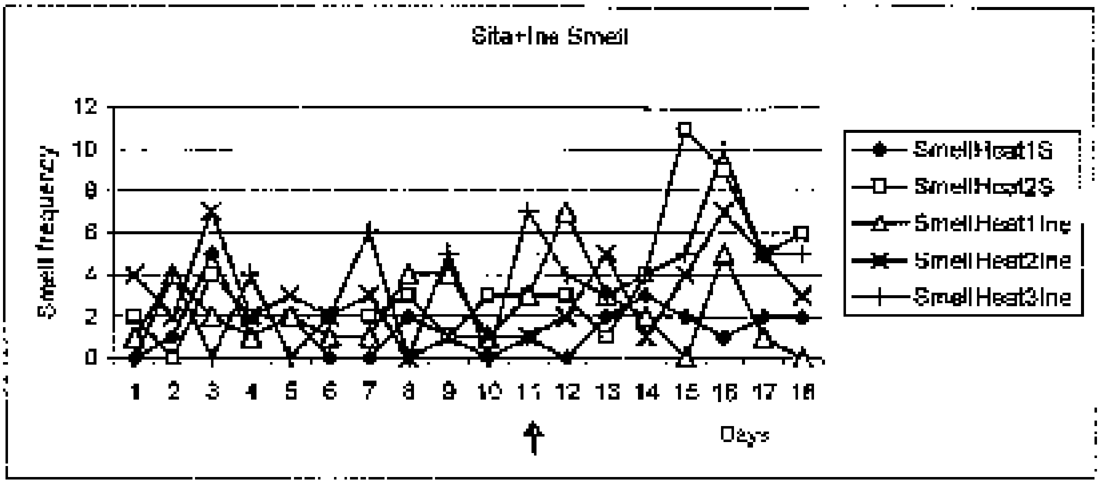

Diagram A5: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period smelling was recorded. SmellHeat1S: Curve of days surrounding Sita's first estrus; SmellHeat2S: Curve of days surrounding Sita's second estrus; SmellHeat1Ine: Curve of days surrounding Ine's first estrus, SmellHeat2Ine: Curve of days surrounding Ine's second estrus; SmellHeat3Ine: Curve of days surrounding Ine's third estrus.

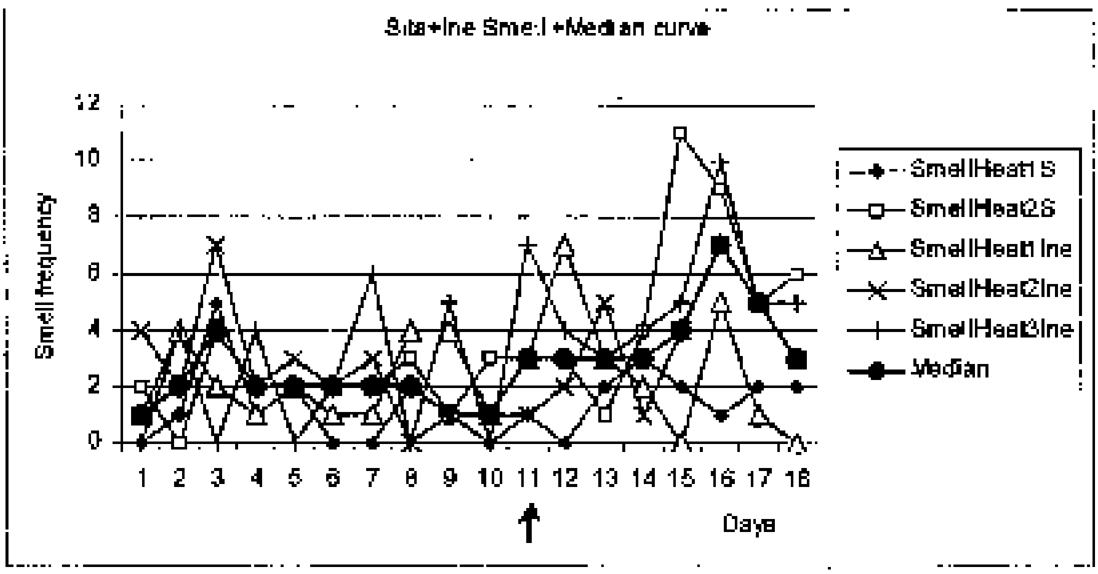

Diagram A8: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period smelling was recorded. SmellHeat1S: Curve of days surrounding Sita's first estrus; SmellHeat2S: Curve of days surrounding Sita's second estrus. SmellHeat1Ine: Curve of days surrounding Ine's first estrus; SmellHeat2Ine: Curve of days surrounding Ine's second estrus; SmellHeat3Ine: Curve of days surrounding Ine's third estrus; Median: Median curve of daily data points.

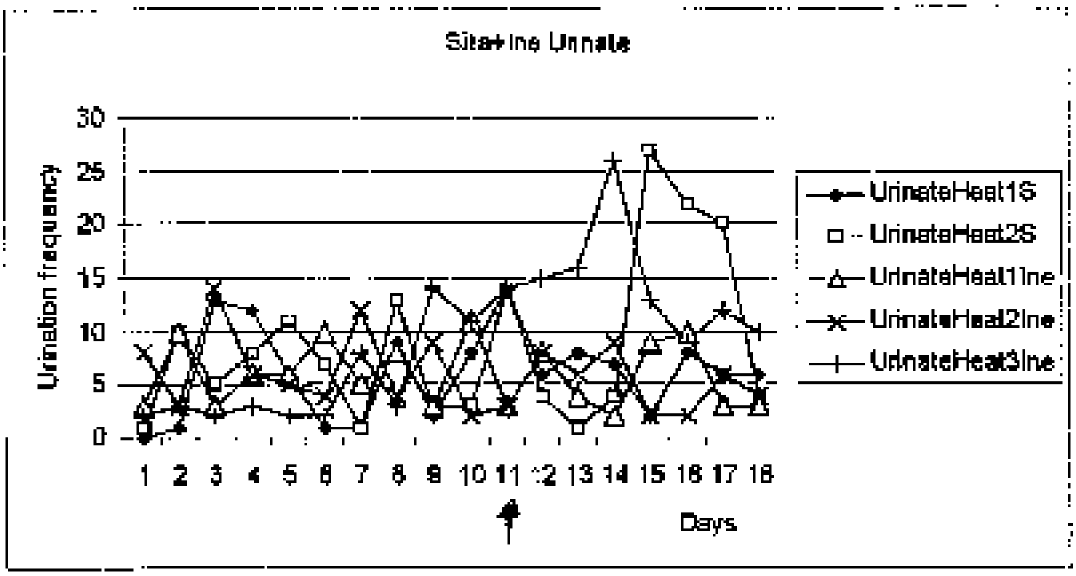

Diagram A9: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period urinating was recorded. UrinateHeat1S: Curve of days surrounding Sita's first estrus; UrinateHeat2S: Curve of days surrounding Sita's second estrus; UrinateHeat1Ine: Curve of days surrounding Ine's first estrus; UrinateHeat2Ine: Curve of days surrounding Ine's second estrus; UrinateHeat3Ine. Curve of days surrounding Ine's third estrus.

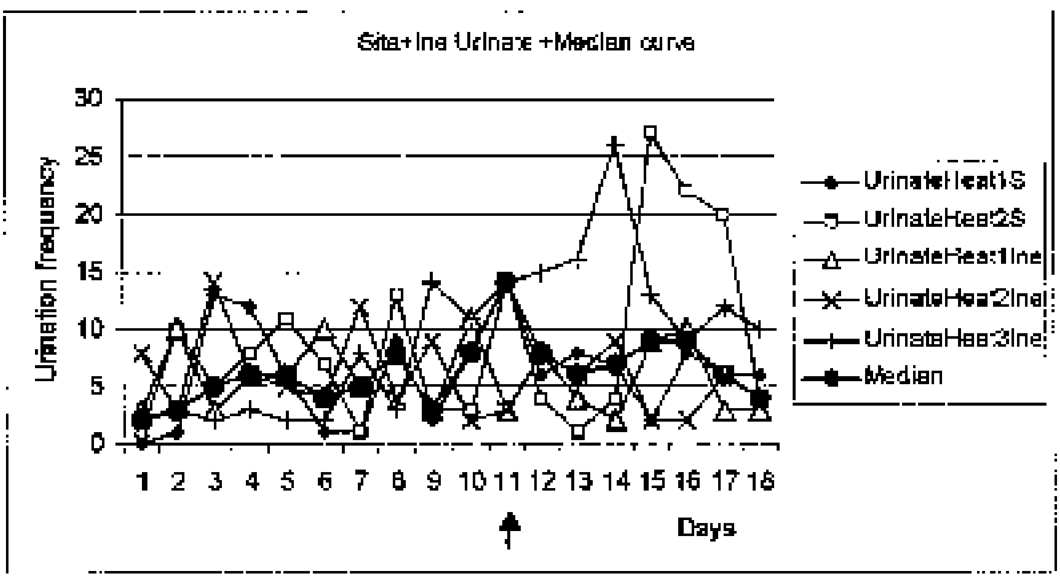

Diagram A10: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period urinating was recorded. UrinateHeat1S: Curve of days surrounding Sita's first estrus; UrinateHeat2S: Curve of days surrounding Sita's second estrus; UrinateHeat1Ine: Curve of days surrounding Ine's first estrus; UrinateHeat2Ine: Curve of days surrounding Ine's second estrus; UrinateHeat3Ine: Curve of days surrounding Ine's third estrus; Median: Median curve of daily data points.

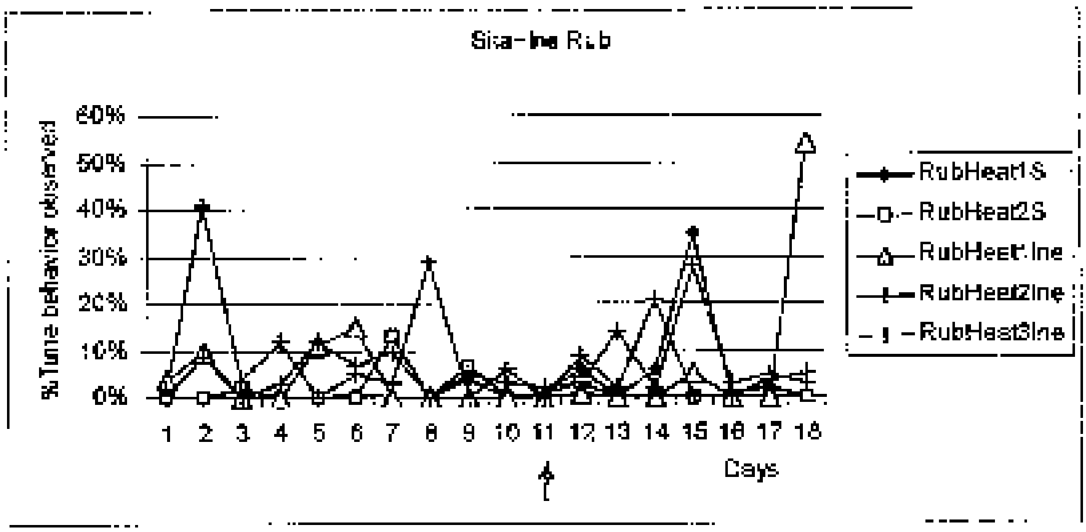

Diagram A11: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period rubbing was recorded. RubHeat1S: Curve of days surrounding Sita's first estrus; RubHeat2S: Curve of days surrounding Sita's second estrus; RubHeat1Ine: Curve of days surrounding Ine's first estrus; RubHeat2Ine: Curve of days surrounding Ine's second estrus; RubHeat3Ine: Curve of days surrounding Ine's third estrus.

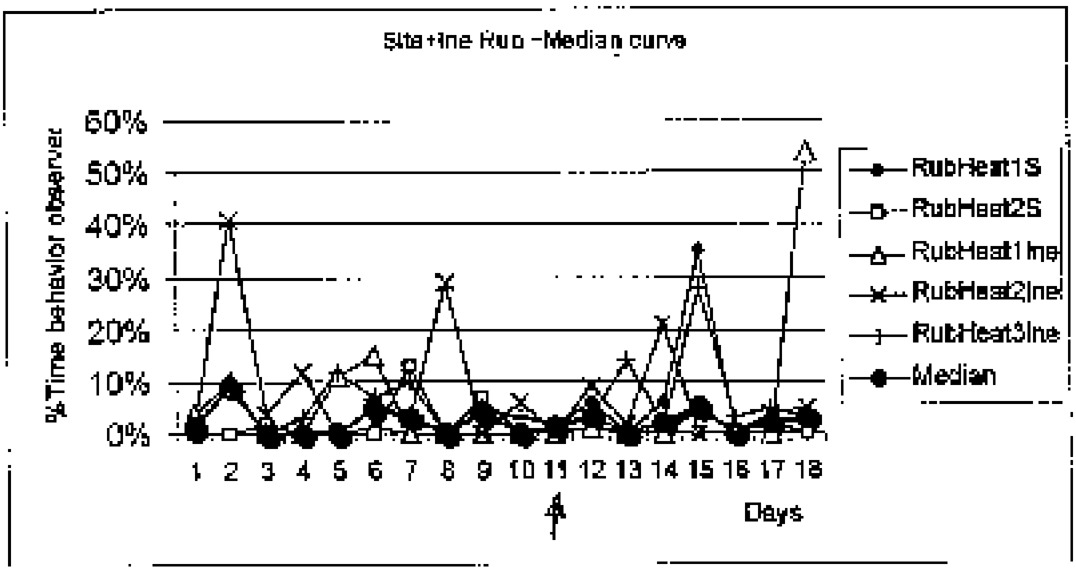

Diagram A12: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period rubbing was recorded. RubHeat1S: Curve of days surrounding Sita's first estrus; RubHeat2S: Curve of days surrounding Sita's second estrus; RubHeat1Ine: Curve of days surrounding Ine's first estrus; RubHeat2Ine: Curve of days surrounding Ine's second estrus; RubHeat3Ine: Curve of days surrounding Ine's third estrus; Median: Median curve of daily data points.

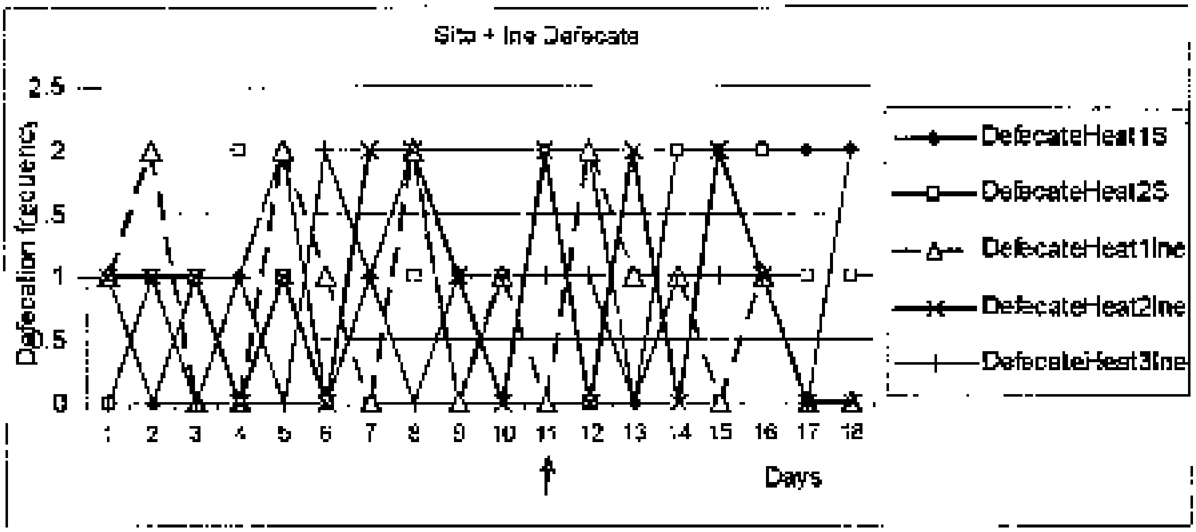

Diagram A13: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period defecating was recorded. DefecateHeat1S: Curve of days surrounding Sita's first estrus: DefecateHeat2S: Curve of days surrounding Sita's second estrus: DefecateHeat1Ine: Curve of days surrounding Ine's first estrus; DefecateHeat2Ine: Curve of days surrounding Ine's second estrus; DefecateHeat3Ine: Curve of days surrounding Ine's third estrus.

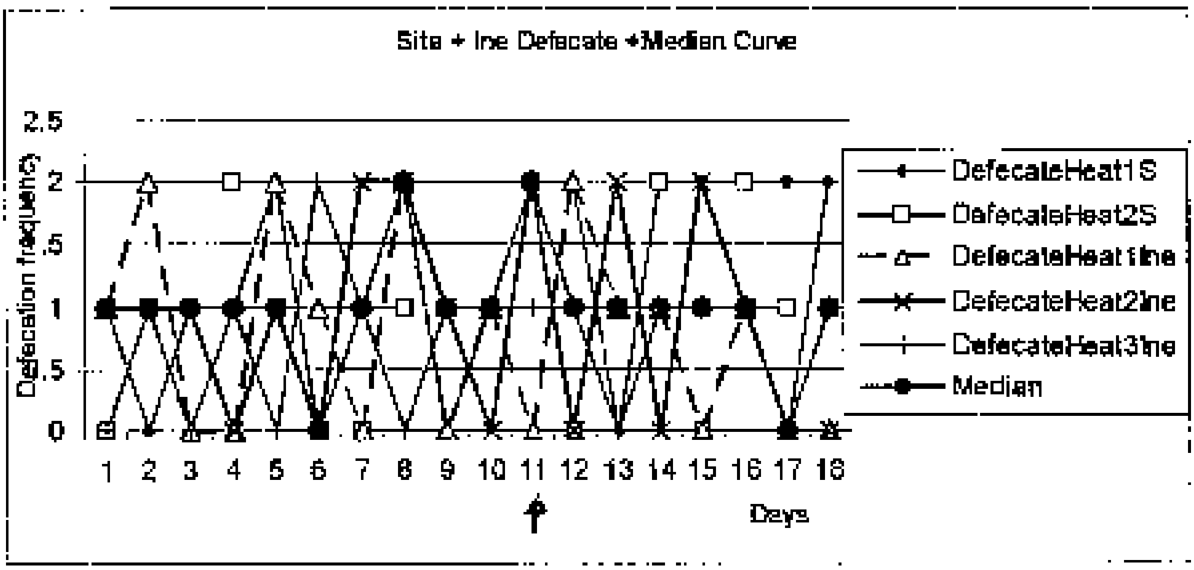

Diagram A14: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period defecating was recorded. DefecateHeat1S; Curve of days surrounding Sita's first estrus; DefecateHeat2S: Curve of days surrounding Sita's second estrus; DefecateHeat1Ine: Curve of days surrounding Ine's first estrus; DefecateHeat2Ine: Curve of days surrounding Ine's second estrus; DefecateHeat3Ine: Curve of days surrounding Ine's third estrus; Median: Median curve of daily data points.

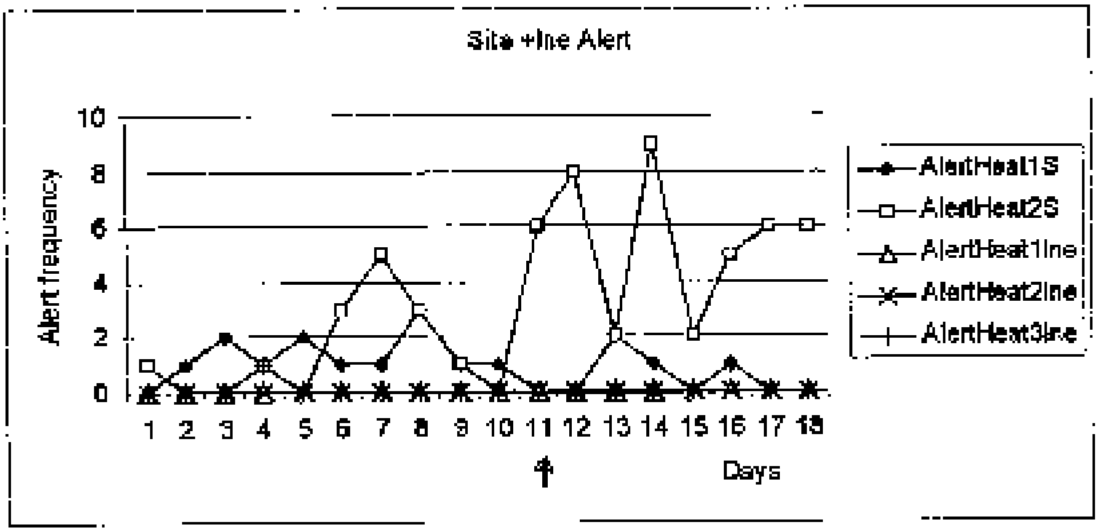

Diagram A15: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period alert was displayed. AlertHeat1S: Curve of days surrounding Sita's first estrus; AlertHeat2S: Curve of days surrounding Sita's second estrus: AlertHeat1Ine: Curve of days surrounding Ine's first estrus; AlertHeat2Ine: Curve of days surrounding Ine's second estrus; AlertHeat3Ine: Curve of days surrounding Ine's third estrus

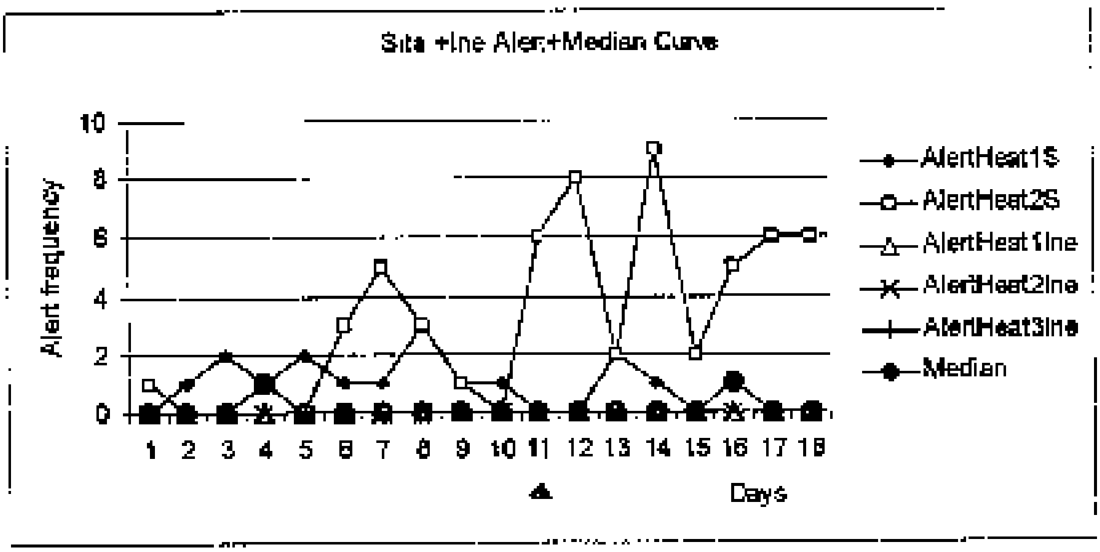

Diagram A16: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period alert was dislpayed. AlertHeat1S: Curve of days surrounding Sita's first estrus; AlertHeat2S: Curve of days surrounding Sita's second estrus; AlertHeat1Ine: Curve of days surrounding Ine's first estrus; AlertHeat2Ine: Curve of days surrounding Ine's second estrus; AlertHeat3Ine: Curve of days surrounding Ine's third estrus; Median: Median curve of daily data points

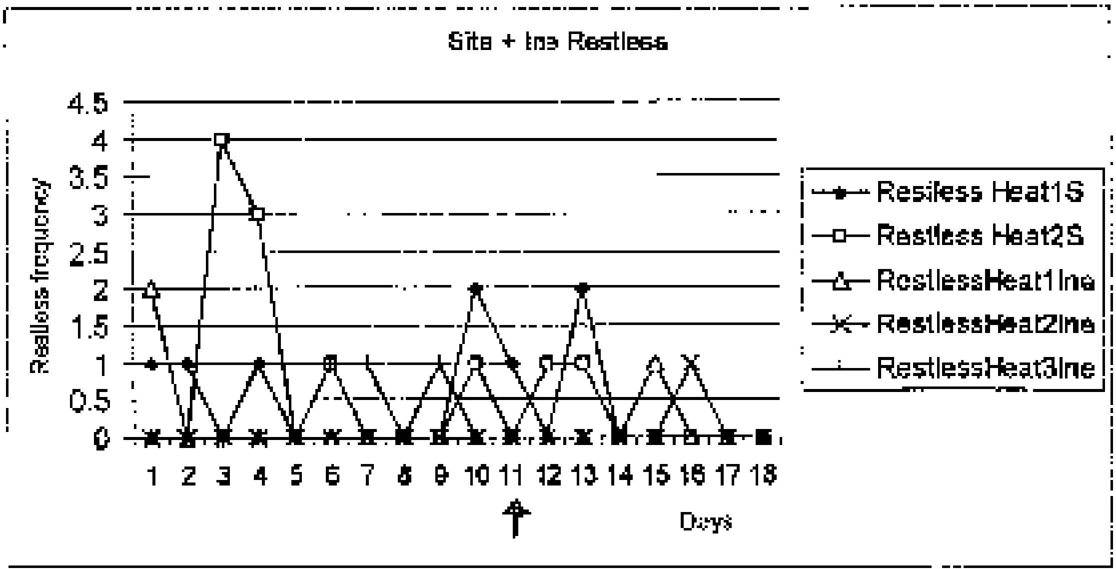

Diagram A17: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period restless was displayed. RestlessHeat1S: Curve of days surrounding Sita's first estrus; RestlessHeat2S: Curve of days surrounding Sita's second estrus; RestlessHeat1Ine: Curve of days surrounding Ine's first estrus, RestlessHeat2Ine: Curve of days surrounding Ine's second estrus; RestlessHeat3Ine: Curve of days surrounding Ine's third estrus

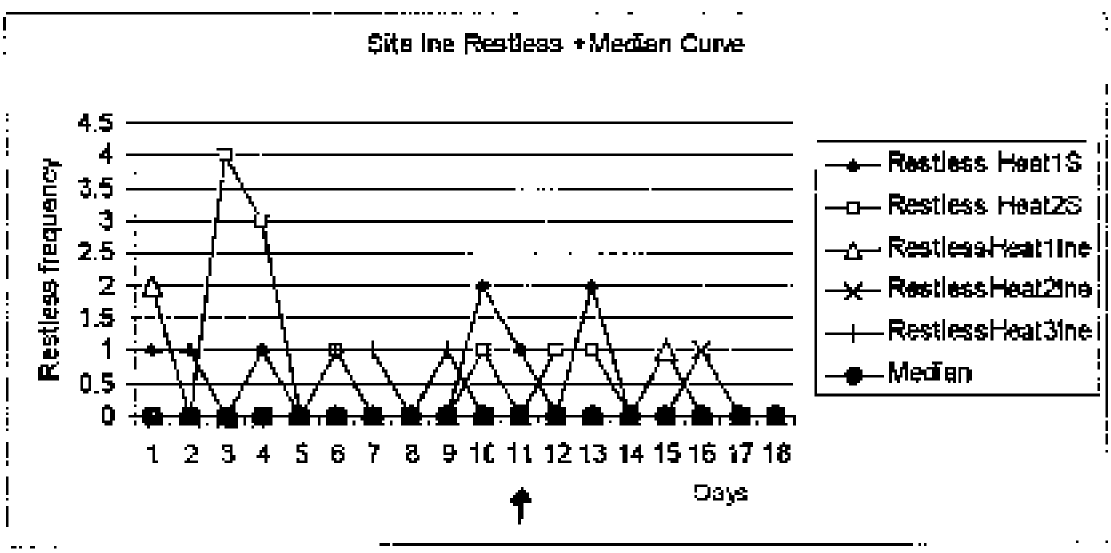

Diagram A18: Combination of all curves of Ine and Sita, with each ovulation occurring on the eleventh day. The data points depict the percentage of the day's observation period restless was displayed. RestlessHeat1S: Curve of days surrounding Sita's first estrus; RestlessHeat2S: Curve of days surrounding Sita's second estrus; RestlessHeat1Ine: Curve of days surrounding Ine's first estrus; RestlessHeat2Ine: Curve of days surrounding Ine's second estrus; RestlessHeat3Ine: Curve of days surrounding Ine's third estrus; Median: Median curve of daily data points.

7.2 Curve Averages

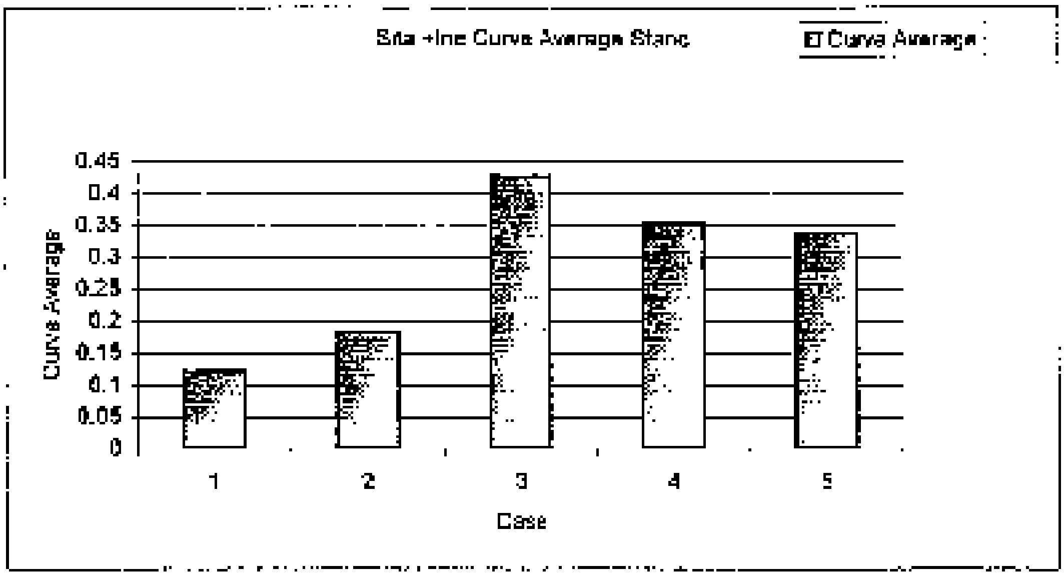

Diagram A19. Each curve for the behavior 'stand' is numbered 1 through 5, and their averages represent the height of the column. 1: Sita's first ovulation curve; 2; Sita's second ovulation curve, 3. Ine's first ovulation curve: 4. Ine's second ovulation curve, 5: Ine's third ovulation curve.

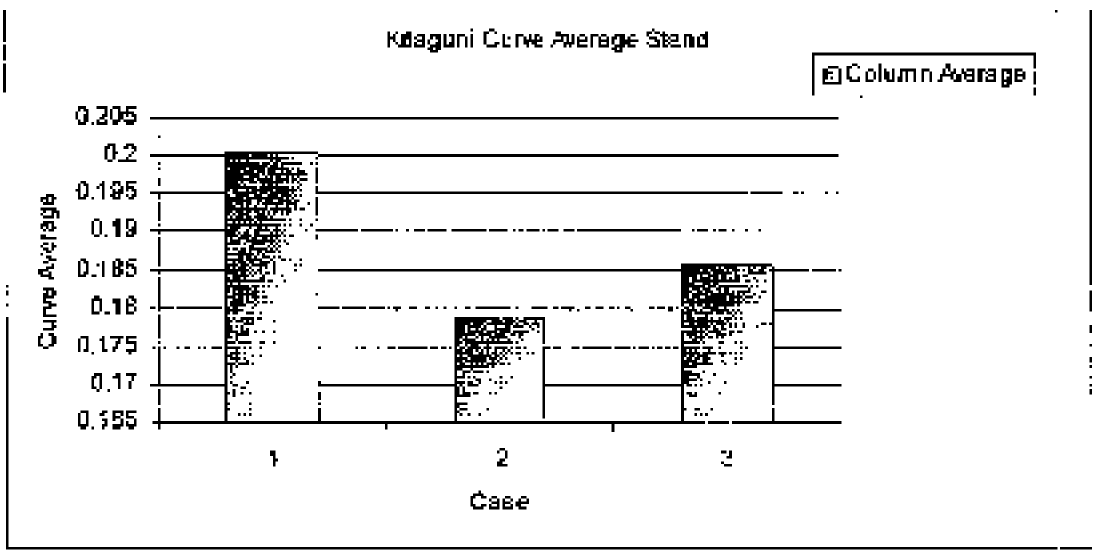

Diagram A20: Each curve for the behavior 'stand' is numbered 1 through 3, and their averages represent the height of the column. 1: Kilaguni's first time-period curve; 2: Kilaguni's second time-period curve; 3: Kilaguni's third time-period curve;

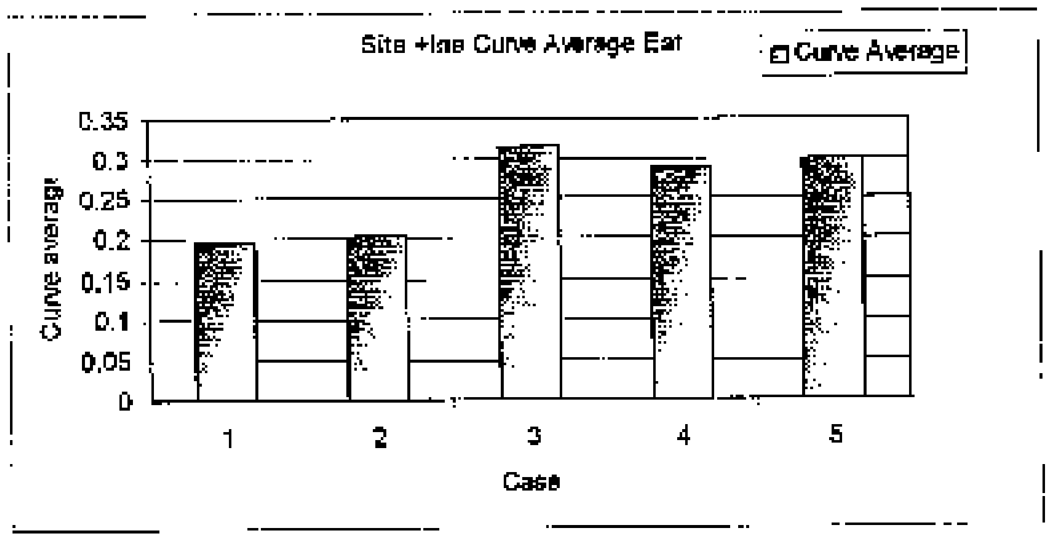

Diagram A21: Each curve for the behavior 'eat' is numbered 1 through 5, and their averages represent the height of the column. 1: Sita's first ovulation curve; 2: Sita's second ovulation curve; 3. Ine's first ovulation curve, 4: Ine's second ovulation curve; 5: Ine's third ovulation curve.

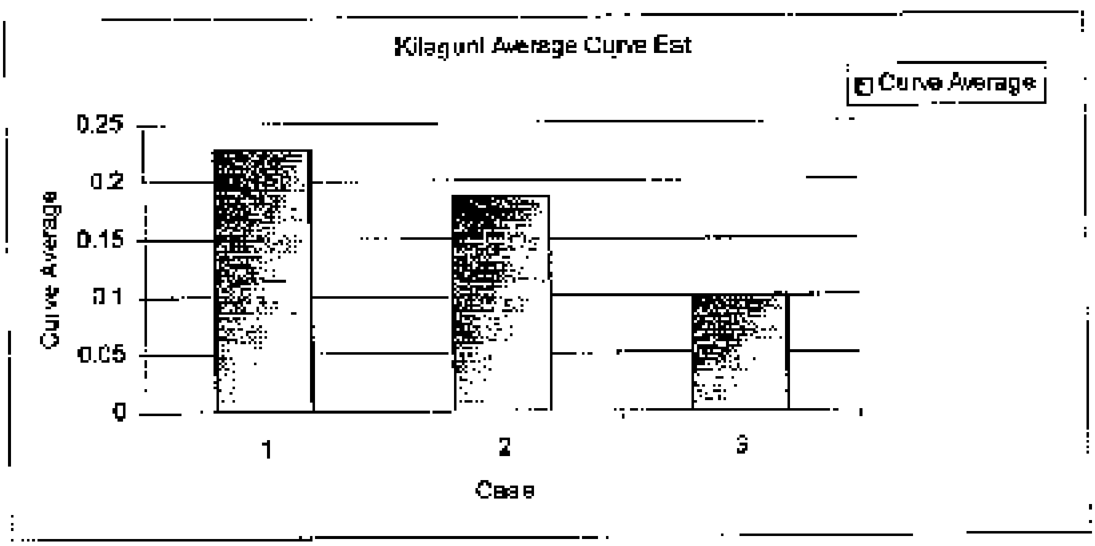

Diagram A22: Each curve for the behavior 'stand' is numbered 1 through 3, and their averages represent the height of the column. 1: Kilaguni's first time-period curve; 2: Kilaguni's second time-period curve; 3: Kilaguni's third time-period curve.

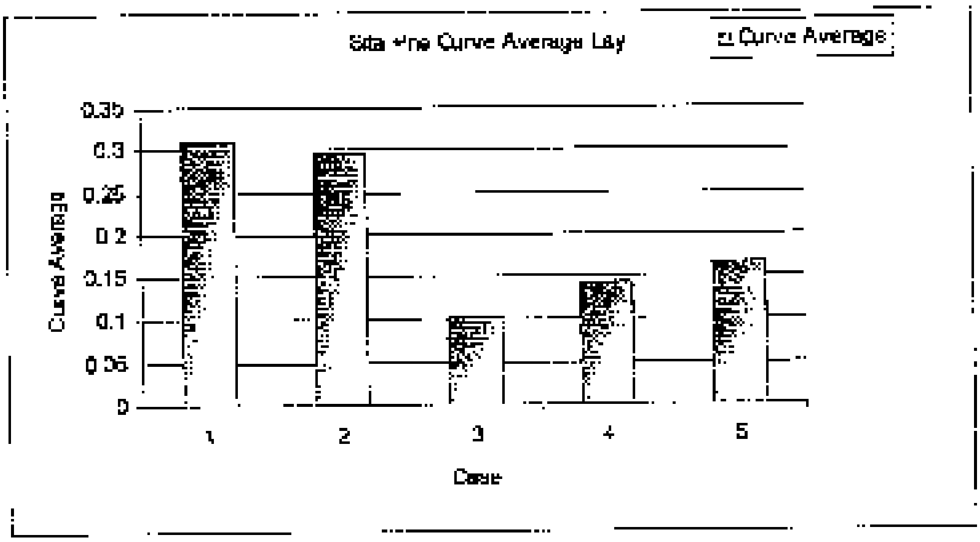

Diagram A23: Each curve for the behavior 'lay' is numbered 1 through 5, and their averages represent the height of the column. 1: Sita's first ovulation curve; 2: Sita's second ovulation curve; 3: Ine's first ovulation curve; 4: Ine's second ovulation curve; 5: Ine's third ovulation curve.

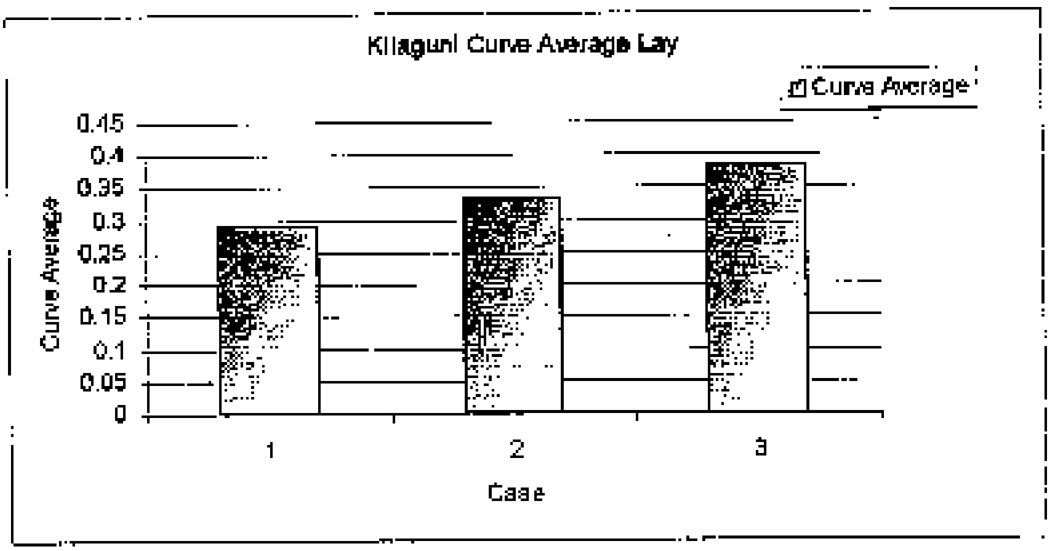

Diagram A24: Each curve for the behavior 'lay' is numbered 1 through 3, and their averages represent the height of the column. 1: Kilaguni's first time-period curve; 2: Kilaguni's second time-period curve; 3: Kilaguni's third time-period curve.

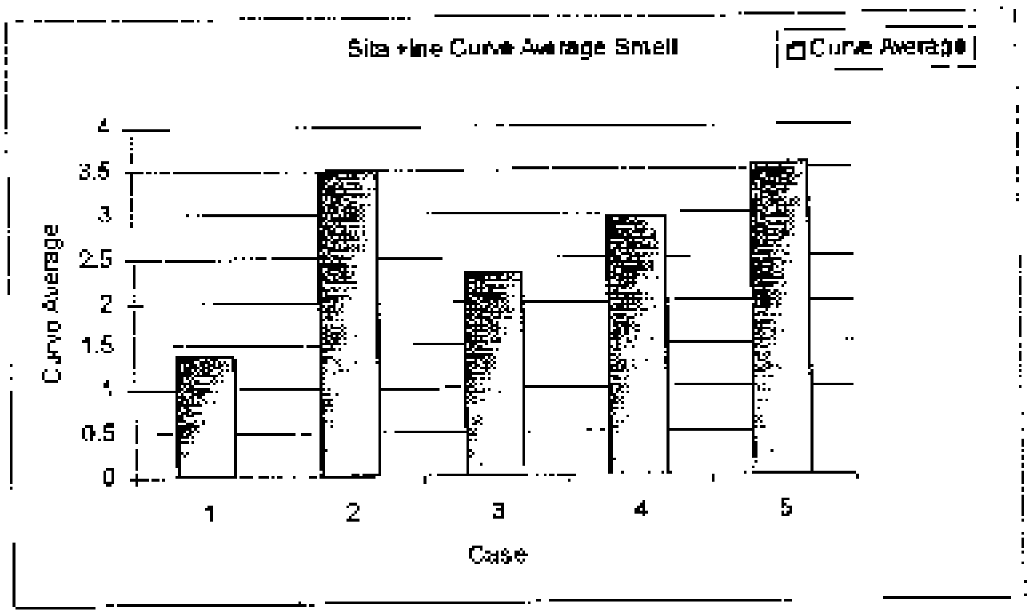

Diagram A25: Each curve for the behavior 'Smell' is numbered 1 through 5, and their averages represent the height of the column. 1: Sita's first ovulation curve; 2: Sita's second ovulation curve; 3: Ine's first ovulation curve; 4: Ine's second ovulation curve; 5: Ine's third ovulation curve.

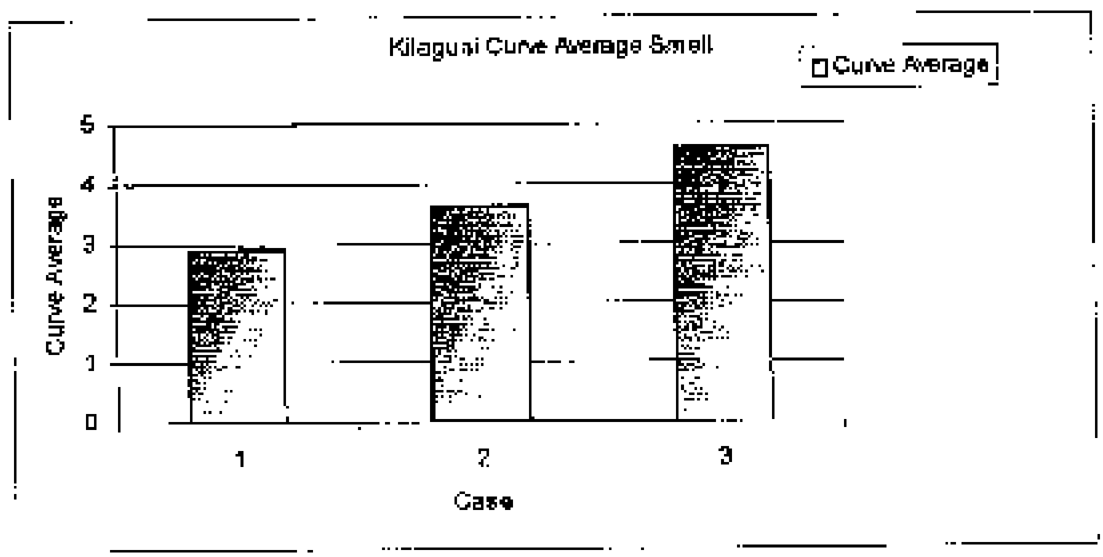

Diagram A26: Each curve for the behavior 'smell' is numbered 1 through 3, and their averages represent the height of the column. 1: Kilaguni's first time-period curve; 2: Kilaguni's second time-period curve; 3: Kilaguni's third time-period curve.

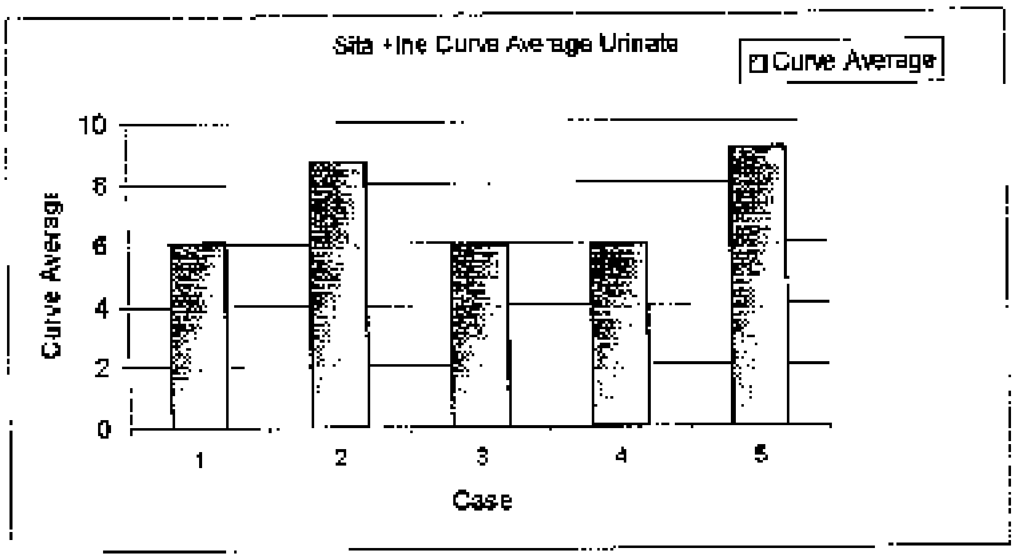

Diagram A27: Each curve for the behavior 'Urinate' is numbered 1 through 5, and their averages represent the height of the column. 1: Sita's first ovulation curve; 2: Sita's second ovulation curve; 3: Ine's first ovulation curve; 4: Ine's second ovulation curve; 5: Ine's third ovulation curve.

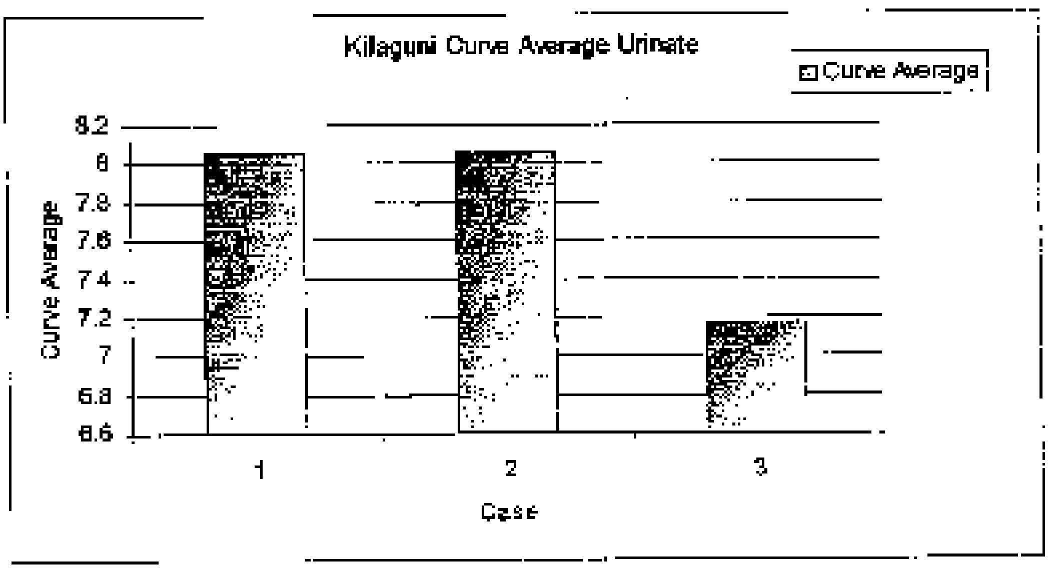

Diagram A28: Each curve for the behavior 'urinate' is numbered 1 through 3, and their averages represent the height of the column. 1: Kilaguni's first time-period curve; 2: Kilaguni's second time-period curve; 3: Kilaguni's third time-period curve.

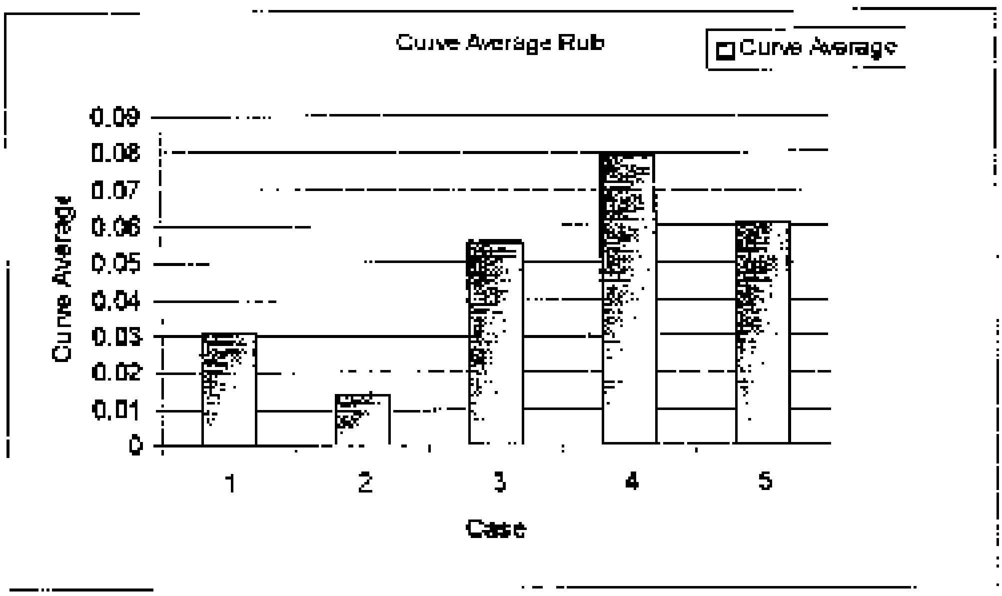

Diagram A29: Each curve for the behavior 'rub' is numbered 1 through 5, and their averages represent the height of the column. 1: Sita's first ovulation curve; 2: Sita's second ovulation curve; 3: Ine's first ovulation curve; 4: Ine's second ovulation curve; 5: Ine's third ovulation curve.

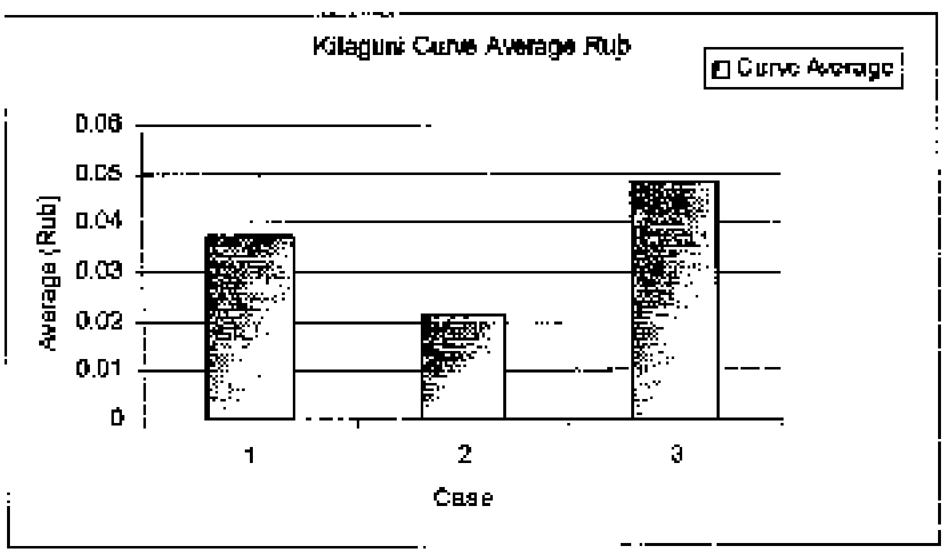

Diagram A30: Each curve for the behavior 'rub' is numbered 1 through 3, and their averages represent the height of the column. 1: Kilaguni's first time-period curve; 2: Kilaguni's second time-period curve; 3: Kilaguni's third time-period curve.

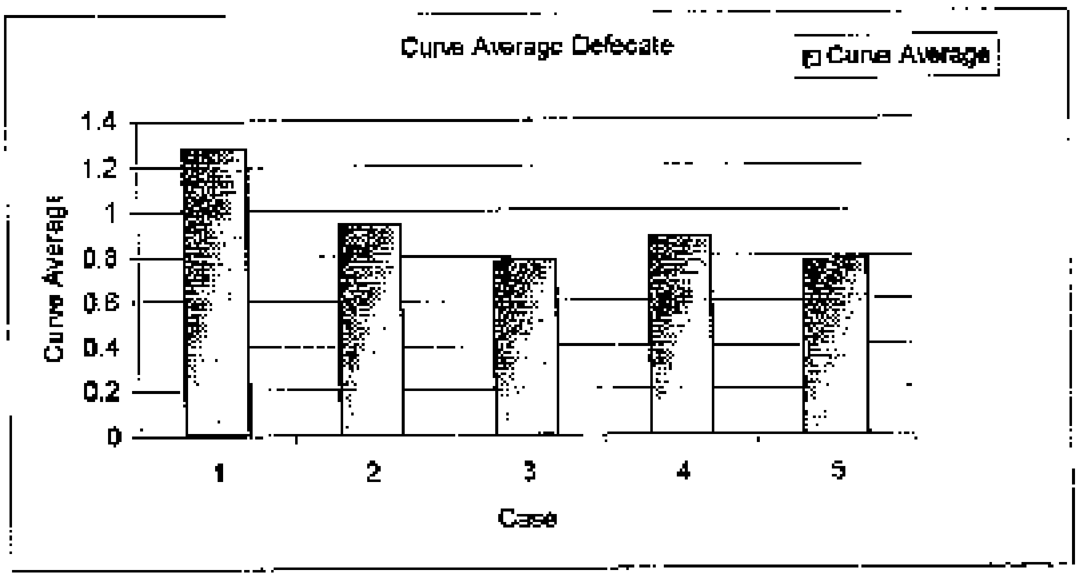

Diagram A31 Each curve for the behavior 'defecate' is numbered 1 through 5, and their averages represent the height of the column. 1: Sita's first ovulation curve; 2: Sita's second ovulation curve; 3: Ine's first ovulation curve; 4: Ine's second ovulation curve; 5: Ine's third ovulation curve.

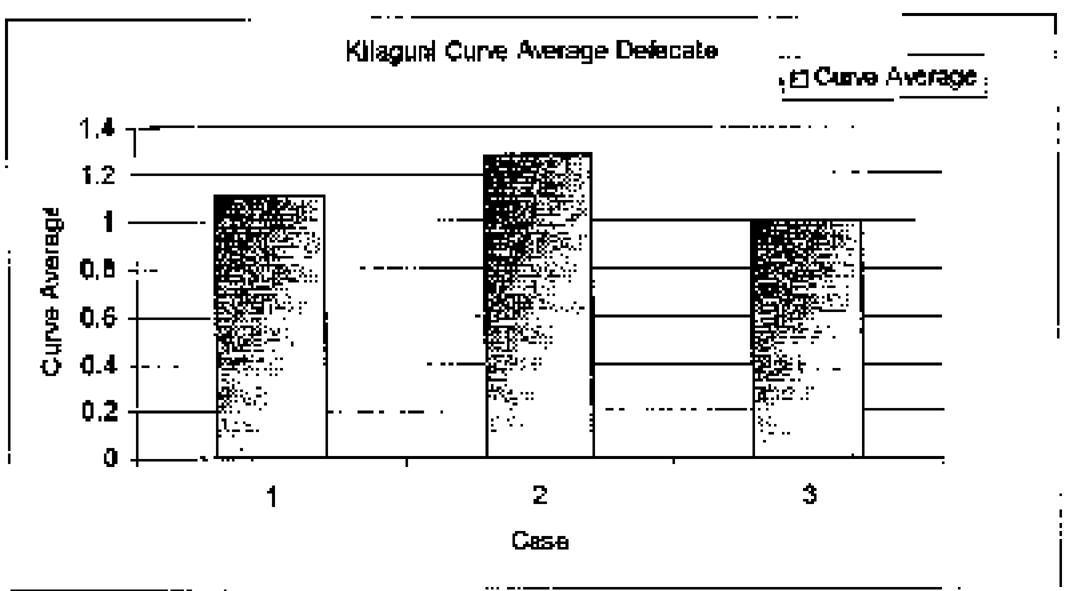

Diagram A32: Each curve for the behavior 'defecate' is numbered 1 through 3, and their averages represent the height of the column. 1: Kilaguni's first time-period curve; 2: Kilaguni's second time-period curve; 3: Kilaguni's third time-period curve.

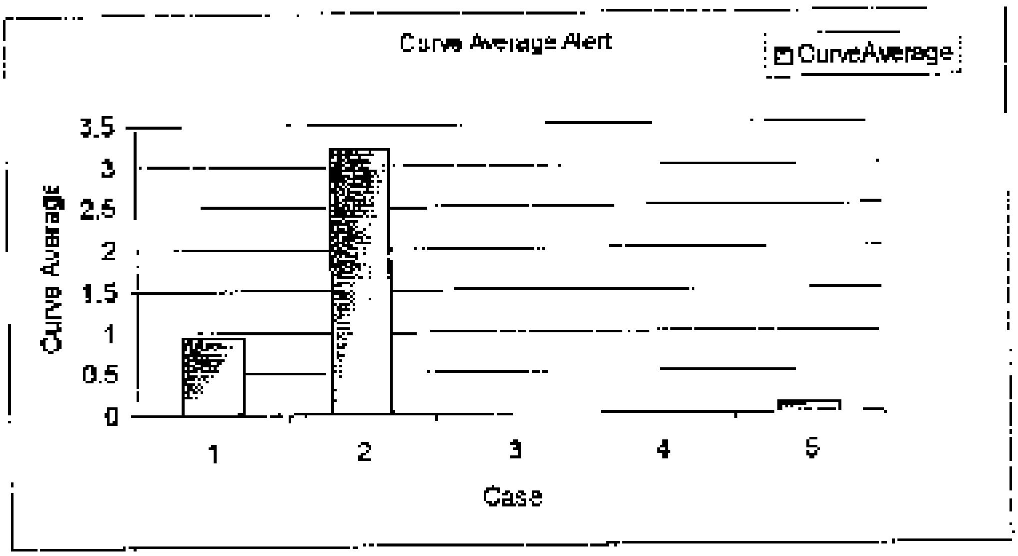

Diagram A33: Each curve for the behavior 'Alert' is numbered 1 through 5, and their averages represent the height of the column. 1: Sita's first ovulation curve; 2. Sita's second ovulation curve; 3: Ine's first ovulation curve; 4: Ine's second ovulation curve; 5: Ine's third ovulation curve.

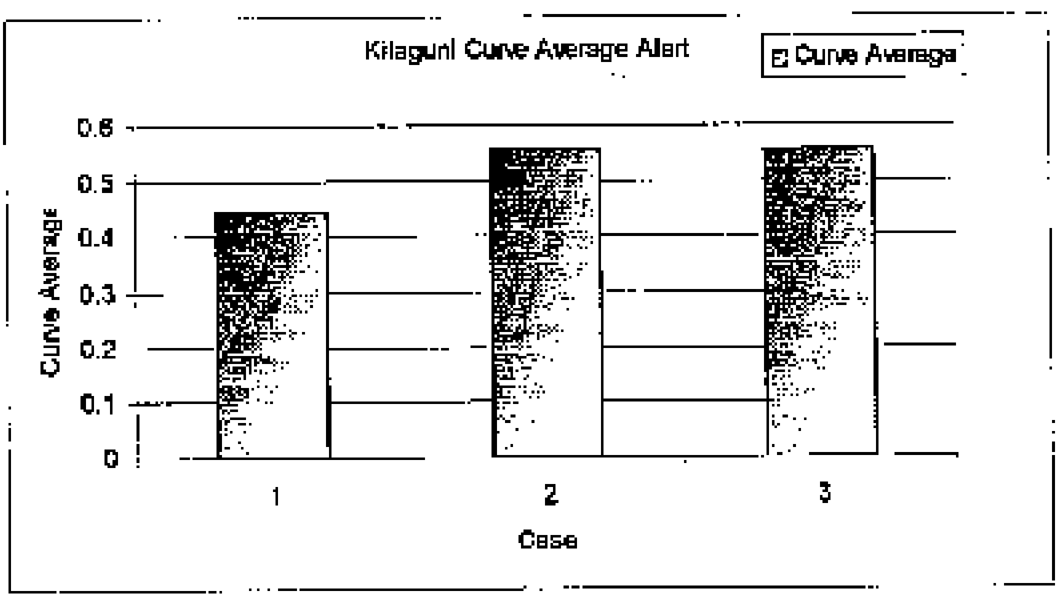

Diagram A34: Each curve for the behavior 'alert' is numbered 1 through 3, and their averages represent the height of the column. 1: Kilaguni's first time-period curve; 2: Kilaguni's second time-period curve; 3: Kilaguni's third time-period curve.

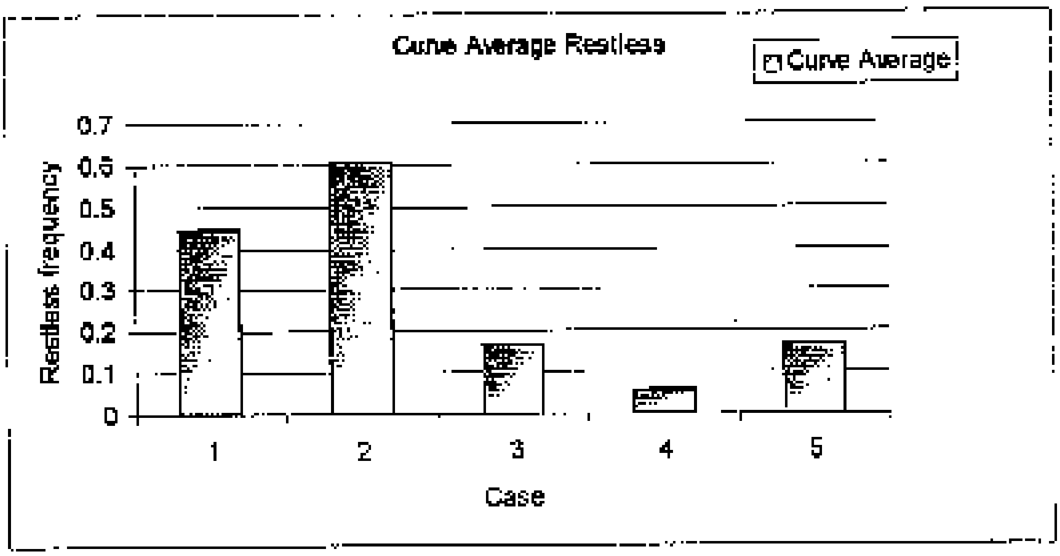

Diagram A35. Each curve for the behavior 'restless' is numbered 1 through 5, and their averages represent the height of the column. 1: Sita's first ovulation curve; 2: Sita's second ovulation curve; 3: Ine's first ovulation curve; 4: Ine's second ovulation curve; 5: Ine's third ovulation curve.

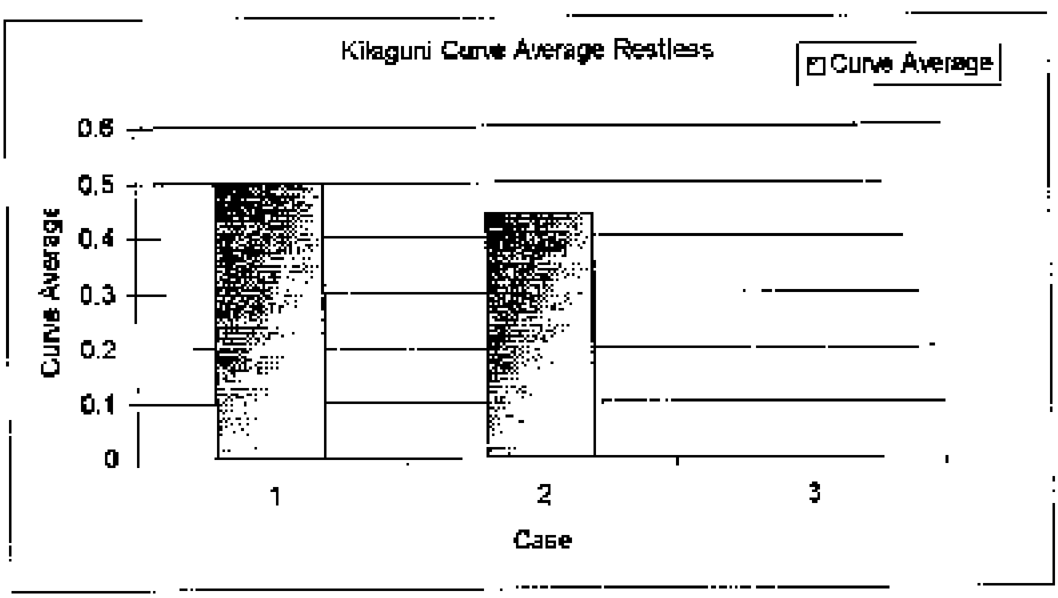

Diagram A36: Each curve for the behavior 'restless' is numbered 1 through 3, and their averages represent the height of the column. 1: Kilaguni's first time-period curve; 2: Kilaguni's second time-period curve; 3: Kilaguni's third time-period curve.

7.3 Temperature Curves:

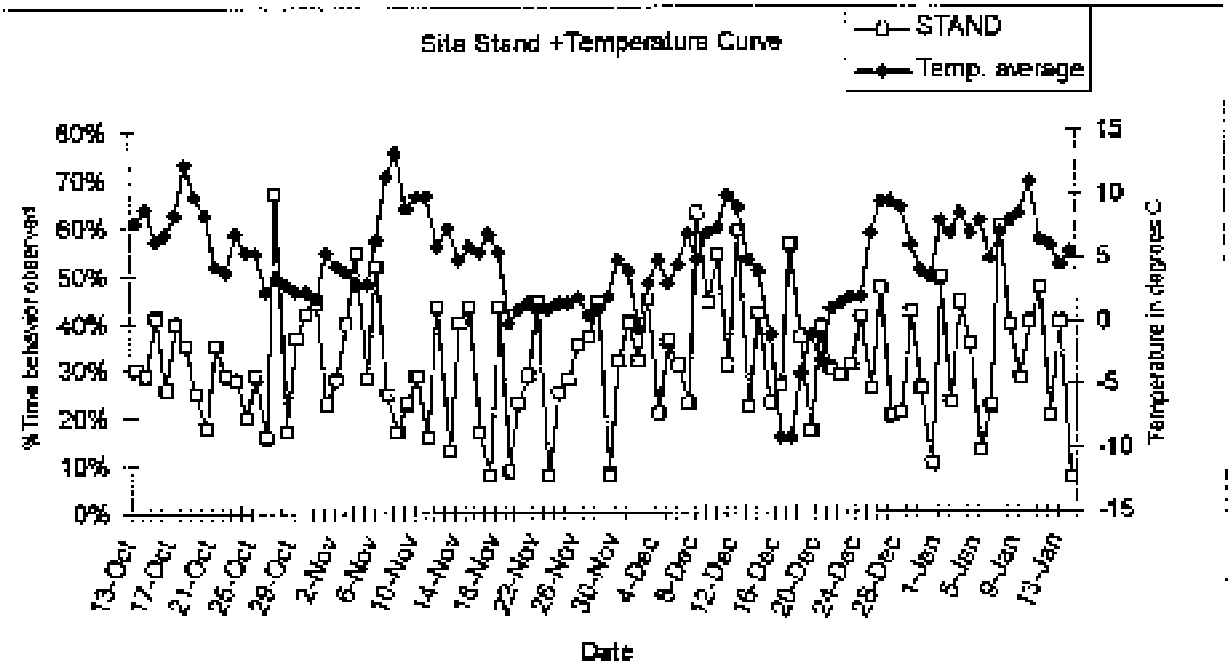

Diagram A37: Temperature curve, showing the average daily temperature in degrees Celsius, Sita's 'stand curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; STAND: Curve depicting Sita's daily behavior concerning 'stand'.

	Sita	Ine	Kilaguni
Pace	0.264	0.249	0.046
Stand	-0.053	-0.097	0.309
Eat	-0.127	-0.183	-0.477
Lay	-0.194	-0.066	0.137
Rub	0.206	-0.022	0.064
Restless	-0.242	-0.03	-0.134
Smell	0.333	0.192	0.357
Urinate	0.147	0.255	0.068
Defecate	0.370	0.069	0.096
Alert	0.266	0.038	0.057

Tab1: Table depicts the correlation coefficient (after Spearman; see Engel; 1997) for each behavior as it relates to the temperature, for each female. Positive numbers show a positive correlation (the higher the temperature gets, the more the behavior was observed). Negative numbers show a negative correlation (the higher the temperature gets, the less the behavior was observed). The closer the number is to one, the more the observed behavior is dependent upon the temperature. The closer to zero the coefficient is, the less the behavior is related to the temperature.

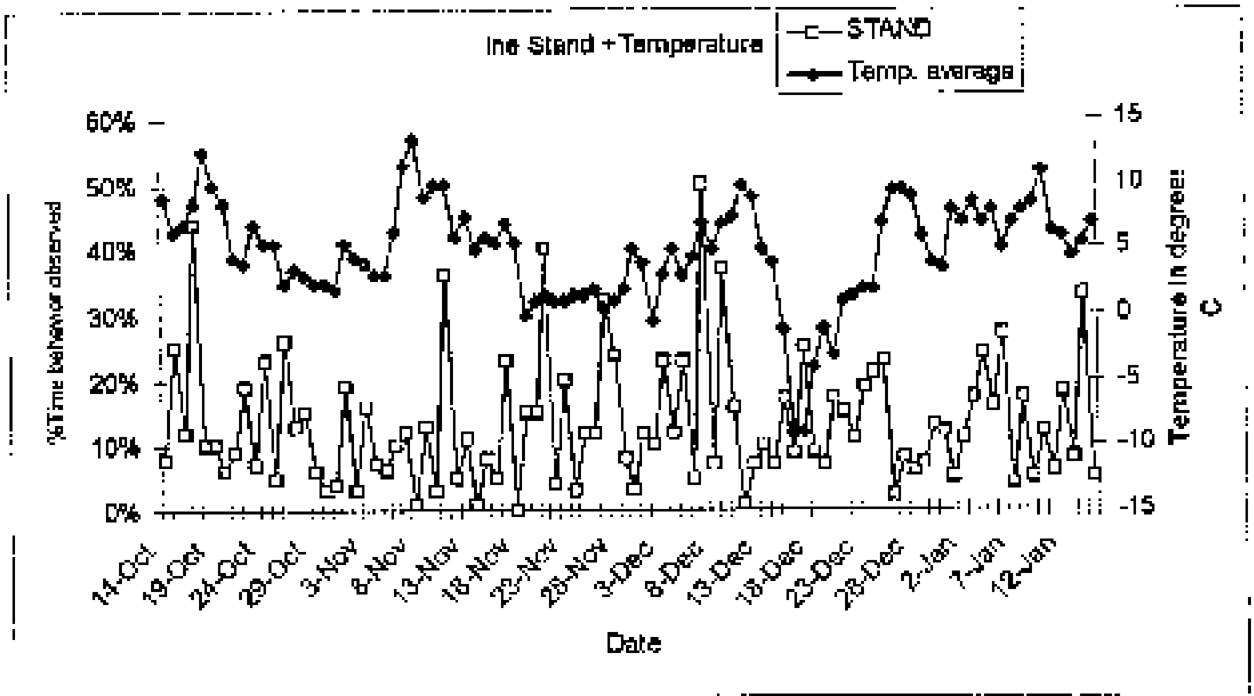

Diagram A38: Temperature curve, showing the average daily temperature in degrees Celsius, Ine's 'stand curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; STAND: Curve depicting Ine's daily behavior concerning 'stand'.

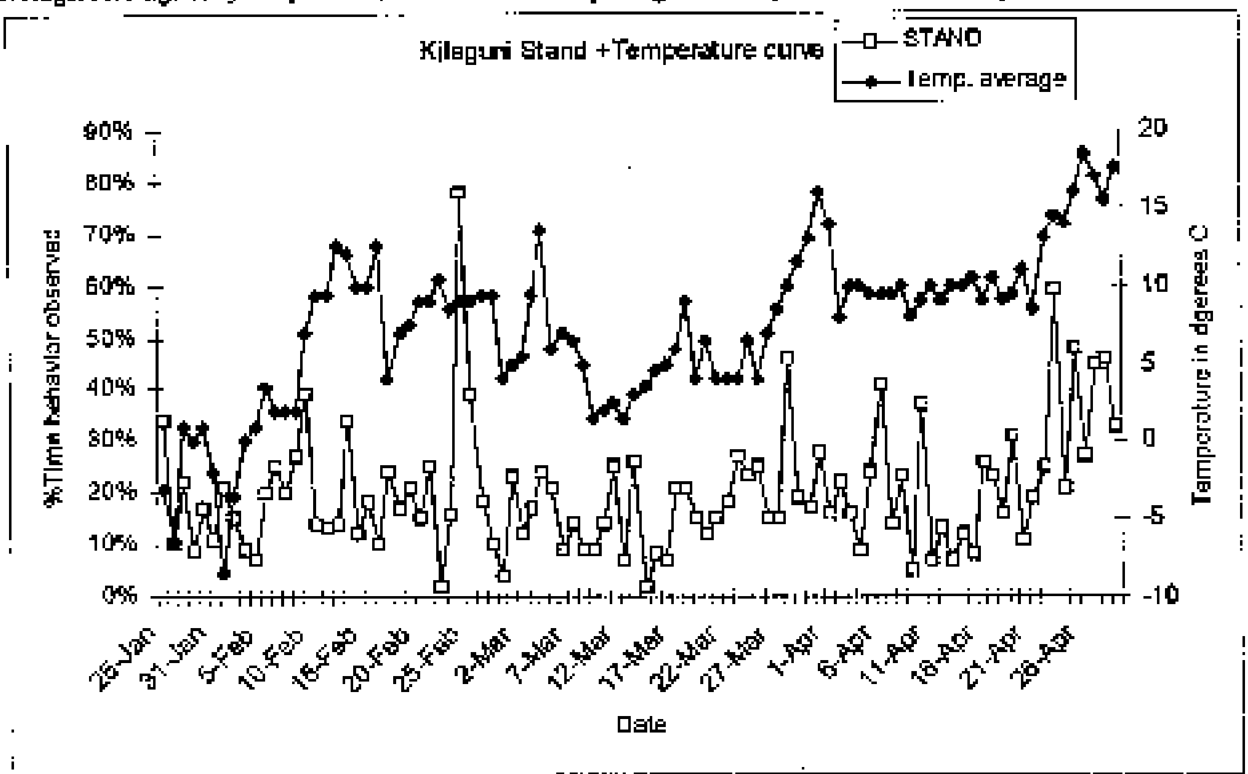

Diagram A39: Temperature curve, showing the average daily temperature in degrees Celsius, Kilaguni's 'stand curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; STAND: Curve depicting Kilaguni's daily behavior concerning 'stand'.

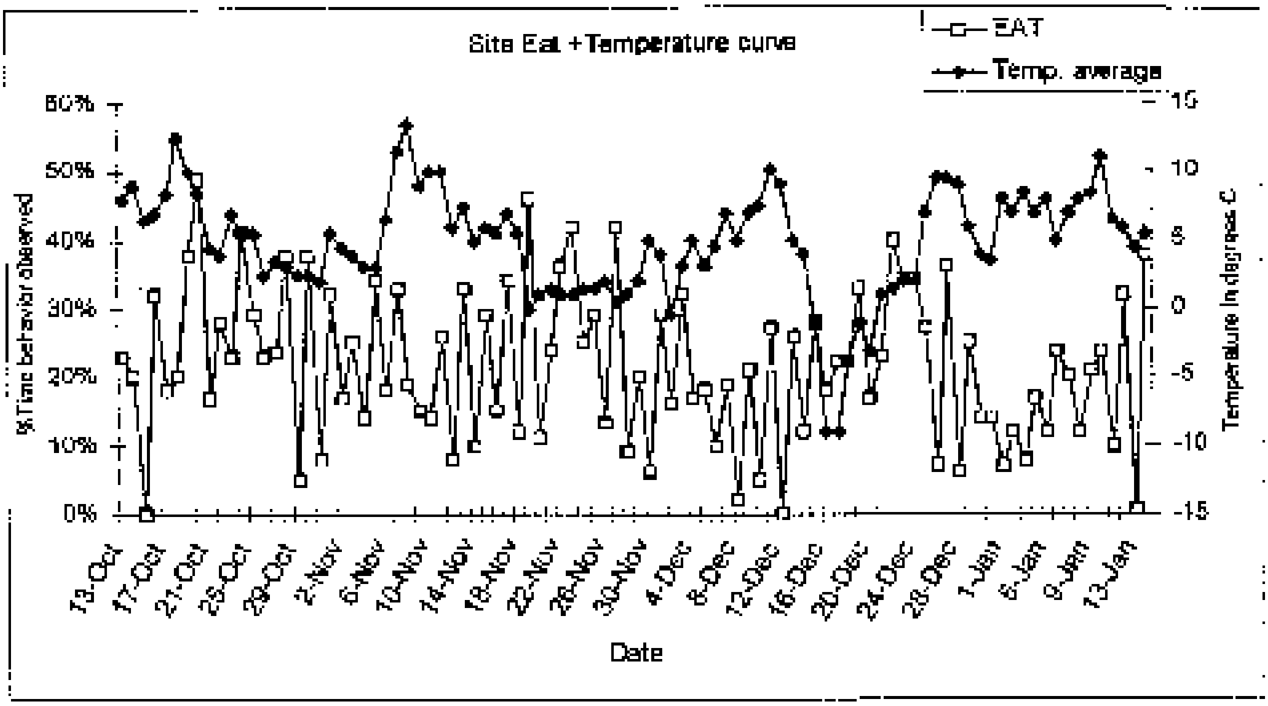

Diagram A40: Temperature curve, showing the average daily temperature in degrees Celsius, Sita's 'eat' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; EAT: Curve depicting Sita's daily behavior concerning 'eat'.

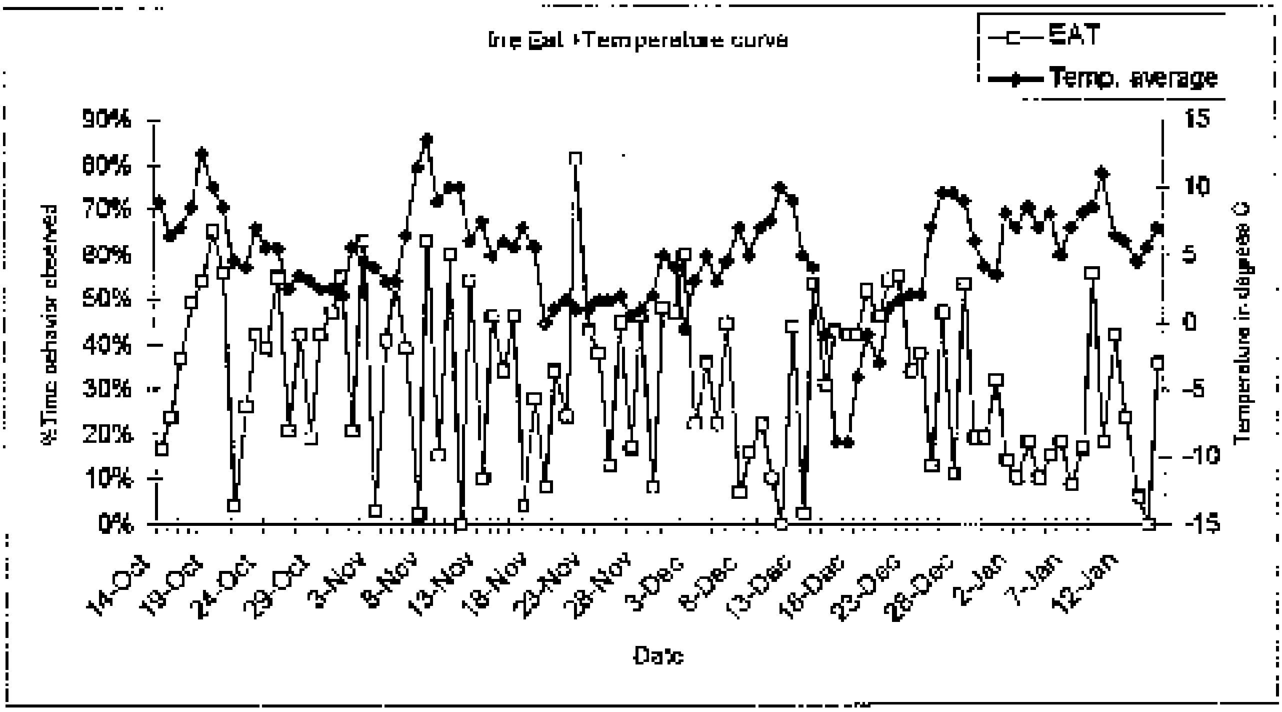

Diagram A41: Temperature curve, showing the average daily temperature in degrees Celsius, Ine's 'eat' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average; Average daily temperature; EAT: Curve depicting Ine's daily behavior concerning 'eat'.

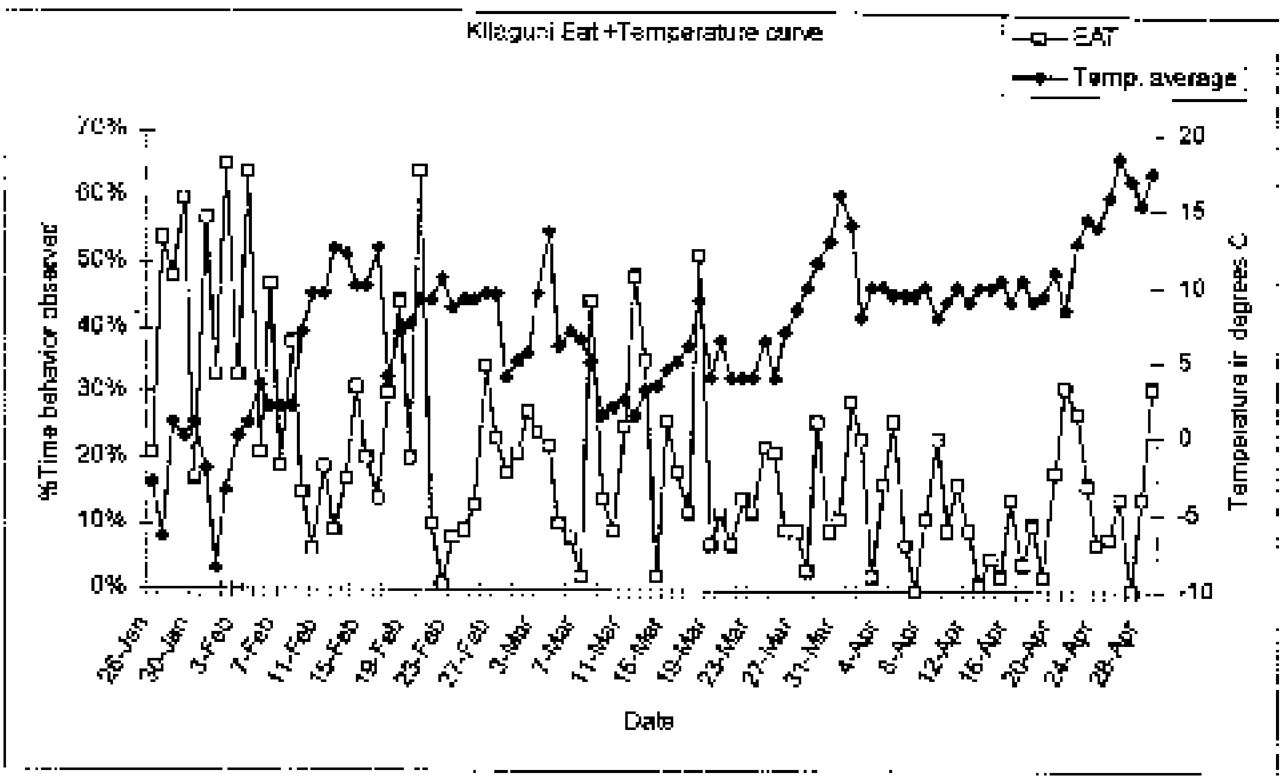

Diagram A42: Temperature curve, showing the average daily temperature in degrees Celsius, Kilaguni's 'eat' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; EAT: Curve depicting Kilaguni's daily behavior concerning 'eat'.

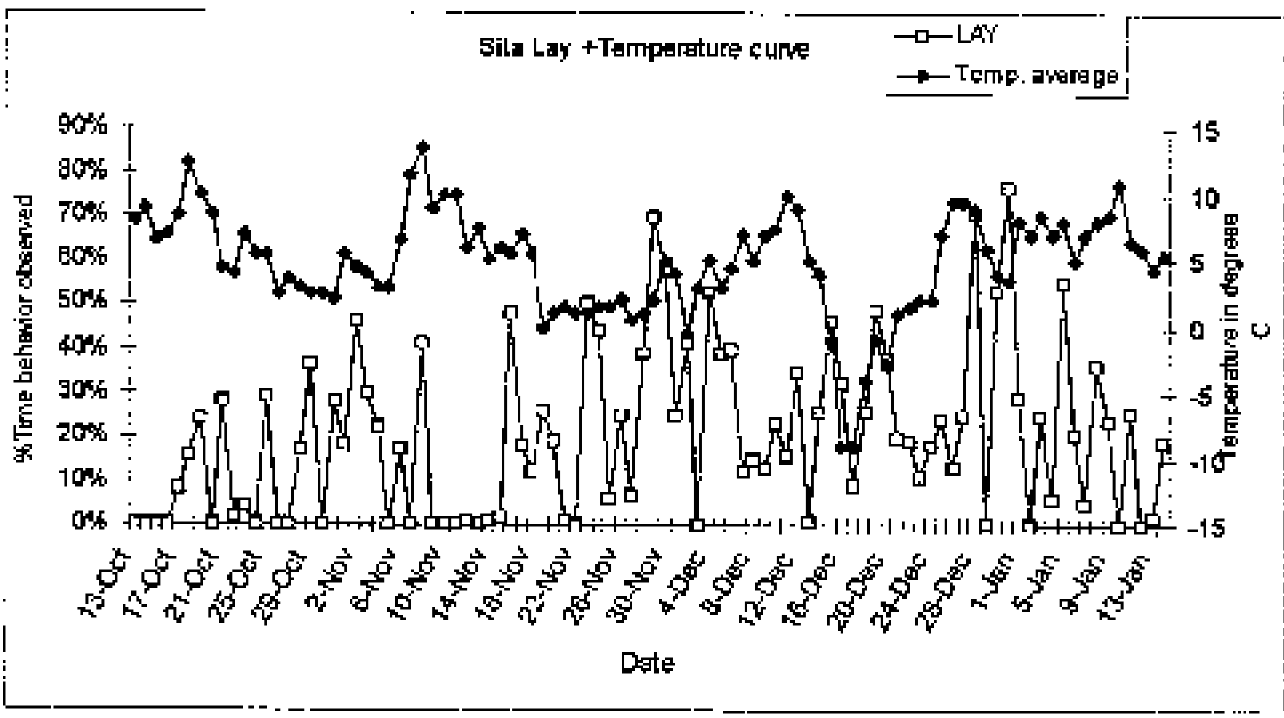

Diagram A43: Temperature curve, showing the average daily temperature in degrees Celsius, Sita's 'lay' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature, LAY: Curve depicting Sita's daily behavior concerning 'lay'.

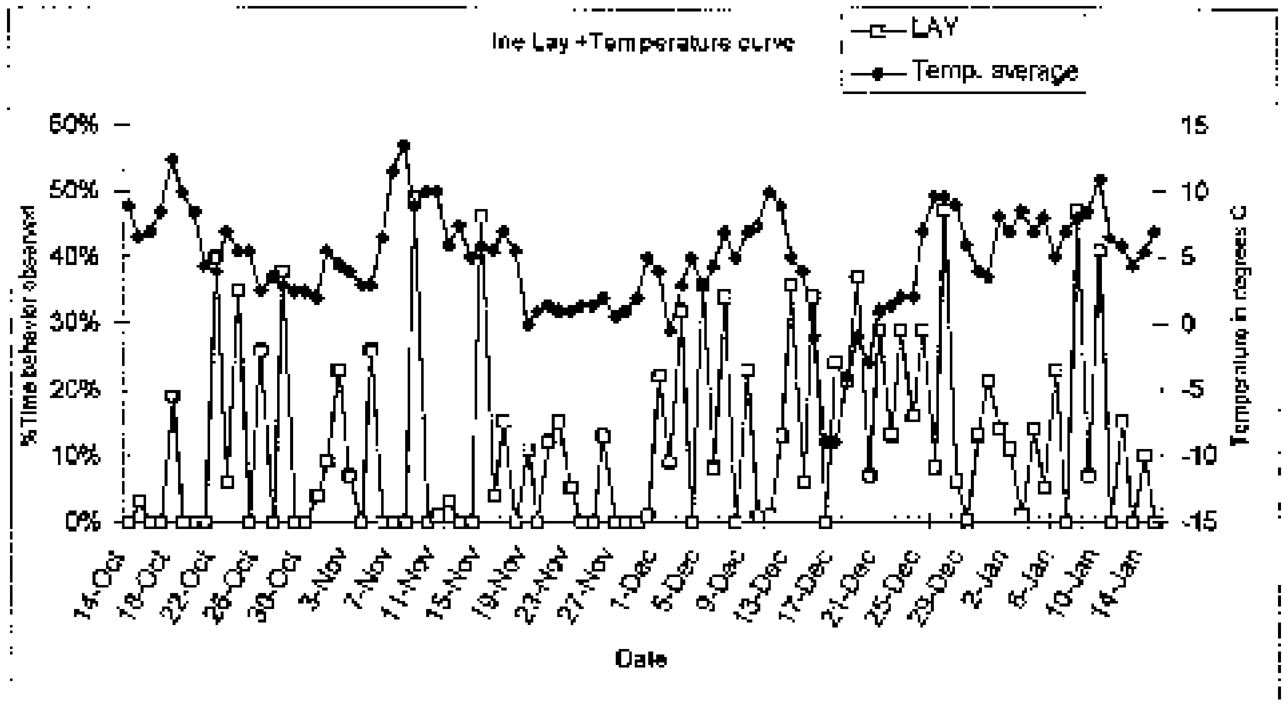

Diagram A44: Temperature curve, showing the average daily temperature in degrees Celsius, Ine's 'lay' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; LAY: Curve depicting Ine's daily behavior concerning 'lay'.

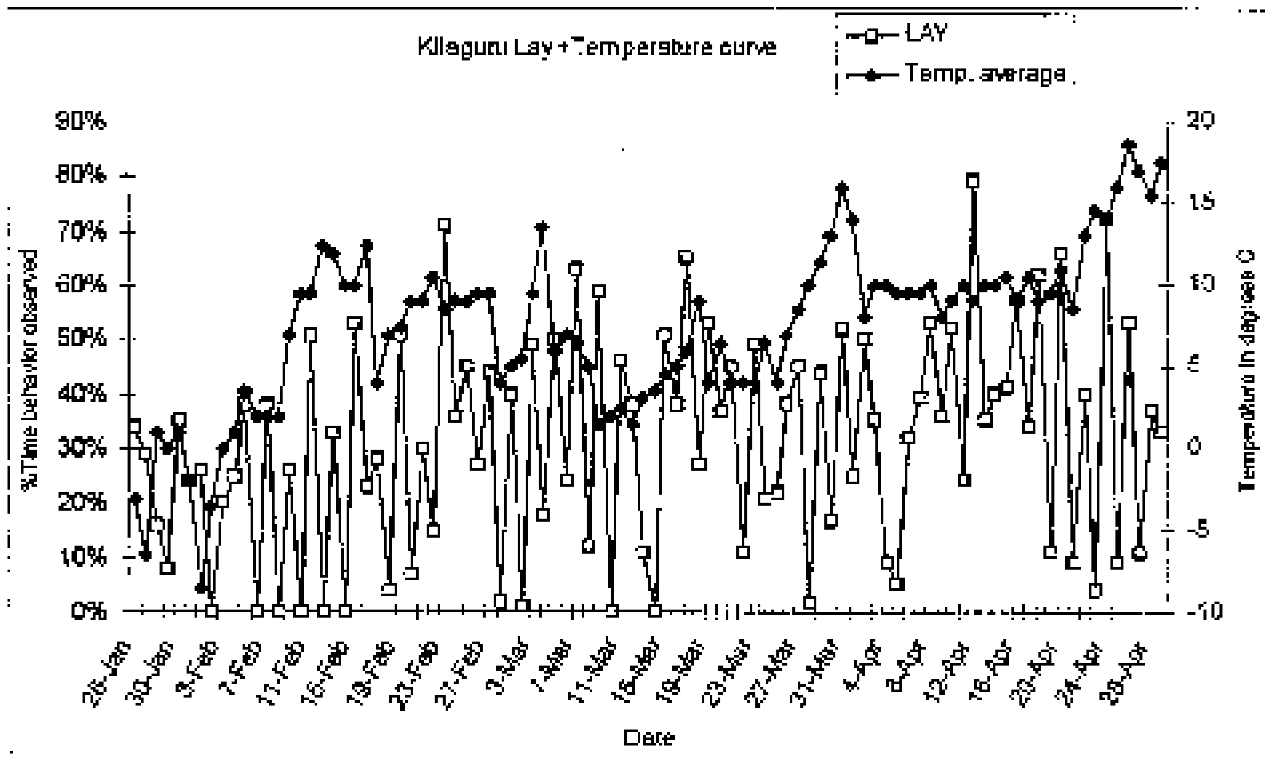

Diagram A45: Temperature curve, showing the average daily temperature in degrees Celsius, Kilaguni's 'lay' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; LAY: Curve depicting Kilaguni's daily behavior concerning 'lay'.

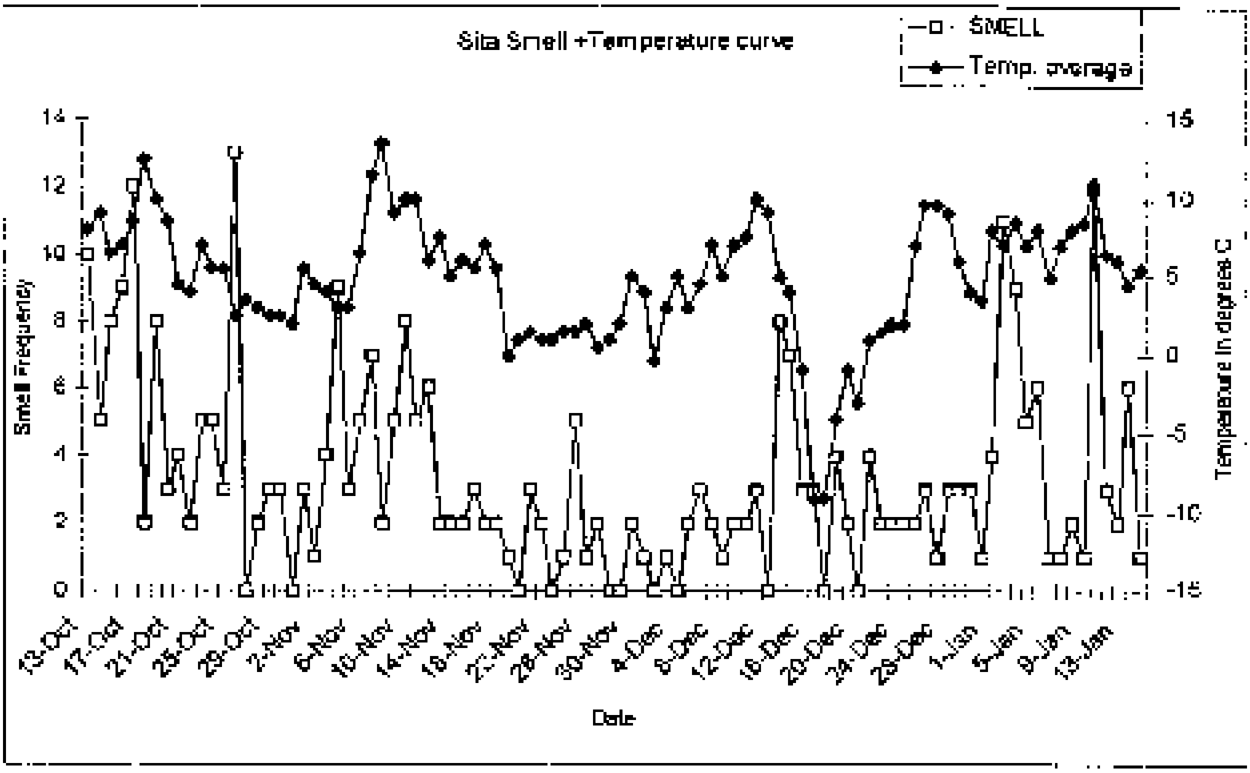

Diagram A46: Temperature curve, showing the average daily temperature in degrees Celsius, Sita's 'smell' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; SMELL: Curve depicting Sita's daily behavior concerning 'smell'.

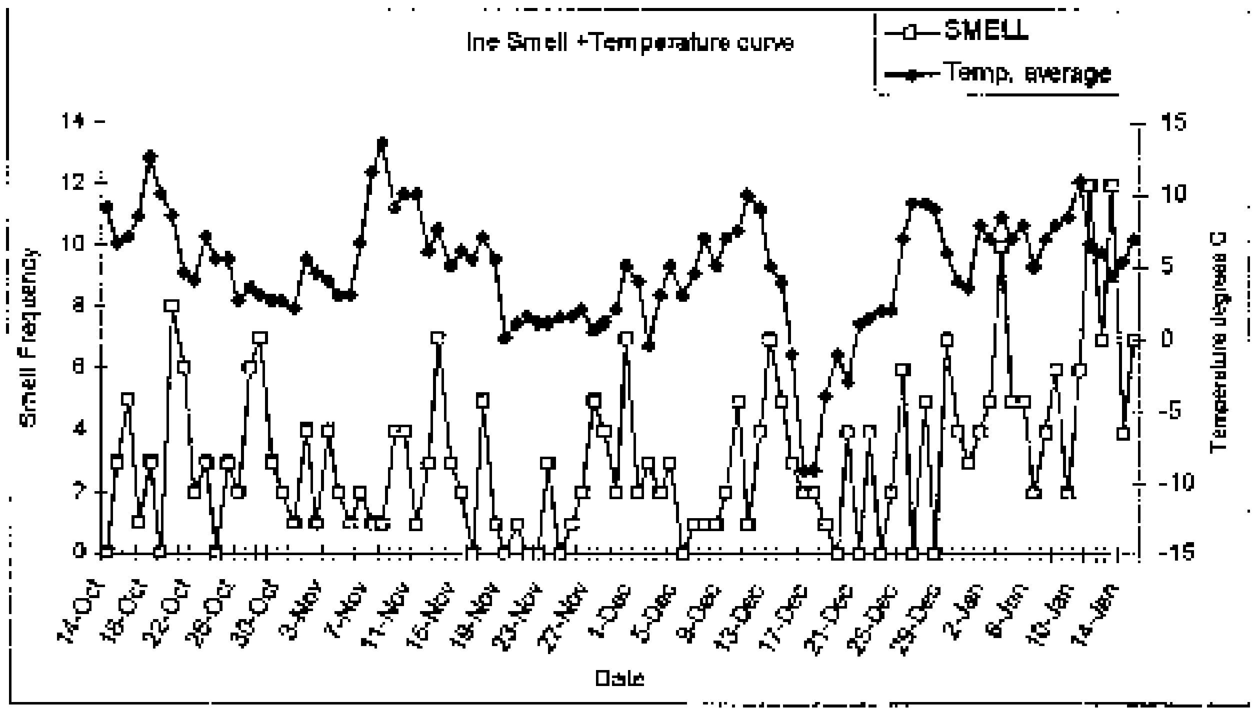

Diagram A47: Temperature curve, showing the average daily temperature in degrees Celsius, Ine's 'smell' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; SMELL: Curve depicting Ine's daily behavior concerning 'smell'.

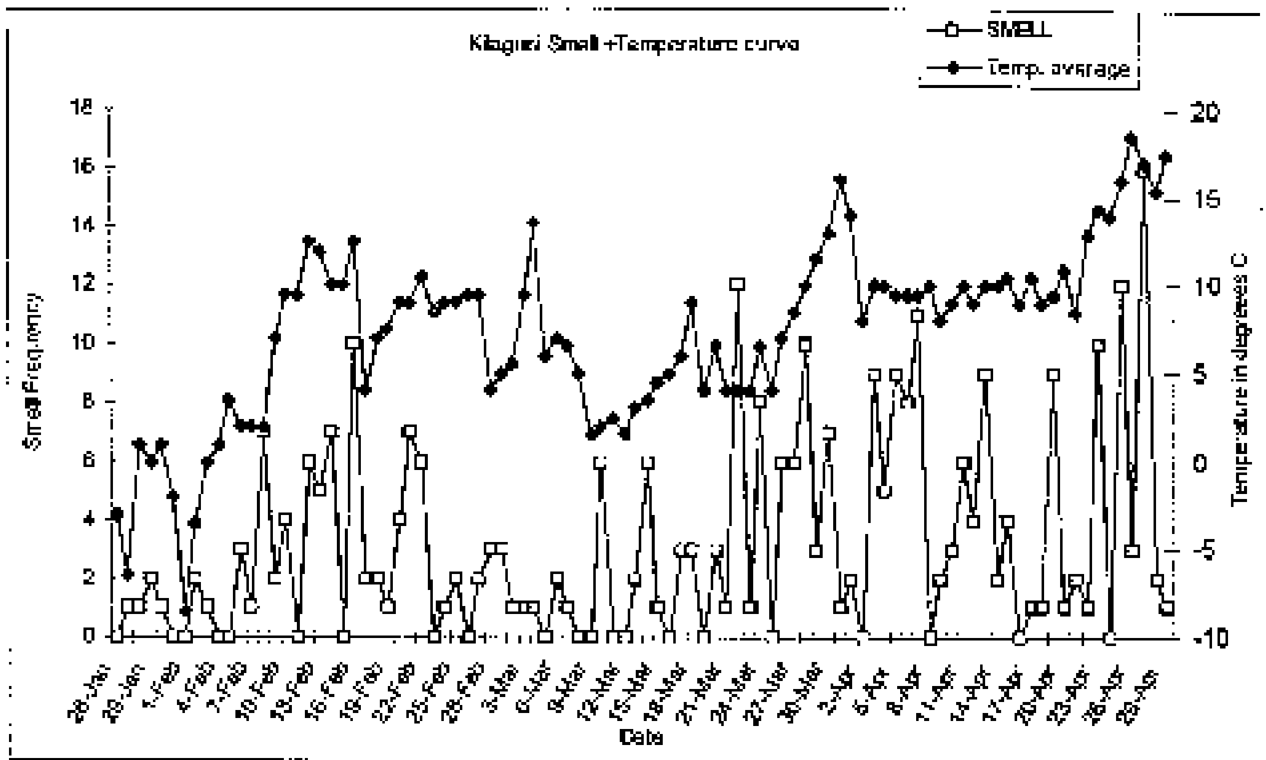

Diagram A48: Temperature curve, showing the average daily temperature in degrees Celsius, Kilaguni's 'smell' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; SMELL: Curve depicting Kilaguni's daily behavior concerning 'smell'.

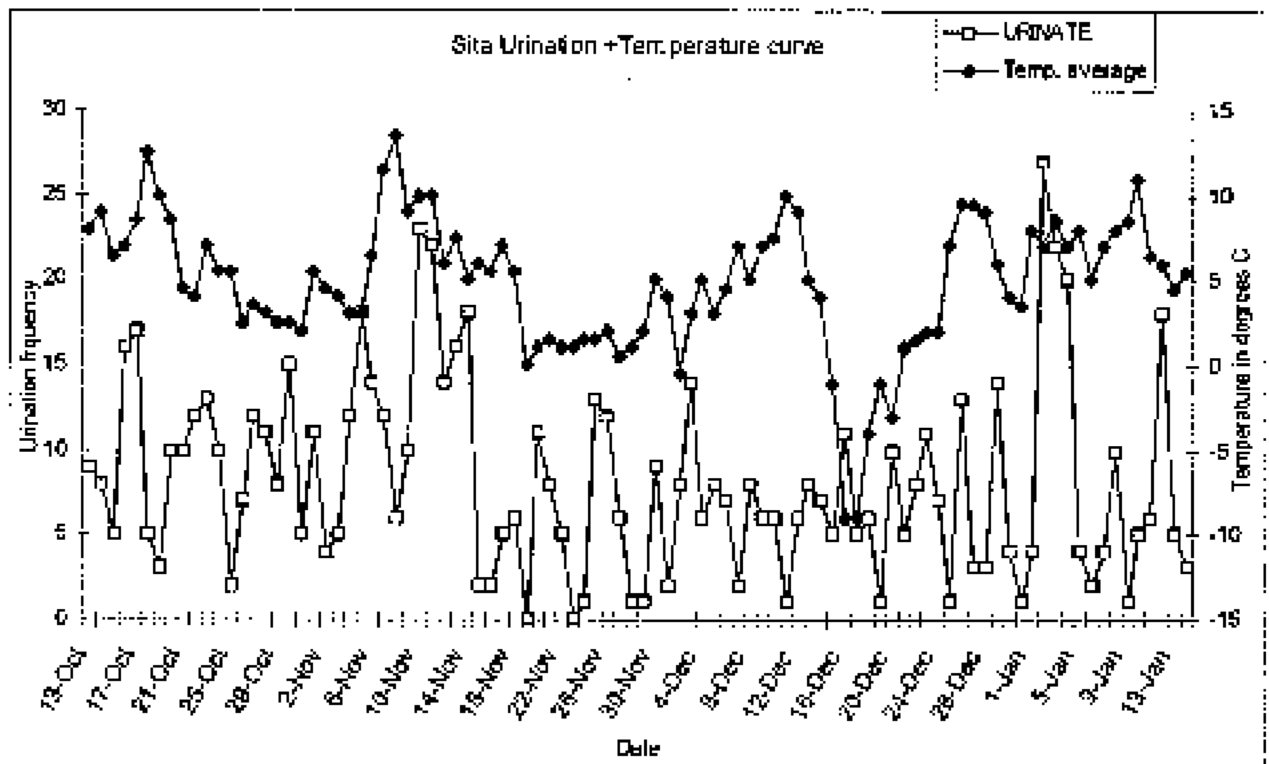

Diagram A49: Temperature curve, showing the average daily temperature in degrees Celsius, Sita's 'urinate' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; URINATE: Curve depicting Sita's daily behavior concerning 'urinate'.

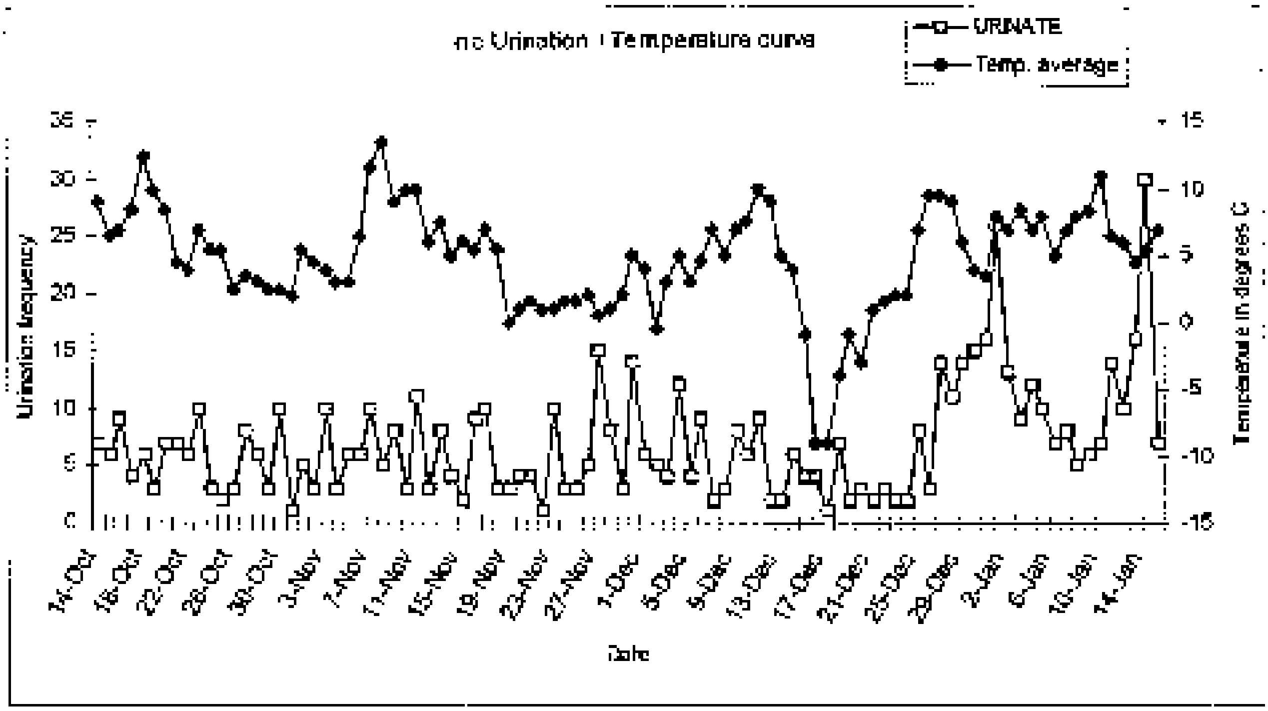

Diagram A50: Temperature curve, showing the average daily temperature in degrees Celsius, Ine's 'urinate' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average. Average daily temperature. URINATE. Curve depicting Ine's daily behavior concerning 'urinate'.

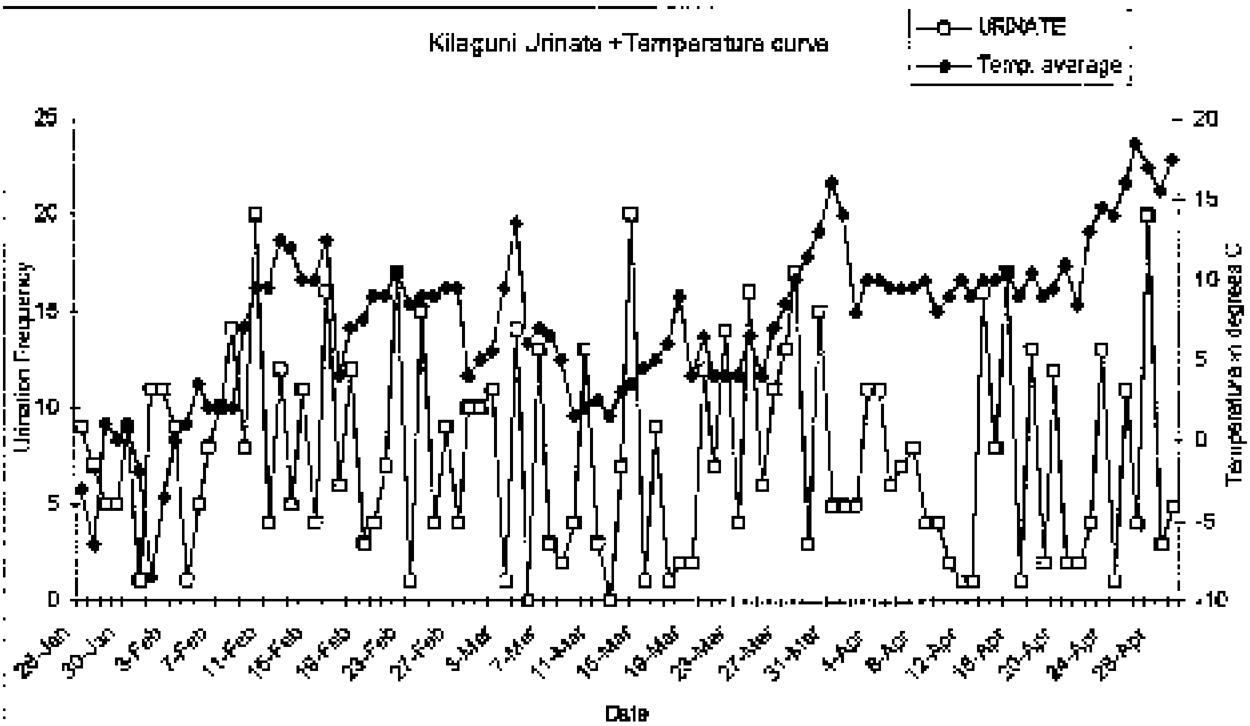

Diagram A51: Temperature curve, showing the average daily temperature in degrees Celsius, Kilaguni's 'urinate' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; URINATE: Curve depicting Kilaguni's daily behavior concerning 'urinate'.

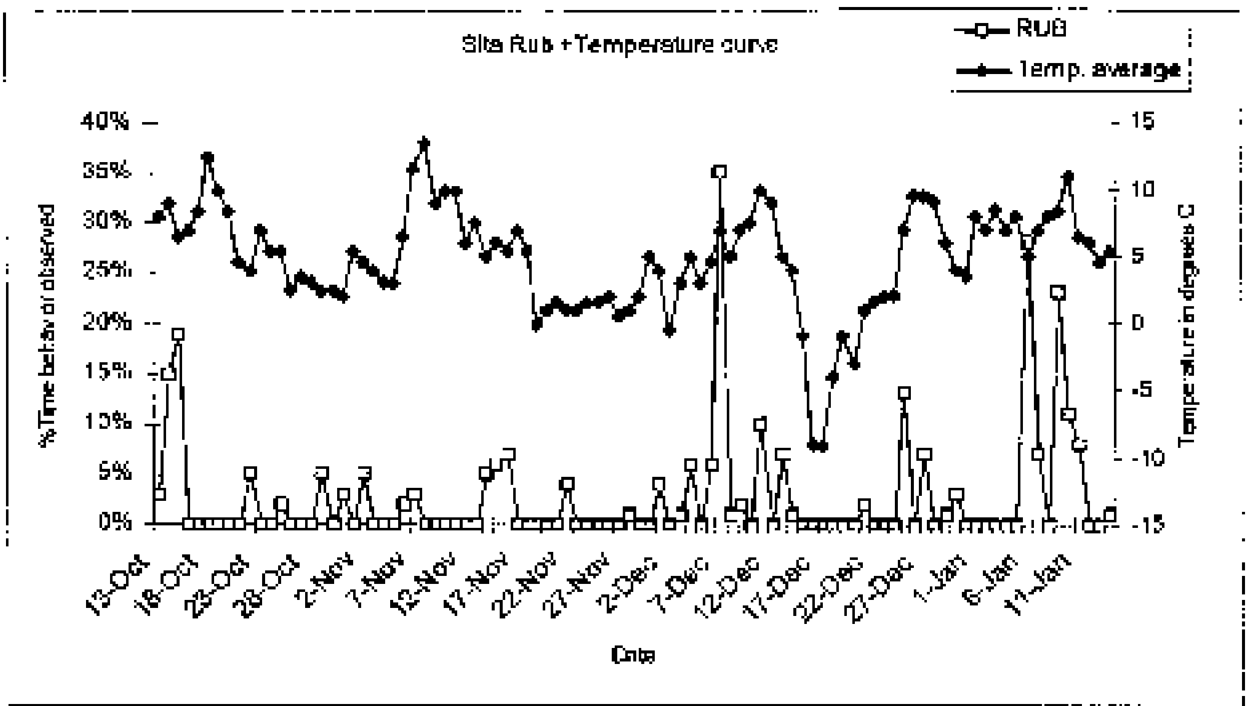

Diagram A52: Temperature curve, showing the average daily temperature in degrees Celsius, Sita's 'rub' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; RUB: Curve depicting Sita's daily behavior concerning 'rub'.

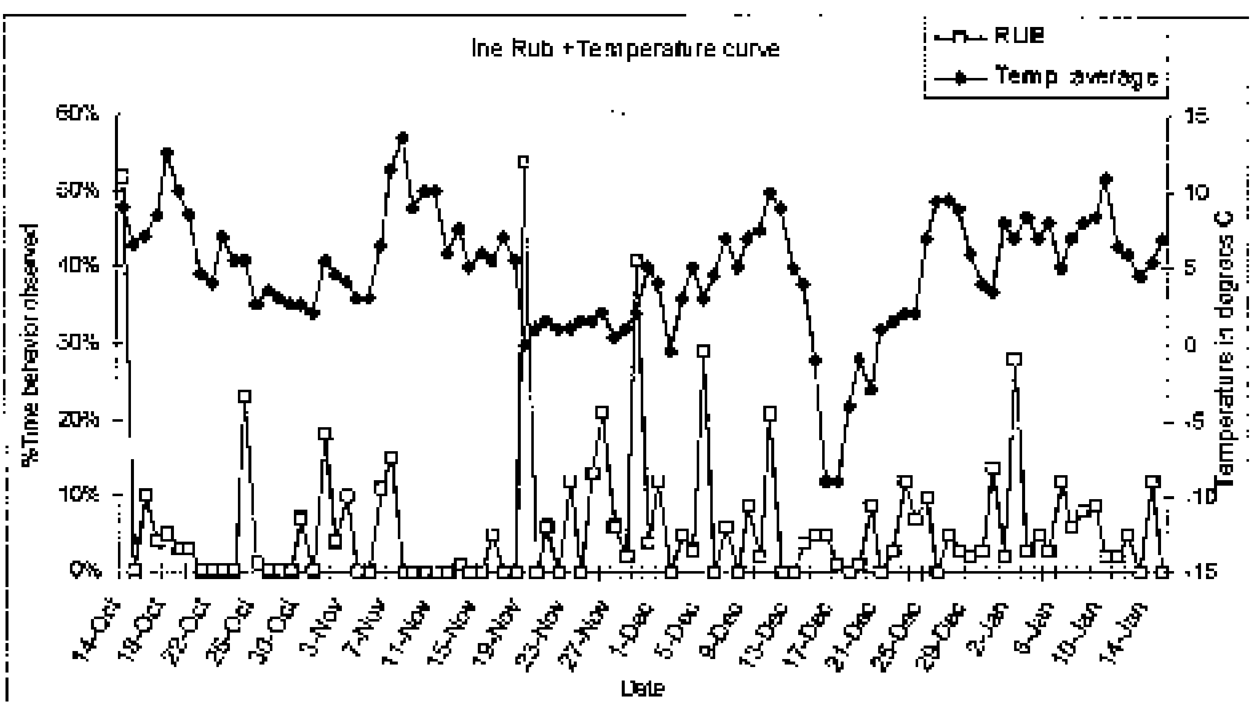

Diagram A53: Temperature curve, showing the average daily temperature in degrees Celsius, Ine's 'rub' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; RUB: Curve depicting Ine's daily behavior concerning 'rub'.

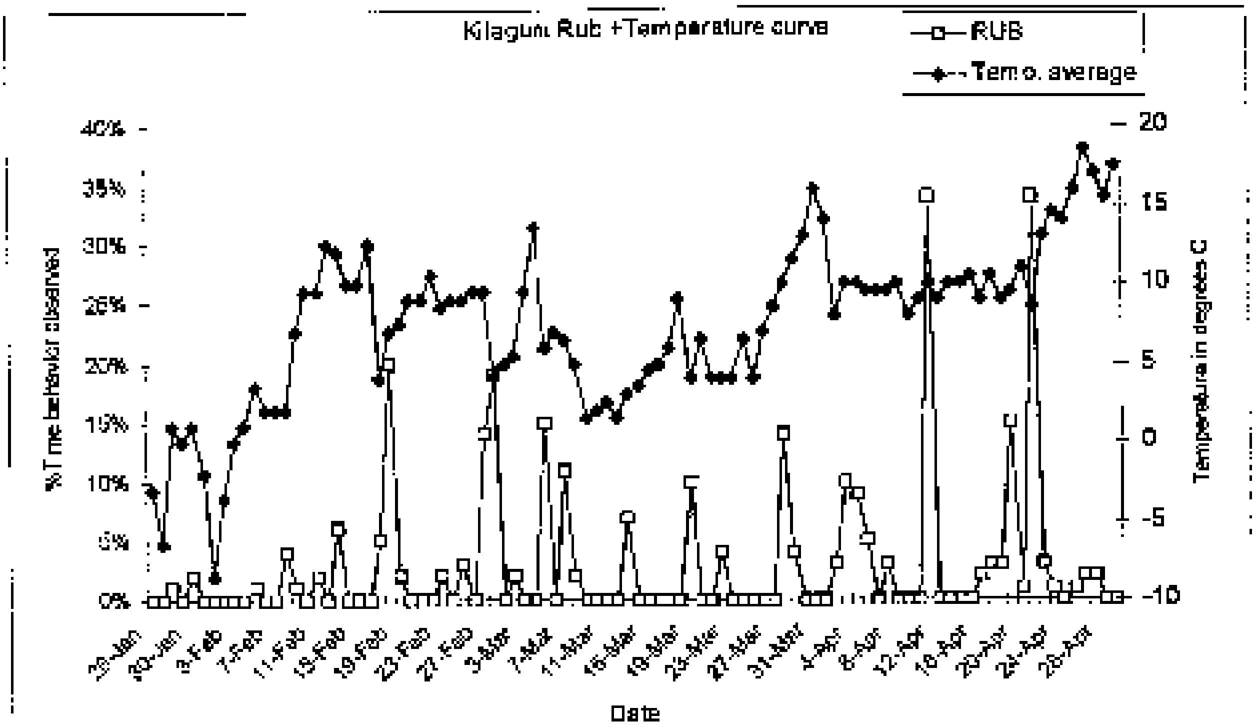

Diagram A54: Temperature curve, showing the average daily temperature in degrees Celsius, Kilaguni's 'rub' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; RUB: Curve depicting Kilaguni's daily behavior concerning 'rub'.

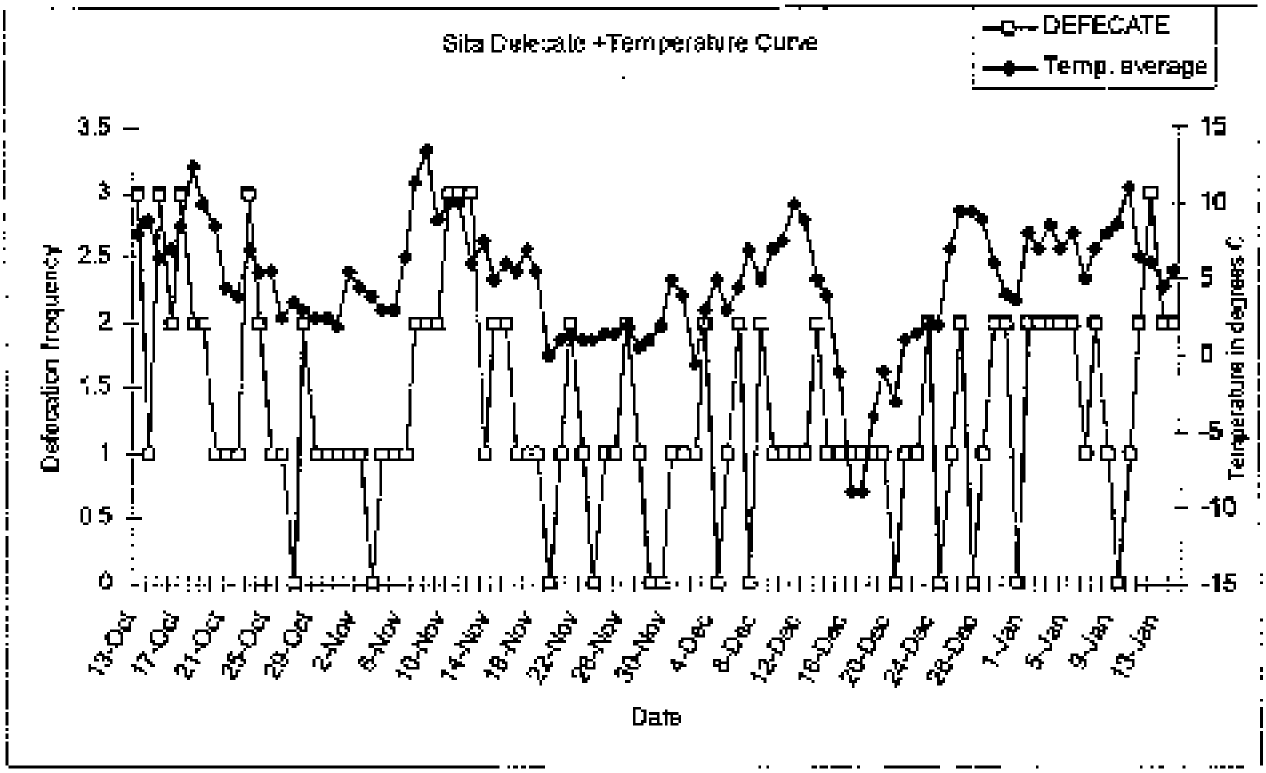

Diagram A55: Temperature curve, showing the average daily temperature in degrees Celsius, Sita's 'defecate' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; DEFECATE: Curve depicting Sita's daily behavior concerning 'defecate'.

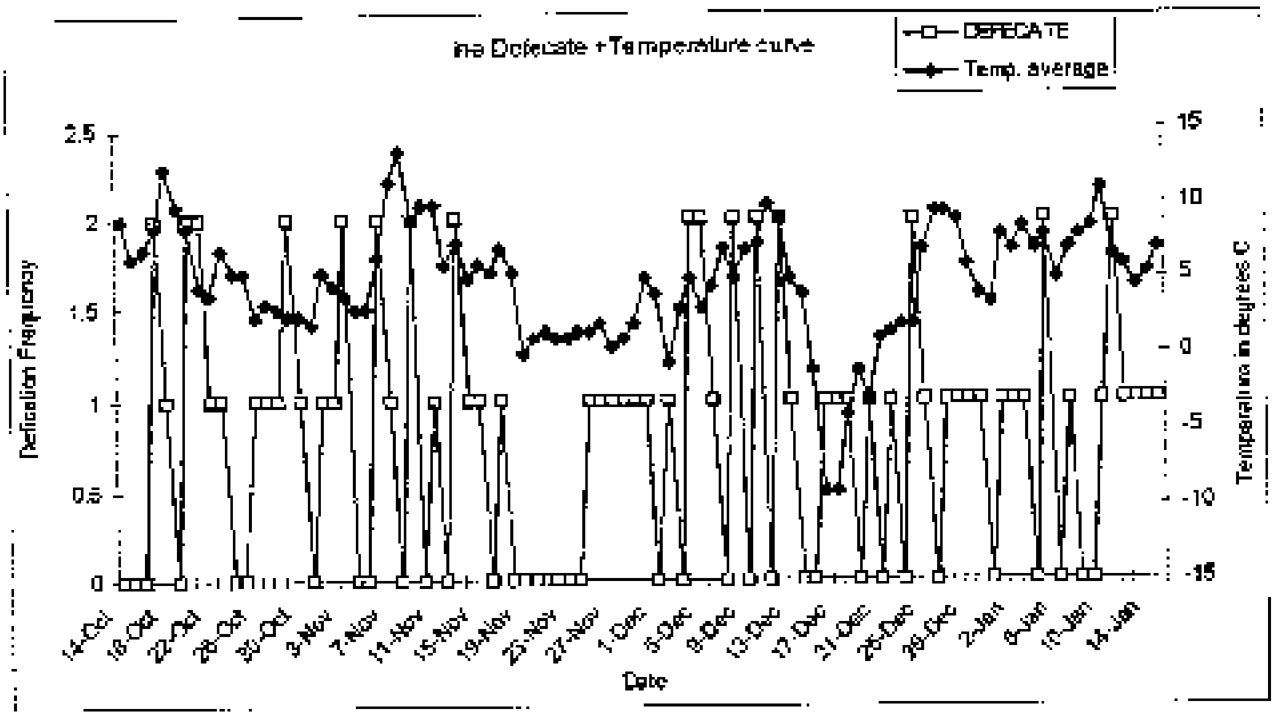

Diagram A56: Temperature curve, showing the average daily temperature in degrees Celsius. Ine's 'defecate' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average. Average daily temperature; DEFECATE: Curve depicting Ine's daily behavior concerning 'defecate'.

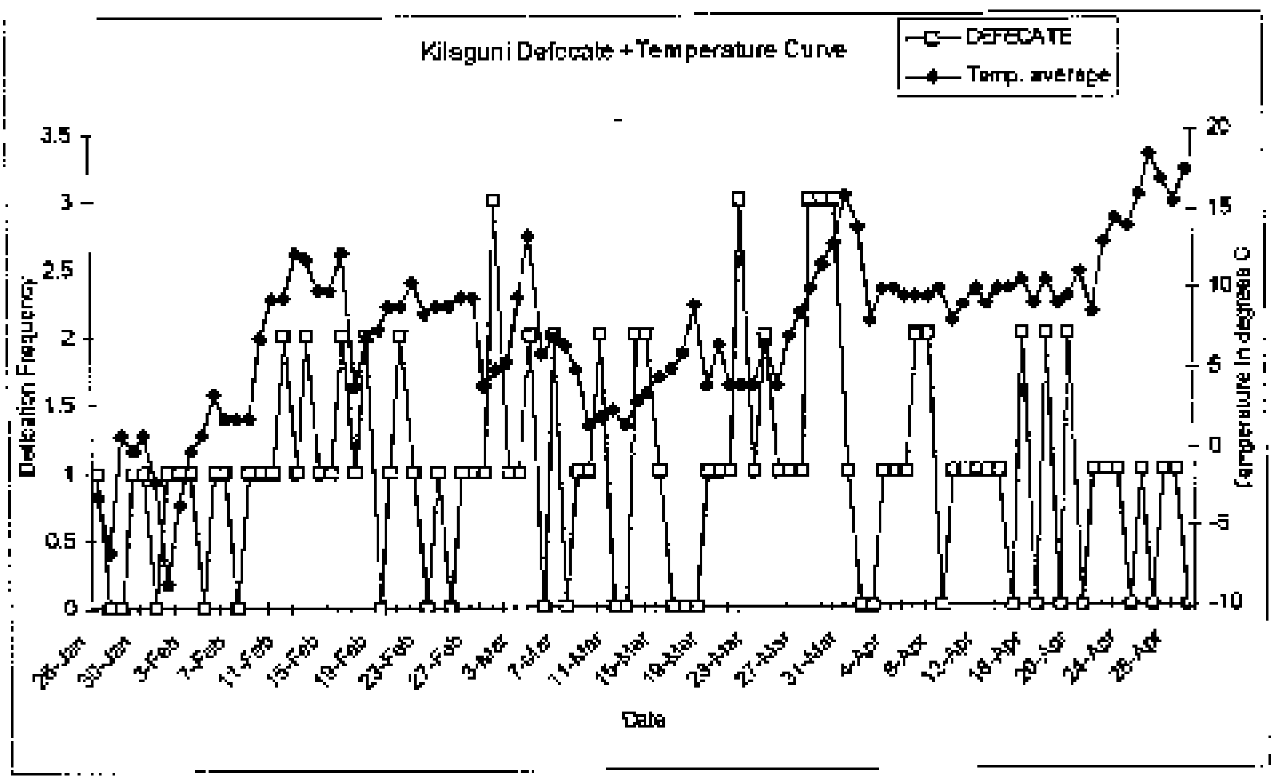

Diagram A57: Temperature curve, showing the average daily temperature in degrees Celsius, Kilaguni's 'defecate' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; DEFECATE: Curve depicting Kilaguni's daily behavior concerning 'defecate'.

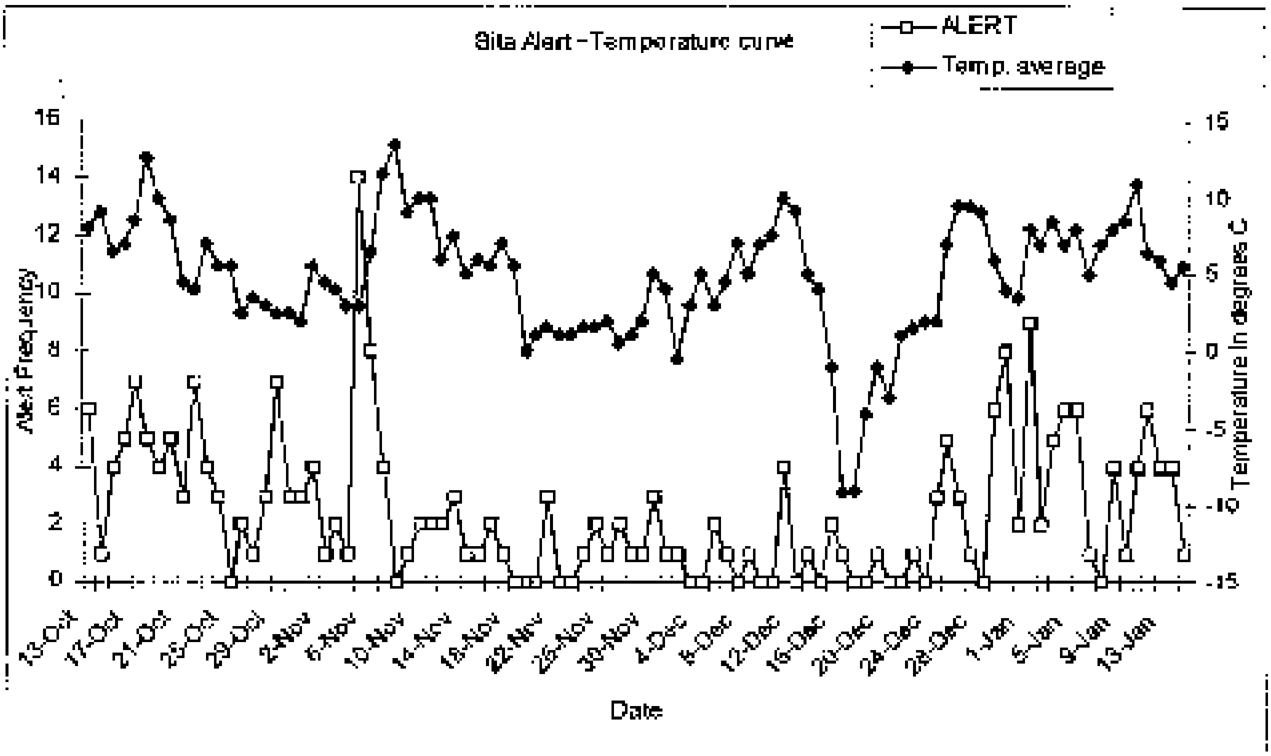

Diagram A58: Temperature curve, showing the average daily temperature in degrees Celsius, Sita's 'alert' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; ALERT: Curve depicting Sita's daily behavior concerning 'alert'

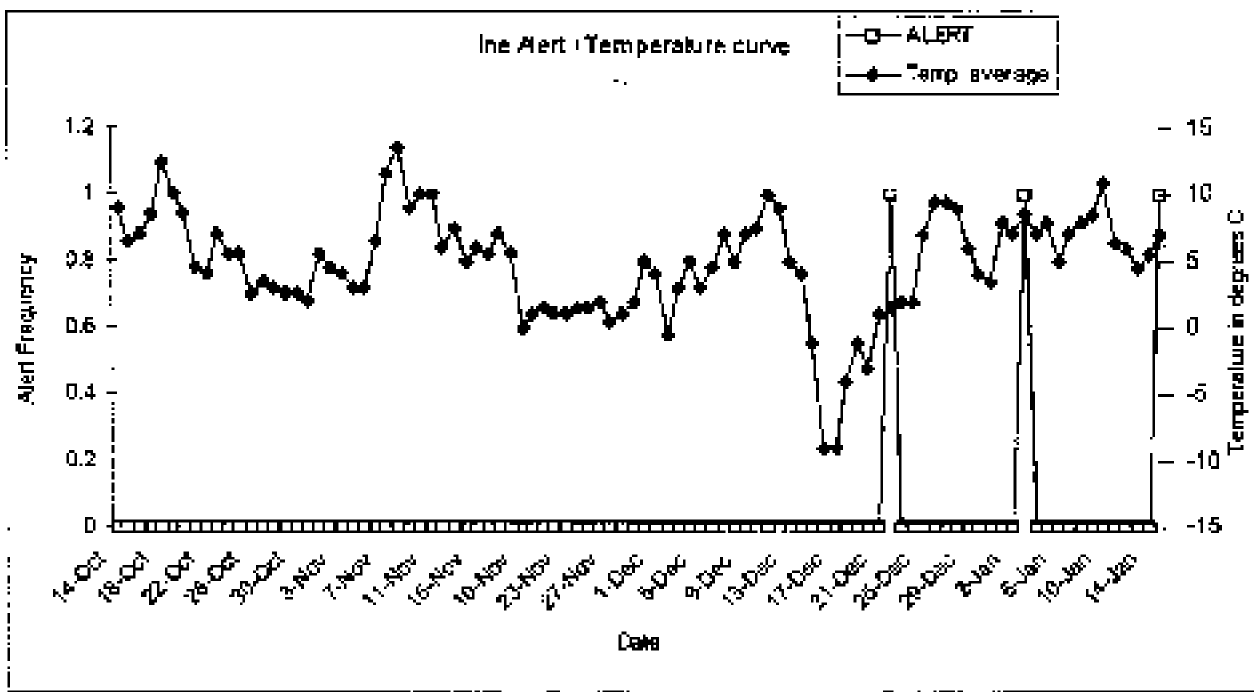

Diagram A59: Temperature curve, showing the average daily temperature in degrees Celsius, Ine's 'alert' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; ALERT: Curve depicting Ine's daily behavior concerning 'alert'.

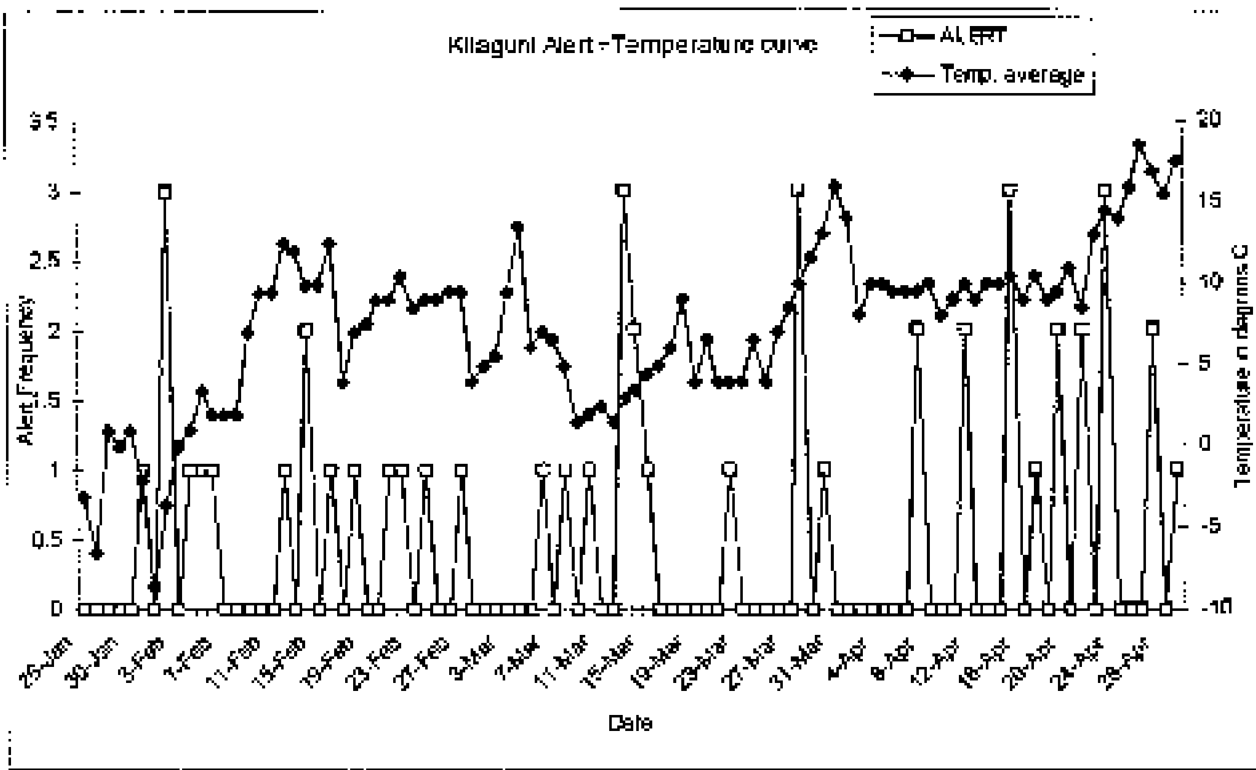

Diagram A60: Temperature curve, showing the average daily temperature in degrees Celsius, Kilaguni's 'alert' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; ALERT: Curve depicting Kilaguni's daily behavior concerning 'alert'.

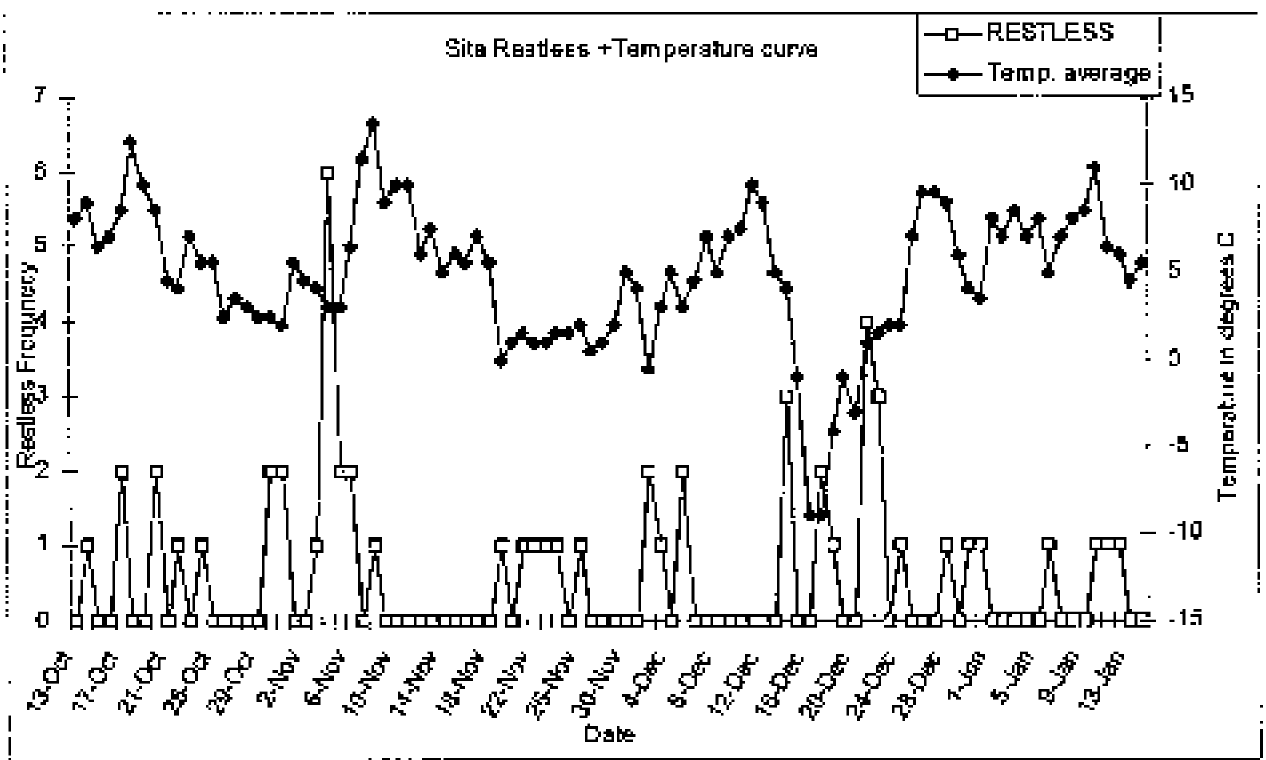

Diagram A61: Temperature curve, showing the average daily temperature in degrees Celsius, Sita's 'restless' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; RESTLESS: Curve depicting Sita's daily behavior concerning 'restless'.

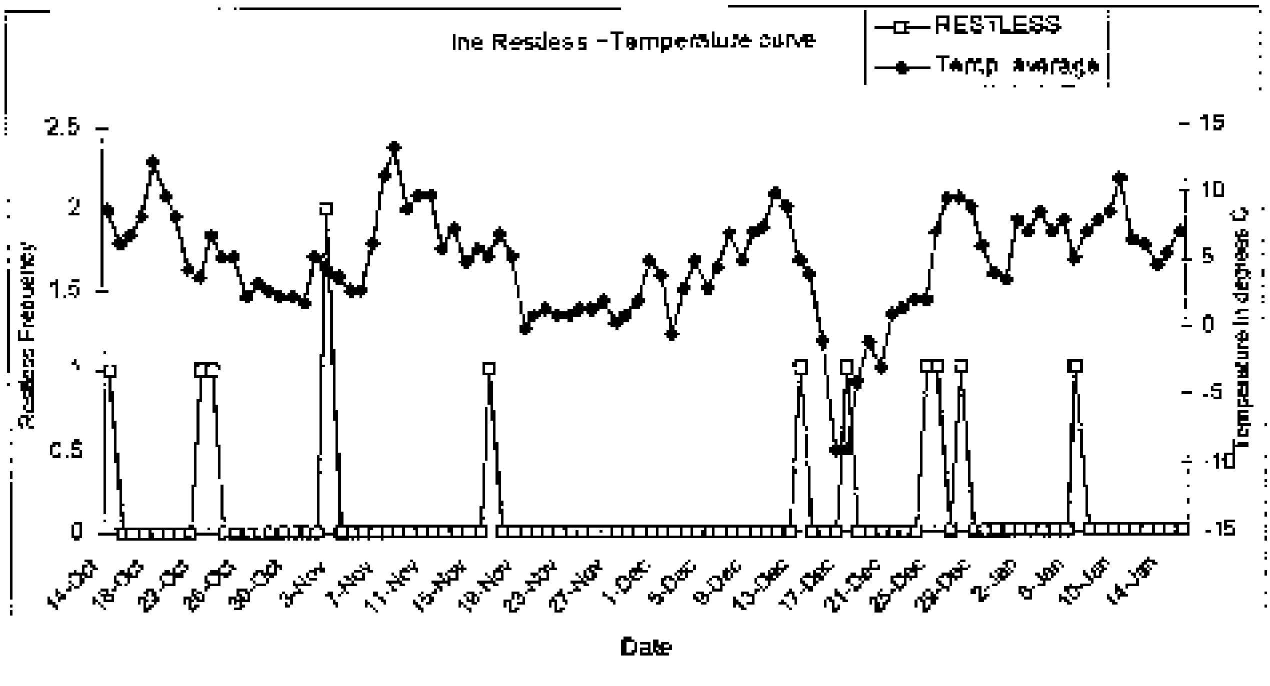

Diagram A62. Temperature curve, showing the average daily temperature in degrees Celsius. Ine's 'restless' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; RESTLESS: Curve depicting Ine's daily behavior concerning 'restless'.

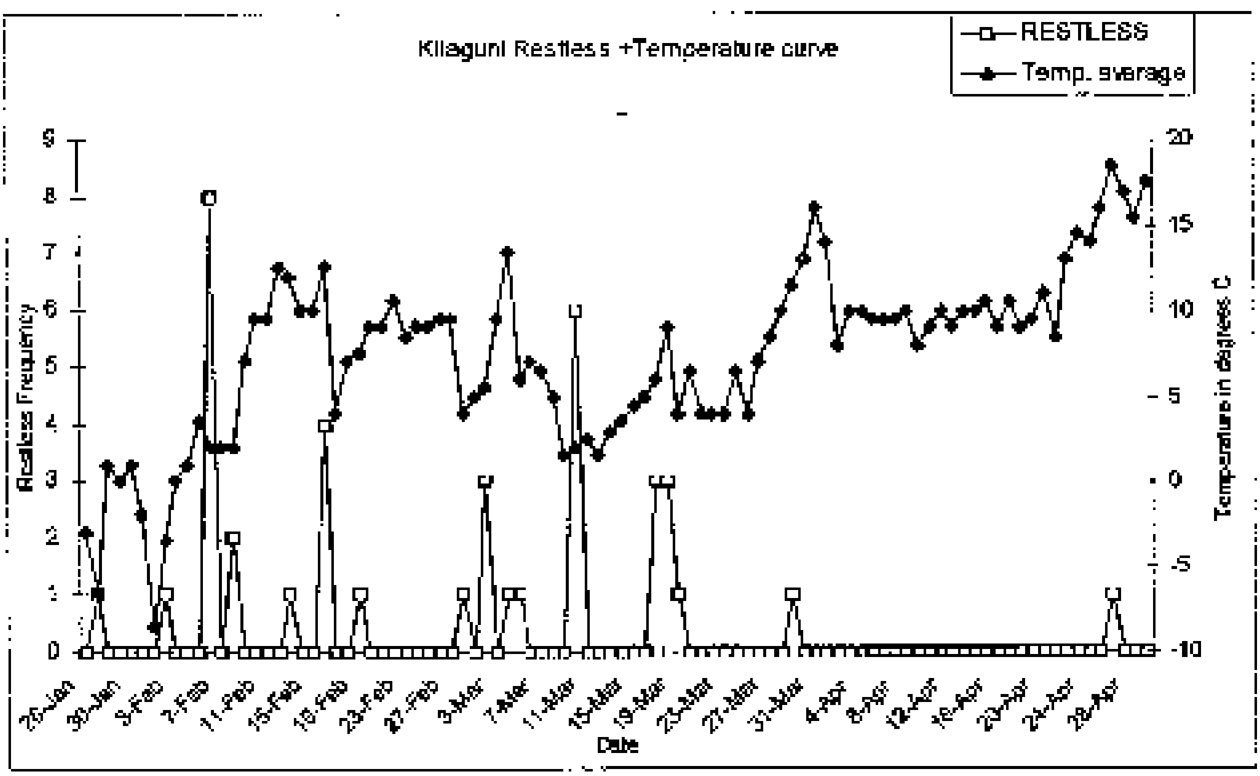

Diagram A63: Temperature curve, showing the average daily temperature in degrees Celsius. Kilaguni's 'restless' curve, showing the percentage of the observation time this behavior pattern was recorded. Temp. average: Average daily temperature; RESTLESS: Curve depicting Kilaguni's daily behavior concerning 'restless'.

7.3 Average Curves

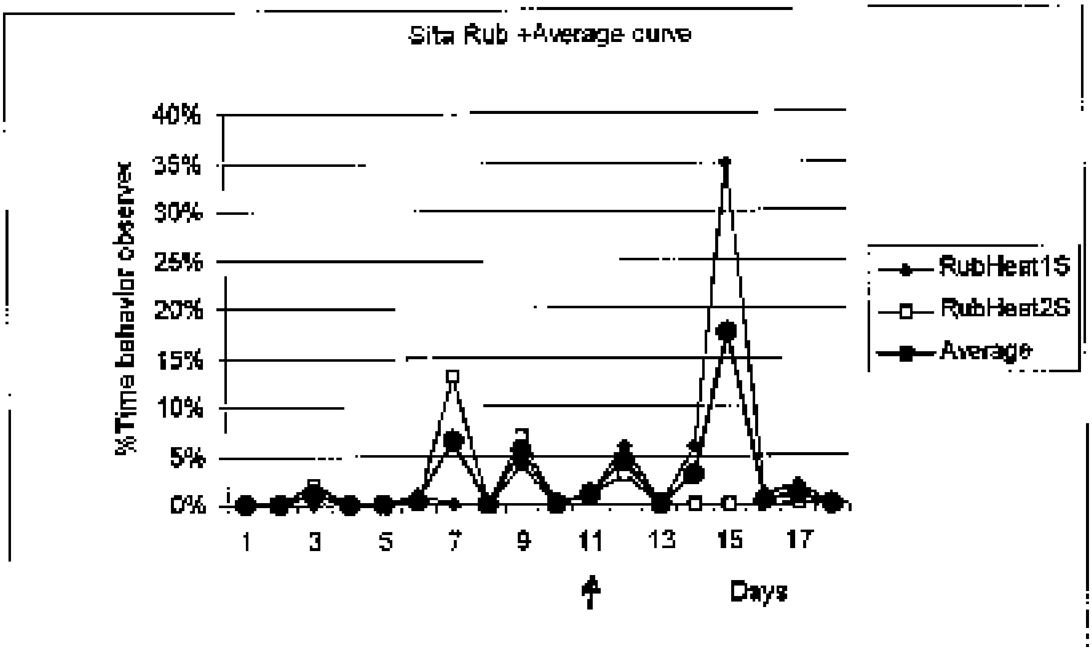

Diagram A64: Behavioral curves for Sita, with peak receptivity on day 11, and the average curve. Data points show the percentage of time Sita spent each observation period rubbing and the average of each day's percentage. RubHeat1S: Curve of days surrounding Sita's first estrus; RubHeat2S: Curve of days surrounding Sita's second estrus; Average. Average of each days data points, and the resulting curve.

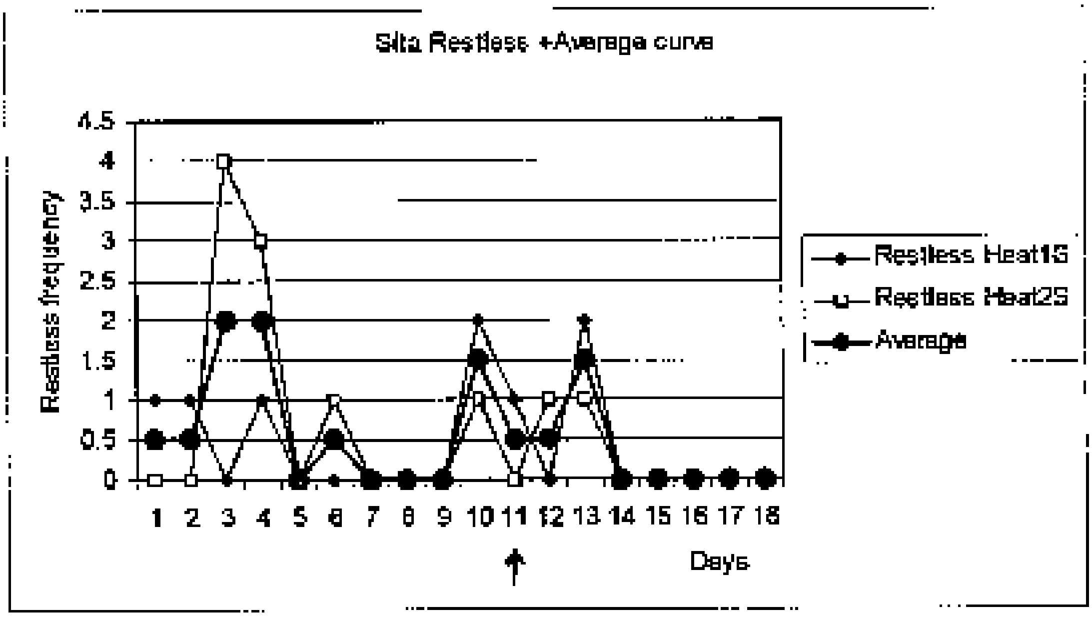

Diagram A65: Behavioral curves for Sita, with peak receptivity on day 11, and the average curve. Data points show the percentage of time each observation period Sita showed 'restless' and the average of each day's percentage. RestlessHeat1S: Curve of days surrounding Sita's first estrus; RestlessHeat2S: Curve of days surrounding Sita's second estrus; Average: Average of each days data points, and the resulting curve.

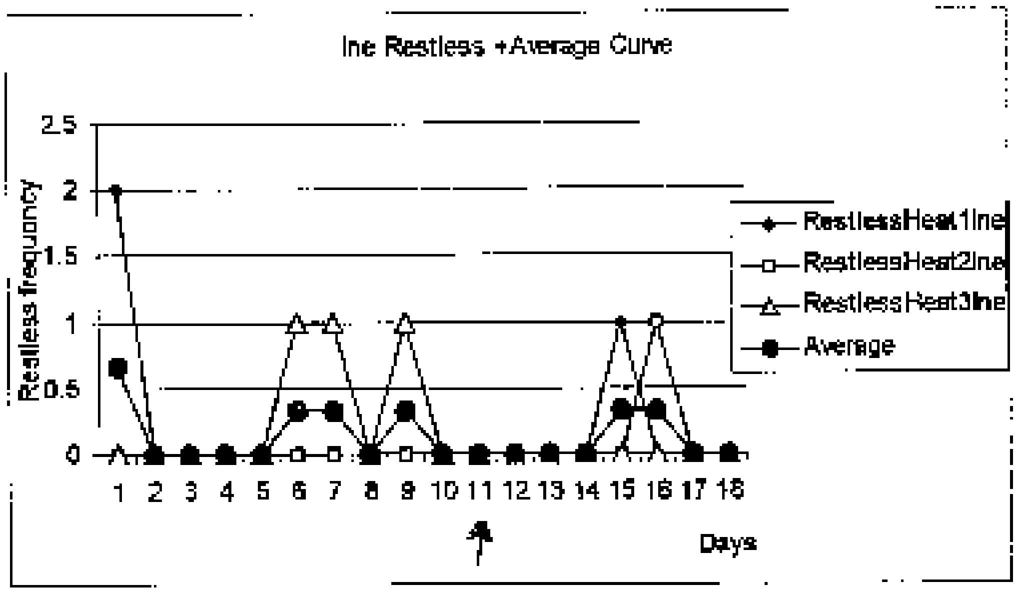

Diagram A66: Behavioral curves for Ine, with peak receptivity on day 11, and the average curve. Data points show the percentage of time each observation period Ine showed 'restless' and the average of each day's percentage. RestlessHeat1Ine: Curve of days surrounding Ine's first estrus; RestlessHeat2Ine: Curve of days surrounding Ine's second estrus; RestlessHeat3Ine: Curve of days surrounding Ine's third estrus; Average. Average of each days data points, and the resulting curve.

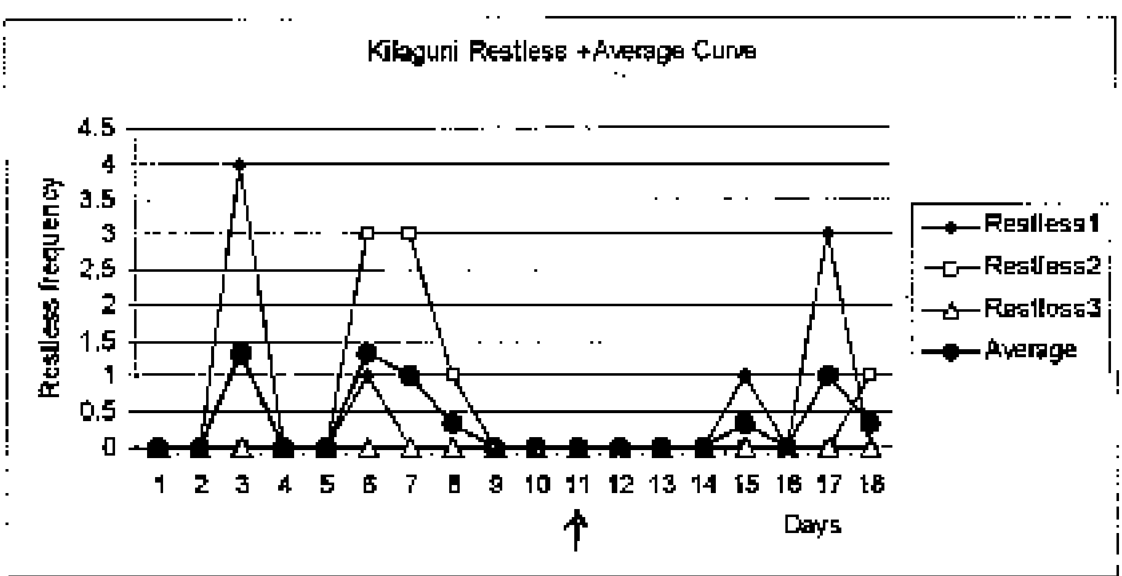

Diagram A67: Behavioral curves for Kilaguni, and the average curve. Data points show the percentage of time each observation period Kilaguni showed 'restless' and the average of each day's percentage. Restless1: Curve of days during Kilaguni's first time-period; Restless2: Curve of days during Kilaguni's second time-period; Restless3: Curve of days during Kilaguni's third time-period; Average. Average of each days data points, and the resulting curve.

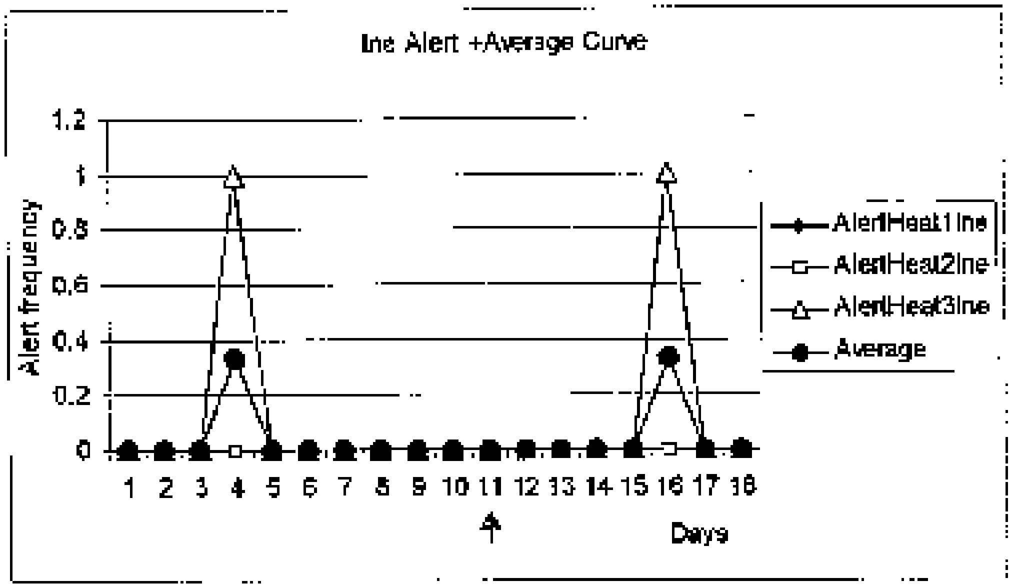

Diagram A68. Behavioral curves for Ine, with peak receptivity on day 11, and the average curve. Data points show the percentage of time each observation period Ine showed 'alert' and the average of each day's percentage. AlertHeat1Ine: Curve of days surrounding Ine's first estrus; AlertHeat2Ine: Curve of days surrounding Ine's second estrus; AlertHeat3Ine: Curve of days surrounding Ine's third estrus; Average: Average of each days data points, and the resulting curve.

7.4 Morning/ Afternoon Separation

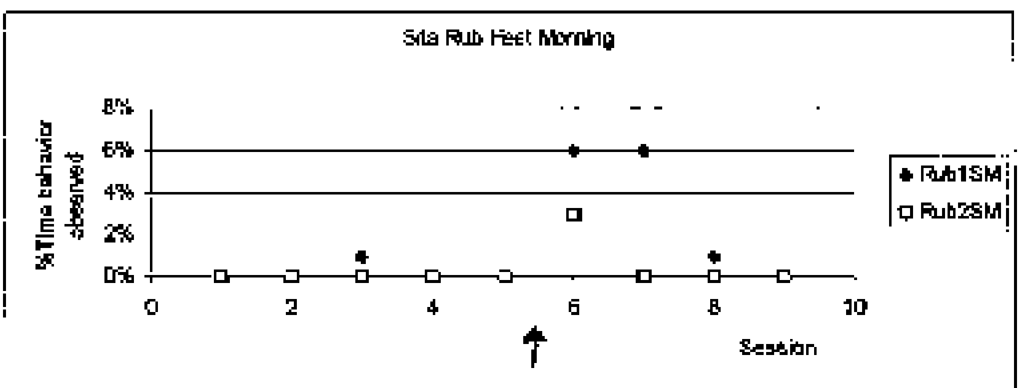

Diagram A69: Data points represent the percentage of time Sita showed the behavior 'rub' on each morning of observation, during the time period previously discussed. Here estrus lies between sessions 5 and 6, which means peak receptivity lies on an afternoon observation day. Rub1SM: Morning observation during Sita's first heat cycle; Rub2SM: Morning observations during Sita's second heat cycle.

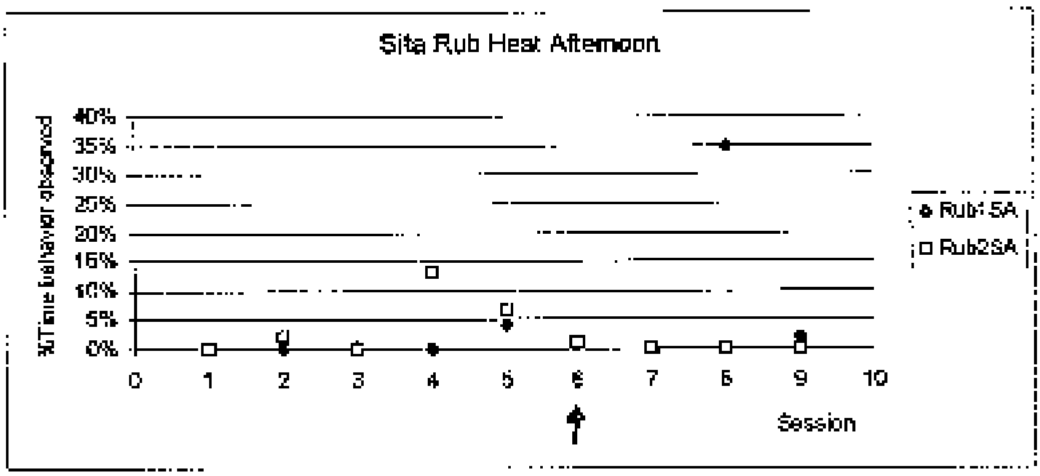

Diagram A70: Data points represent the percentage of time Sita showed the behavior 'rub' on each afternoon of observation, during the time period previously discussed. Here estrus lies in session 6. Rub1SA: Afternoon observation during Sita's first heat cycle; Rub2SA: Afternoon observations during Sita's second heat cycle.

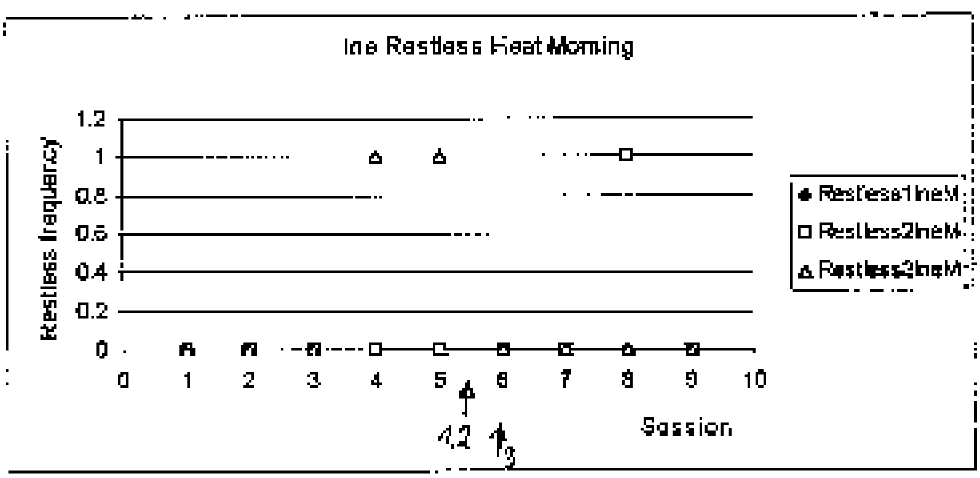

Diagram A71: Data points represent the percentage of time Ine showed the behavior 'restless' on each morning of observation, during the time period previously discussed. Here estrus lies between sessions 5 and 6 for the first two curves, which means peak receptivity lies on an afternoon observation day. For the third curve estrus lies during session 6. Restless1IneM: Morning observation during Ine's first heat cycle; Restless2IneM: Morning observations during Ine's second heat cycle; Restless3IneM: Morning observations during Ine's third heat cycle.

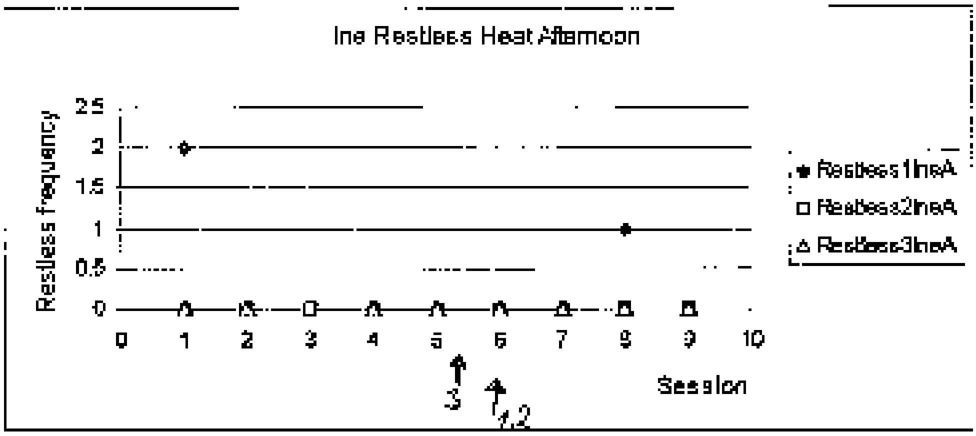

Diagram A72. Data points represent the percentage of time Ine showed the behavior 'restless' on each afternoon of observation, during the time period previously discussed. Here estrus lies between sessions 5 and 6 for the third curve, which means peak receptivity lies on an afternoon observation day. For the first and second curves, estrus lies during session 6. Restless1IneA: Afternoon observation during Ine's first heat cycle; Restless2IneA: Afternoon observations during Ine's second heat cycle; Restless3IneA: Afternoon observations during Ine's third heat cycle

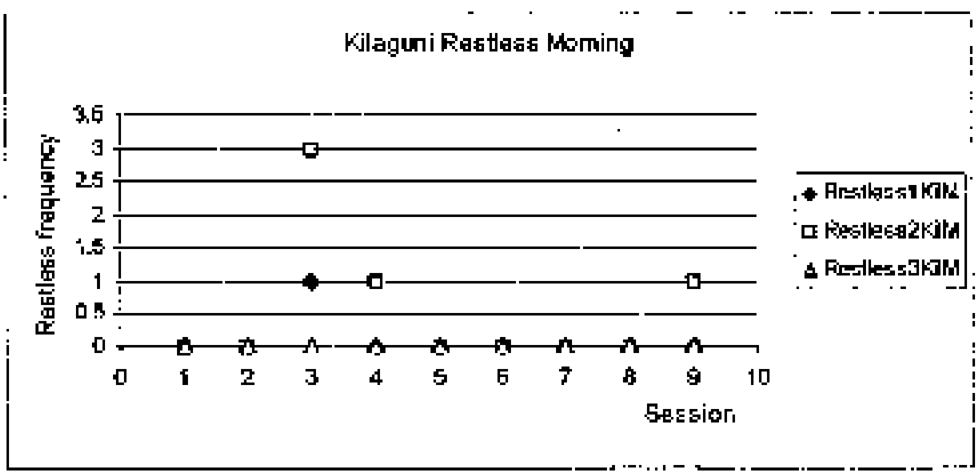

Diagram A73: Data points represent the percentage of time Kilaguni showed the behavior 'restless' on each morning of observation, during the time period previously discussed. Restless1KilM: Morning observation during Kilaguni's first time-period; Restless2KilM: Morning observations during Kilaguni's second time-period; Restless3KilM: Morning observations during Kilaguni's third time-period.

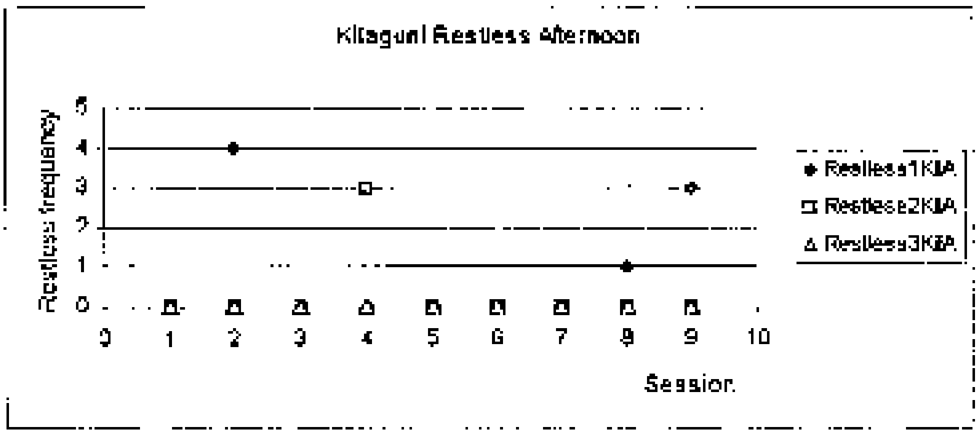

Diagram A74: Data points represent the percentage of time Kilaguni showed the behavior 'restless' on each afternoon of observation, during the time period previously discussed. Restless1KiIA: Afternoon observation during Kilaguni's first time-period; Restless2KiIA: Afternoon observations during Kilaguni's second time-period; Restless3KiIA: Afternoon observations during Kilaguni's third time-period.

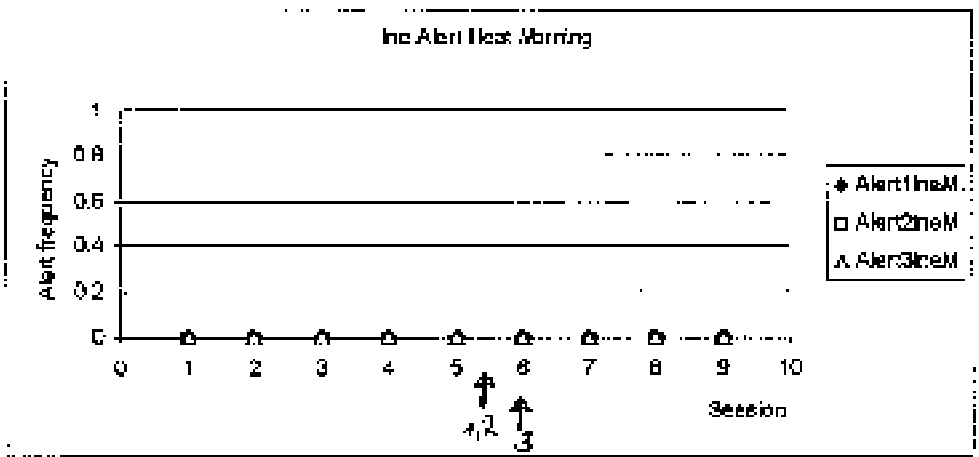

Diagram A75: Data points represent the percentage of time Ine showed the behavior 'alert' on each morning of observation, during the time period previously discussed. Here estrus lies between sessions 5 and 6 for the first two curves, which means peak receptivity lies on an afternoon observation day. For the third curve estrus lies during session 6. Alert1IneM: Morning observation during Ine's first heat cycle; Alert2IneM: Morning observations during Ine's second heat cycle; Alert3IneM: Morning observations during Ine's third heat cycle.

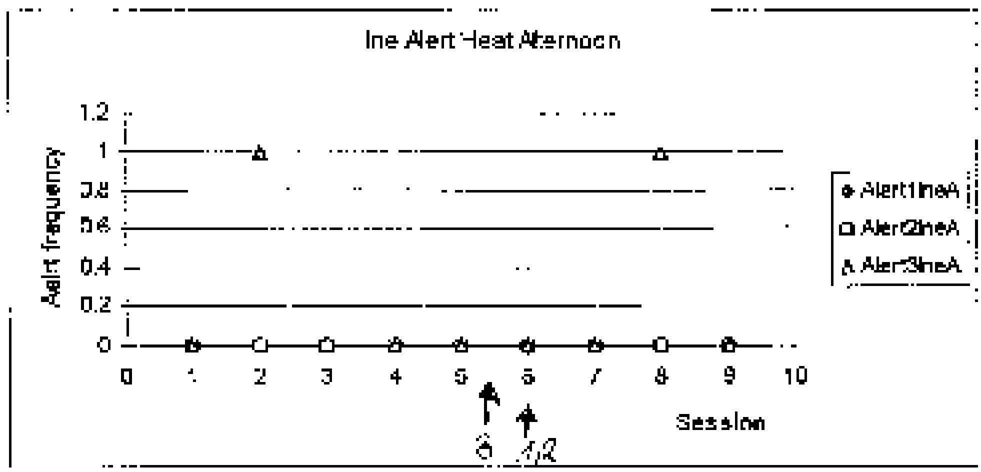

Diagram A76. Data points represent the percentage of time Ine showed the behavior 'alert' on each afternoon of observation, during the time period previously discussed. Here estrus lies between sessions 5 and 6 for the third curve, which means peak receptivity lies on an afternoon observation day. For the first and second curves, estrus lies during session 6. Alert1IneA: Afternoon observation during Ine's first heat cycle; Alert2IneA: Afternoon observations during Ine's second heat cycle; Alert3IneA: Afternoon observations during Ine's third heat cycle.

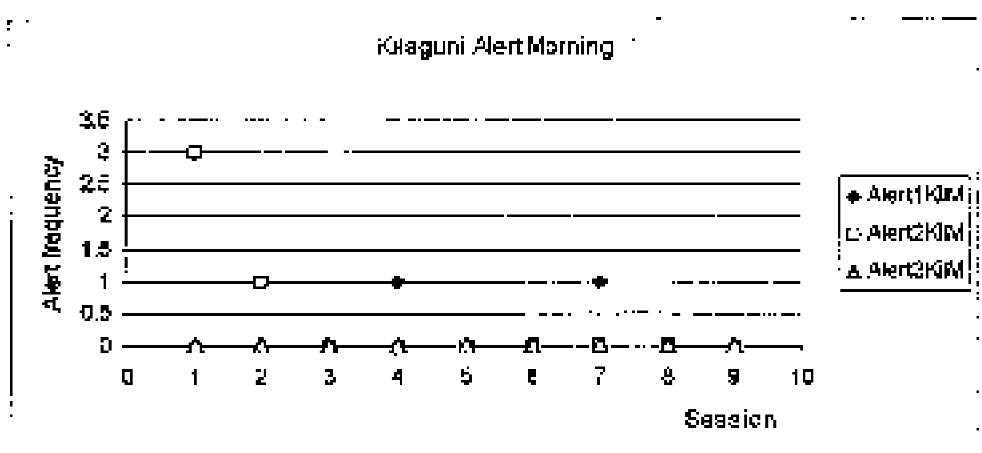

Diagram A77: Data points represent the percentage of time Kilaguni showed the behavior 'alert' on each morning of observation, during the time period previously discussed. Alert1KilM: Morning observation during Kilaguni's first time-period; Restless2KilM: Morning observations during Kilaguni's second time-period. Restless3KilM: Morning observations during Kilaguni's third time-period.

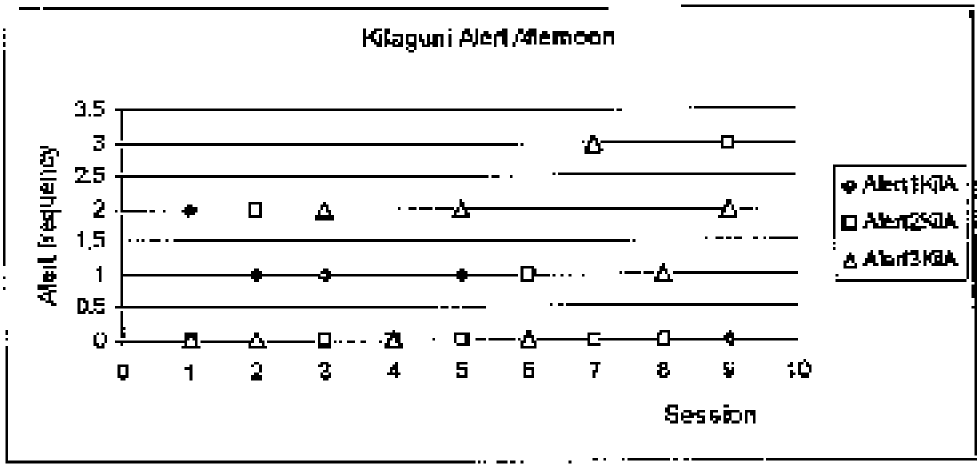

Diagram A78: Data points represent the percentage of time Kilaguni showed the behavior 'alert' on each afternoon of observation, during the time period previously discussed. Alert1KilA: Afternoon observation during Kilaguni's first time-period; Alert2KilA: Afternoon observations during Kilaguni's second time-period; Alert3KilA: Afternoon observations during Kilaguni's third time-period.