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Sexual and social behaviors of pony stallions and mares

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Abstract

Aspects related to social organization and its effects on the reproductive behavior of domestic stallions breeding under free range management systems have not been studied. This study was carried out with the following objectives: to identify the social units established between Brazilian Pony Breed stallions and mares; to verify the effect of the stallion in harem composition and mating activity; and to verify nocturnal sexual activity. This study was carried out during two breeding seasons. In the first year animals were observed for 12 days (8.1 h/day). In the second year, another group was observed in three periods with an average daily duration of 9.6 hours. Stallions ranging in age from 3 to more than 12 years and a group of mares ranging in age from 3 to 20 years were used. Two social units were identified: harem and bachelor group. Three-year-old stallions did not form a harem. Hierarchic relationships among stallions and inside harems were established. Dominance, fight ability, aggressive behavior and age of stallions seem to influence size and harems maintenance. The total observed matings in Years I and II was 28 and 134, respectively. Mares were mated on average 1.9 times and the average number of daily mating was 1.2. The average number of receptive mares and matings per day was 8.5 and 1.1, respectively. The average copulation time was 38.4 and 37 sec in Years I and II, and the average daily interval between matings was 79.8 and 104.1 min, respectively. Considering the three observation periods in Year II, the mares were mated on average 2.2 times. The average number of daily matings was 2.1. The average number of receptive and mated mares per day was 20.7 and 1.8, respectively. In the two years nocturnal sexual activity was verified. The general pregnancy rate was 79.4% in the first and 72.2% in the second year.

Keywords: behavior, horses.

Introduction

Wild and domesticated equids live in different social units, and differences in their sexual behavior have been observed. One difference concerning breeding systems is that some mature stallions mate mares from their own harem and others copulate only in their territory, while immature stallions stay without mares in the bachelor group (Klingel, 1975, 1982; Keiper, 1985).

The harems are relatively stabilized social units, mainly when mares are pregnant. The females can remain in the same social unit during their whole life. After harems are established, the stallion controls the mares and their offspring, some for over 10 years, blocking their access to other groups or minimizing their contact (Klingel, 1982). The difference in family size depends on the reproductive efficiency of stallions and foal mortality. The foal production in stabilized groups exceeds the production in unstable ones (Berger, 1983, 1986; Kaseda *et al.*, 1996) and the reproductive success of stallions is positively related to the number of adult mares in this harem (Klingel, 1982).

Observations regarding reproductive behavior of feral and domestic horses indicate that stallions at hand-breed systems have lower rates of sexual vigor and fertility and higher rates of sexual behavior dysfunction compared to equids breeding freely (McDonnell, 2000). There are reports on stallions and donkeys at pasture breeding females every 1 or 2 h during the day and at night with excellent sustained fertility (Bristol, 1982; Henry *et al.*, 1991; Steinbjörnsson and Kristjansson, 1999), whereas for most hand-breed stallions, libido and fertility decrease with breeding schedules of more than once or twice per day (McDonnell, 2000).

Although the pasture-breed systems have been used for years, in Brazil, few studies report the factors involved in the social organization, mating activity, sexual efficiency, male/female ratios and fertility of domestic horses kept at pasture.

Mating behavior and social organization observations of domesticated equids can avail important information to improve the knowledge about their behavior and provide more informations to establish changes in the management, which can increase their reproductive efficiency or even alleviate the sexual dysfunction of stallions.

This study was carried out with the following objectives: to identify the social units established between domestic Brazilian Pony breed stallions and mares; to verify the effect of stallions in harem composition and mating activity; and to verify nocturnal sexual activity.

Materials and Methods

Study site

The experiment was carried out on a Brazilian Pony breeding farm, located in Pantano Grande, State of Rio Grande do Sul, in the Southern region of Brazil at 30º 11' 29" S latitude and 52° 22' 25" W longitude. The climate is subtropical with temperatures ranging from

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5°C to 42°C (19.2°C) and a mean annual rainfall of 1.500 mm. The months of higher ovulation rate (>50%) were from November to April. The anestrous period (≥25% of mares with CL in at least one ovary) was from June to September (Tarouco *et al*., 1995). The animals were observed in a 4-ha observation paddock with a relatively plain topography which allowed its entire view and covered with native grass, having a reservoir as water source.

Animals

A group of 4 stallions aging 3, 5, and >12 years was formed in the first year of study (S3, S5, S12a and S12b) kept with 46 non-lactating mares (7 pregnant) ranging in age from 3 to 20 years old. Another group of 3 stallions (S4, S2 and S12) and S5 (Year I) aging 3, 6, and >12 years and 40 other non-lactating mares were observed in the second year. The ages were estimated on the basis of dental evaluation. Stallions and pregnant mares were identified according to their coat color and individual markings. The mares received sequential numeric identification on the right and left flanks. All the animals were revised and photographed to avoid identification problems.

Animals were raised extensively with little management. Worm control was accomplished twice a year as part of health management and did not receive any feed supplementation. Out of the breeding season, stallions and mares were kept in different paddocks. Although reproductive histories of males and females were unknown, the animals already had sexual experience except for the two youngest stallions (S3 and S4) and S5 in the first year. The breeding system used on the farm was at pasture and the animals were artificially grouped, according to a selection criteria established by the breeder.

Procedures with the mares

Year I

Females from the property were not usually submitted to any kind of gynecological examination. However, in order to find out the phase of the estrous cycle and diagnose pregnancy in the present study, gynecological examination by rectal palpation and ultrasound (5 MHz linear array transducer, Aloka SSD 500, Aloka Co., Tokyo, Japan) was performed on five occasions. The first examination happened in the beginning of the study. Further examinations were performed on the 5th, 8th, 12th days of observation, and the final diagnosis was performed 41 days after the end.

Year II

One day before the beginning of each observation period (1, 2 and 3) all mares were submitted to gynecological examination using the same procedures as the first year. A second examination was performed 14 days after the two first observation periods (1 and 2) to identify pregnancy. Only in Year II, pregnancies between 14 and 24 days were interrupted using 10 mg of dinoprost i.m. ($PGF_{2\alpha}$; Lutalyse®, Rhodia-Mérieux Veterinaria Ltda, São Francisco Farm, Paulínia, São Paulo). These procedures were accomplished to assure that most mares could conserve the same estrous cycle stage at the beginning of each observation period. During the last observation period mares were examined only a day before the beginning and the final pregnancy diagnosis was performed 65 days after the end.

Observation time

The animals were observed in two years (Year I and Year II). In the first year, the ponies were observed daily by two observers for 12 days in December (117 h: 97 h daylight and 19.8 h at night). In the second year, animals were observed in three periods [(1) 6 days, (2) 7 days, and (3) 8 days] during December and January (daylight hours of 14 and 13.5 h, respectively) by the same observers with a 21-day interval among periods until the moment when the social units were disrupted and stallions and mares lost contact. The daily observation period was on average 9.6 h in a total of 203.5 h.

In order to verify nocturnal mating activity, stallions and mares were observed with flashlights, the light from rural facilities and infrared binocular twice (19 h) in Year I and once (9 h) in Year II. The number of matings for each stallion was only registered. These observations were not included in the statistical analyses.

Social organization observation

On the first day of the daily observation periods in both years, mares were identified and previously examined and then released into the paddock. Afterwards the two observers set their positions where they could visualize all of animals. Some time later, stallions were also released and since then every movement and interaction with the mares that allowed the identification of the composition of social units and the dominance relationships among the animals were registered. Each observer followed the social units individually. In the first year, stallions S3, S12b and their harem were sporadically observed. In the fourth day of observation, when harems were stabilized, the animals were removed from the paddock because of its small size. From this day on, only S5, S12a and their harems were observed, with a remaining number of 38 animals in the observation paddock until the end of the study in Year I.

Social units considered in this study

Harem

A social group containing a stallion and the mares kept under its control.

Bachelor group

A group formed by only one or more stallions.

Harem composition

In both years the number of receptive, non-receptive and pregnant mares that belonged to the harem in the beginning (MI) and at the end (MF) of observation were registered daily, as well as the variations that occurred during the day.

Stability and dominance relationships in the harems

Since the harem is a relatively stable social unit, the number of days needed to have stable associations between mares and stallions established was figured out during the observations. Harems were considered stable when there were no mare exchanges in their final composition (MF) during each daily observation, with a greater distance among their components and when the mares responded actively to the snaking behavior (herding with the head and neck extended and ears held back) performed by the stallion (Ginther *et al*., 2002).

To evaluate the dominance relationships among the animals, the following aspects were considered: age; access to water source; threatening and submissive behavior (agonistic behavior); ability to fight during stallions confronts; leadership movements in the observation paddock; initiative in activities such as grazing, resting, danger signal and a certain level of group control.

Observation of general and sexual behavior

Specific interactions among stallions, mares and stallions and mares were identified according to the McDonnell and Haviland (1995) ethogram. Copulation was considered when there was penis intromission and the stallion remained stationary over the mare for a short period of time after several pelvic thrusts and dismounted with erection loss. For stallions the following daily observations were considered: number of matings (MAT), number of mares mated (MMAT), duration of the copulation (TIME), intervals between matings with the same mare (INT_MEAN_SM) and different mares (INT_MEAN_MAT**)**. It was registered in the first year only during the daylight observations: number of mounts without erection (ME**),** with erection (MWE)**,** with penetration and without ejaculation (MWP) for stallions S5 and S12a.

Statistical analyses

All procedures were performed by SAS version 9.1.3 (SAS Institute Inc., Cary, NC, USA)

Social organization

To verify the effect of the stallion in harem composition (size) in Year I, analysis of variance (ANOVA) in a duple classification by GLM procedure was used. The adjustment verification of the ANOVA model was done using the Levene variance homogeneity test and the differences between means were performed by Tukey test with 5% significant level, according to the model:

$$Y_{ijk} = \mu + \alpha_i + \varepsilon_{ij}$$

μ is the general mean

α_i is the stallion effect

ε_{ij} is the unobservable random error associated an observation

Variables used during the two years of observation were: MI = no. of mares in the harem at the beginning of the daily observation period; MF = no. of mares in the harem at the end of the daily observation period; MDAYM = mean no. of mares in harem/day; RMI = no. of receptive mares in the harem at the beginning of the daily observation period; RMF = no. of receptive mares at the end of the daily observation period.; MDIARM = mean no. of receptive mares in harem/day; MMAT/day = no. of mares mated/day; MAT/day = no. of matings/day.

In the second year this effect was performed using ANOVA for repeated measurements considering the effects of day, stallion, observation period (1, 2 and 3) and the effects of the interaction stallion x observation periods, according to the model:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \delta_{ij} + \gamma_k + \beta\gamma_{jk} + \varepsilon_{ijk}$$

where:
i = 1, 2, 3,... (day index)
j = 1, 2, 3,... (stallion index)
k = 1, 2, 3,... (observation period index)

being: Y_{ijk} the observation related to variable evaluated in the day i, to stallion j and observation period k.

μ is the final mean

α_i is the day effect

β_j is the stallion effect

δ_{ij} is the whole plot random error effect, interation day vs stallion

γ_k is the observation period effect

$\beta\gamma_{ijk}$ is the interaction stallion vs. observation period effect

ε_{ijk} is the subplot random error effect, unobservable associated an observation

Sexual behavior

To verify the effect of stallion on duration of copulation (TIME**)** and intervals between matings one

way analysis of variance was used. The differences between means were compared by Tukey test with 5% significance. In the second year the same variables were analyzed by ANOVA for repeated measurements considering the effects of stallion, observation periods and their interaction. To verify the effect of the age of mares on the number of matings in Year II in all observations periods, ANOVA was utilized for repeated measurements considering the effects of the age of mares, observation periods and the effect of this interaction. The effect of the age of mares on each observation period was analyzed using one-way ANOVA. Differences between means were identified by Tukey test (5%) in both opportunities.

Results

Social organization

Year I

On the first day of observation an arrangement in the harems by the older stallions was identified. Whereas the older breeders competed for the mares, the youngest stallion (S3; 3 years old) remained distant. He neither competed nor approached mares at any moment, nor fought with others stallions, and thus he was characterized as the only member of a bachelor group social unit. After the first daily observation period one bachelor group (S3) and three harems had been formed which were identified according to the stallion (S12a, S12b, and S5). The social units were stabilized on the fourth day when its composition did not change, the distance among their components increased and the mares responded to the snaking behavior performed by the stallion. Stallions avoided confrontation and kept their harems distant, decreasing the herding and snaking episodes. The harems were composed of S12a and 11 mares, S5 and 25 mares and S12b and 10 mares.

Year II

The harem composition varied during the three periods. It was impossible to identify the stabilization of the harems. There were mares exchanging groups along the periods. Serious fighting and mare competitions were observed between stallions S5 and S2. S12 always had a smaller harem in the observation periods and S4 did not form his own harem. In some occasions S4 joined S2, but at the end of the third observation period he formed a bachelor group with stallion S12. Table 1 shows the final composition of the harems and the bachelor group at the end of observations.

Harem composition and mating activity

The number of mares in the harems changed daily until the fourth day in Year I. Because of these changes in harem composition along the day, average values of the variables referred to harem composition, as well as mating activity of each stallion were utilized. Those values are in Table 2.

Table 1. Harem and bachelor group composition at the end of each observation period.

Period	Final harem and bachelor band composition	Total of mares
1	S5 + 22 mares; S2 + 16 mares; S12, S4 + 2 mares	40
2	S5 + 23 mares; S2 + 15 mares; S12, S4 + 2 mares	40
3	S5 + 27 mares; S2 + 13 mares; S12 and S4	40

Table 2. Mean ± SEM of variables related to harem composition and mating activity of stallions in Year I.

Stallion	Days of observation	MI	MF	MDAYM
S5	12	22.0 ± 6.9[a]	22.9 ± 6.3[a]	22.5 ± 6.3[a]
S12a	12	12.6 ± 3.3[b]	11.3 ± 1.2[b]	11.9 ± 1.9[b]
S12b	4	14.0 ± 6.9[b]	15.2 ± 8.5[b]	14.6 ± 7.6[b]
Stallion	Days of observation	RMI	RMF	MDAYRM
S5	12	4.7 ± 2.6	5.0 ± 2.6	4.8 ± 2.5
S12a	12	3.4 ± 2.5	3.0 ± 2.0	3.2 ± 2.2
S12b	4	1.7 ± 2.4	2.2 ± 3.3	2.0 ± 2.8
Stallion	Days of observation	MMAT/day		MAT/day
S5	12	1.3 ± 1.2		1.4 ± 1.2
S12a	12	0.8 ± 1.2		0.9 ± 1.4
S12b	4	1.0 ± 1.4		1.0 ± 1.4

MI = no. of mares in the harem at the beginning of the daily observation period; MF = no. of mares in the harem at the end of the daily observation period; MDAYM = mean no. of mares in harem/day; RMI = no. of receptive mares in the harem at the beginning of the daily observation period; RMF = no. of receptive mares at the end of the daily observation period.; MDIARM = mean no. of receptive mares in harem/day; MMAT/day = no. of mares mated /day; MAT/day = no. of matings/day.

[a, b]Means in the same column with different letters are statistically different, ($P < 0.05$).

The harem composition changed daily in the three observation periods in Year II. The average values of variables regarding harem composition for each stallion considering the three observation periods are represented in Table 3.

When the variables regarding harem composition of each stallion were compared among the three observation periods (Year II), the only significant observed differences were: average number of mares in harem/day and average number of receptive mares in harem/day, considering stallions S5 and S2.

In the variables related to mating activity (average number of mares mated/day, average number of matings/day) stallion effect regardless the observation period was verified. S5 performed the greatest average number of matings (3; $P < 0.05$) with a larger number of mares compared to the other two stallions (S2: 2.2; S12: 0.6; $P < 0.05$). However, the average number of receptive mares in harem/day did not differ between the bigger harems (Table 3).

The stallions perfomed a major number of matings in the first day of the first observation period (S5: 8; S2: 2; S12: 3).The animals were in long sexual rest. However, during the following observation periods (second and third) the stallions distributed their matings throughout the days.

Table 3. Means values of variables related to harem composition of stallions in the three observation periods in year II.

S	P	MI	MF	MDAYM	RMI	RMF	MDAYRM
S5	1	22.8[a]	21.8[a]	20.3[a]	10.0[a]	9.1[a]	9.1[a]
S2	1	14.0[b]	15.7[b]	14.9[b]	8.4[a]	9.1[a]	8.8[a]
S12	1	3.2[c]	2.9[c]	3.1[c]	2.2[b]	2.0[b]	2.1[b]
S5	2	32.0[a]	33.0[a]	32.8[a]	18.7[a]	17.8[a]	18.2[a]
S2	2	6.3[b]	6.2[b]	6.2[b]	5.2[b]	5.2[b]	5.2[b]
S12	2	1.2[b]	0.8[b]	1.0[b]	1.2[b]	0.8[b]	1.0[b]
S5	3	16.3[a]	18.4[a]	17.4[a]	10.4[a]	11.1[a]	10.8[a]
S2	3	23.3[a]	21.3[a]	22.3[a]	12.4[a]	11.4[a]	11.9[a]
S12	3	0.4[b]	0.0[b]	0.2[b]	0.4[b]	0.0[b]	0.4[b]

S = stallion; P = observation period; MI = no. of mares in the harem at the beginning of the daily observation period; MF = no. of mares in the harem at the end of the daily observation period; MDAYM = average number of mares in the harem/day; RMI = no. of receptive mares in the harem at the beginning of the daily observation period; RMF = no. of receptive mares in the harem at the end of the daily observation period; MDAYRM = average number of receptive mares in the harem/day.

[a, b, c]Means in the same column with different letters are statistically different, ($P < 0.05$).

Dominance relationship

Dominance relationship among stallions and inside harems in the two years of study were identified. The dominance order among stallions was verified during confrontations. Besides the physical superiority and the major fight ability of the dominant (S5) compared to the submissive stallions (S12a, S12b), it was observed that the last ones usually moved backwards during the fight. The dominant status helped him gather the greater number of mares under his control. After the stabilization of the social units, S12a and S12b avoided the approaching of their harems to S5. Hence, in the first year the dominance order was: S5 > S12b > S12a > S3. However, the three-year-old stallion did not dispute mares, he avoided confrontations and was considered the last member of the hierarchy due to his total isolation and for being younger. Dominance order between the stallion and the dominant mare was detected inside the harem regarding water access and initiative of displacements in the observation pasture, and in a lower intensity, by threat posturing and submission among mares.

Since S12b and his harem were sporadically observed and after the establishment of the social units he was removed from the paddock, dominance relationships in the harem were not identified. S5 was the dominant member of his harem regardless of its composition. In all occasions this stallion was the first to drink water and was always driving the harem in the observation pasture.

In the harem of S12a, a mare was considered the dominant member of the group. This mare interfered in matings in many occasions and also led the displacements. At the moment she entered the harem of S5, the stallion sustained the condition of dominance. Two young mares were apparently the last members of the hierarchic order in the harem of S12a because they remained far from the other members and had a clear submission posture in the presence of other females.

The order of dominance identified among the stallions in the second year was: S5 > S2 > S12 > S4. The stallion G5 always sustained his condition of dominance regardless of harem composition in both years. The main confrontations and mare competitions happened between S5 and S2. The submissive stallions (S12 and S4) started to avoid confrontations and did not compete for the mares, forming a small harem (2 stallions and 2 mares) in the first two periods of

observation and a group of bachelors in the last one. A dominant mare member from the harem of S12 in the first observation period was identified. This mare sustained the condition of dominance in the presence of other females, even when she moved from harems in the other observation periods.

General and sexual behavior

General behavior

The stallions that formed their harems attempted to maintain their mares and to behave in a similar way regarding herding and snaking posture. The animals usually herded their mares in the following situations: when harems gathered and the rival stallion became a threat, during the displacements for grazing or water access and when they interacted with a mare without sexual intention.

The Stallion S5 seemed to have greater devotion for his mares and because of it the herding episodes occurred more frequently than in the other harems. Nevertheless, the stallions S12a (Year I) and S2 (Year II) herded their mares less frequently after the harem stabilization and did not maintain them close, except when rival stallions and their harems were nearby. During confrontations stallions usually had a typical behavior: to approach up to the minimal distance of 15 meters, pawing sporadically, trotting some meters in parallel, doing the elimination/marking sequence - sometimes simultaneously, fighting and herding their mares, and staying between the threat (rival stallion) and their harem.

The elimination/marking sequences were frequent and associated with the confrontations between stallions, mating activity and displacements. This behavior was different according to the excretion found: when the stallions found feces from other stallions, they defecated over them. However, they usually urinated over the feces and urine of receptive mares and, less frequently defecated over their feces. The elimination/marking sequence was always associated with a flehmen response and happened more often than in the sexual context being only observed in adult stallions.

Close relationships among mares from the same harems were identified and did not seem to be directly associated with their reproductive status. Pairs of mares were usually seen, but sometimes those groups included more than two mares. The stallions also seemed to prefer the interaction with certain mares for sexual purposes.

Sexual behavior

In the first contact between stallions and the group of mares, harems were formed and the stallions courted and mated the receptive females in both observation periods. Though variations on the precopulatory interaction among stallions occurred, some patterns were observed which included vocalizations, olfactory investigations of different body regions, but essentially perineal region, followed by a flehmen response, approaching and naso-nasal contacts, and also mounts with or without erection. Apparently, the stallions used different methods to identify mares in estrus. When compared to stallion S12a, S5 courted mares more often and sometimes without a particular interest, stimulating the manifestation of the receptive mares, mostly the closer ones. In other occasions, the stallion teased directly one or more females and mated. Generally, stallion S5 courted mares more frequently including some pregnant ones in several occasions in the first year.

The interaction duration between stallions and mares before mating varied and depended on the sexual degree of receptivity of the females. In the early days of estrus most mares seemed solicitous during the precopulatory interaction, but then resisted and ended the interaction just after or as soon as the stallion initiated the mounting. This caused stallions to mount with or without erection or penetration, without ejaculation. The same mares became more receptive in the subsequent days. On two occasions during the first year, stallion S12a insistently chased two non receptive mares during several minutes (17 and 10, respectively), made various mountings with or without erection and mountings with penetration, but he did not achieve the mating. Three days after this episode the same stallion mated one of the mares, when she demonstrated to be in estrus. However mating involving the other mare was not observed. This female was not diagnosed as pregnant at the end of the study. Mounting without erection followed by mating occurred in the average ratio 2:1 and more often for S5 in the first year.

In the first year the signs of estrus observed were the characteristic ones for the species, with some variations of intensity among females. In the same year the females were sexually receptive, on average, during 4.7 days, ranging from 1 to 12 days and in the second year during 3.9 days, varying from 1 to 8 days, considering the three periods of observation. In the second year, besides the typical signs of estrus it was possible to identify the formation of a sexually active group of mares in the second and third periods of observation. This group was composed of approximately 10 mares that usually remained near the stallions. These mares teased, mounted and made olfactory investigation followed by flehmen in the others mares in estrus. Elimination/marking sequences were observed for some of these mares, which sometimes interfered in the matings. In addition to that observed for the stallions, mares showed preferences for specific females. The receptive mares that executed mounts showed this behavior in the subsequent estrus.

The teasing episodes performed by stallions were either followed by a rapid loss of interest or by mounting with or without copulation. If the stallions failed intromission, they usually returned to grazing and lost interest in mares.

The masturbation episodes exceeded 60 sec and occurred in the following situations: after the rest period while grazing, mainly when they were close to the receptive mares, and less frequently after the teasing episodes that were not followed by mating. In this case, erections with a rhythmic drawing of the penis against the abdomen only for S5 in both years were observed.

The copulation behavior had little variation among stallions and followed the models usually described for the species (McDonnell, 1992). Nevertheless, in the first year of observation, lateral mating was more frequently observed for S5. The frequency of attitudes related of mating activity is in Table 4.

Table 4. Frequency of attitudes related to mating activity and precopulatory interaction of stallions in Year I.

Stallion	ATTITUDES*							
	MAT	MMAT	MWE	MM	ME	MM	MWP	MM
S12a	11	5	15	5	2	2	5	5
S5	17	10	7	6	2	2	9	5

*MAT = total of matings; MMAT = no. of mares mated in the 12 days; MWE = mounts without erection; MM = no. of mares mounted; ME = mounts with erection; MWP = mounts with penetration, without ejaculation.

The total number of matings observed within the 12 days in Year I was 28, from which 11 (39.3%) were executed by S12a and 17 (60.7%) by S5. The mares were mated on average 1.9 times and the average number of daily mating was 1.2, without statistical difference between stallions S5 and S12a ($P > 0.05$). From the 33 open mares, considering the gynecologic exams performed during the experiment, 15 were mated: 5 by S12a and 10 by S5. The average number of mares mated/day was 1.2, (0.8 by S12a and 1.3 by S5; $P > 0.05$). The average number of receptive mares day was 8.5.

The number of mares that were mated by only one stallion was 11 (73.3%) and by more than one stallion were 4 (26.7%). From the 15 mated mares, six (40%) were mated only once, eight (53.3%) more than one time by the same stallion and one (6.7%) more than one time by different stallions.

The average copulation time in the first year was 38.4 sec (48 sec for G12a and 34 sec for G5). No significant difference between the stallions was observed ($P > 0.05$).

The daily average time between copulations differed among stallions. The maximum number of matings registered to S12a in one day was 4 with an average interval of 123.5 min between them. The maximum number of matings registered to stallion S5 in one day was 4 and the average interval among them was 131 min. The average interval among matings in the 12 days was 79.8 min (74.8/S12a, 84.7/S5) without significant difference among stallions ($P > 0.05$).

All results concerning matings must be considered as relative values, because the nocturnal sexual activity of stallions was observed only twice in Year I and once in Year II.

The stallions performed a total of 134 matings in the second year. S5 performed 55.7% of the matings observed, while S2 and 35.7% and S12 only 8.5%. Considering the three periods of observation mares were mated on average 2.2 times. The average number of daily matings was 2.1, being 3.5, 2.2 and 0.4 performed by stallions S5, S2 and S12, respectively. The daily average number of receptive mares was 20.7 or 53%. The average number of mares mated/day was 1.8 (3 by stallion S5, 1.9 by stallion S2 and 0.4 by stallion S12). However, it must be considered that S12 stayed without mares almost the entire third period and his harem was always the smallest.

It was observed in the second year that the same mares were mated by different stallions in the three periods. In the first period 9 mares were mated by more than one stallion, while in the second and third period, 2 and 5 females were registered in this situation, respectively.

The average total number of matings/day, the average interval between matings, the total number of matings and the average interval between matings with the same mare differed among stallions despite of the observation period (Table 5).

There was no significant difference in copulation time among stallions observed in Year II. The average value was 37sec, with 43.5sec, 40sec and 27.5 sec for stallions S5, S12 and S2, respectively.

Difference in the average number of matings according to the age of mares was observed in the first and third periods of the second year. Mares with the highest average number of matings were aged 5, 6, 11 and 12 years. Therefore, it was not possible to establish any relation between the age of mares and the number of matings.

Nocturnal sexual activity

In both years nocturnal sexual activity was verified. In the first year S12a mated twice, while in the second year three matings were registered for each stallion (S5 and S2).

General pregnancy rate

The pregnancy rates in the harems were not calculated, since several mares were mated by different stallions. This would be possible only with parentage testing. The mares that were pregnant in the beginning of the study were not considered. The general rate was 79.4% in the first year and 72.2 % in second year.

Table 5. Average values of the variables related to the interval between matings/day in year II.

Stallion	Variable			
	TOTAL MAT**	INT MEAN MAT**(min.)	MMAT**	INT MEAN SM***(min)
S5	3.6[a]	114.3[a]	1.0[a]	195.4[a]
S2	2.1[b]	191.8[a]	0.4[a,b]	0.0[b]
S12	0.5[c]	6.2[b]	0.1[b]	0.0[b]

**Stallion effect was verified regardless of the observation period, ($P < 0.001$); n = 21 days. ***Stallion effect was verified only in the third period ($P < 0.006$);n = 7 days

[a, b, c]Means in the same column with different letters are statistically different, $P < 0.05$;
TOTAL MAT = total number of matings/day; INT MEAN MAT = average interval between matings/day;
MMAT = total number of matings with the same mare/day; INT.
MEAN SM = average interval between matings with the same mare/day).

Discussion

The social units identified in this study, harem and bachelor groups, are usually described in wild and domestic horse populations (Berger, 1977; Klingel, 1977, 1982; Kaseda, 1981; Salter and Hudson, 1982; McCort, 1984). The young stallions leave their natal group and experience three distinct stages from birth until forming their own harem (Khalil and Murakami, 1999a) and are not considered as rivals by adult stallions until they are three years old (Tyler, 1972).

In this study the younger stallions did not form harems and were not involved in the competition for mares either. In the first year S3 was considered the only member of the bachelor group social unit, while in the second year, S4 and S12 formed a bachelor group with two members at the end of the third period. In wild populations the size of a bachelor group varies from one to 16 individuals (Welsh, 1975; Feist and McCullough, 1976; Keiper, 1976; Berger, 1977).

Alliances among young and older stallions have been described in wild populations according to Welsh (1975), Feist and McCullough (1976), Keiper (1976) and Berger (1977), as well as in domestic populations (McDonnell and Murray, 1995). According to Feh (1999) most stallions first tried to monopolize mares by themselves, but only a few succeeded at the first attempt. Stallions that failed seemed to have had two options: either join another stallion in a two-male group or stay in a bachelor group and secretly try to mate mares. In the second year, S4 (3 years old) was accepted as a member of the harem which belonged to the older stallions (S2 and S12). Nevertheless, the dominant stallion S5 did not accept the presence of the other stallion in his harem in any of three observation periods.

Khalil and Murakami (1999b) observed that the younger stallions formed harems between the ages of 3.8 to 7.6 (average age of 5.2 years) and 93% of these new groups were formed at the beginning of the breeding season. In 87% of these occasions the harems were formed by the acquisition of wandering mares and in 13% of the occasion mares were stolen from established bands.

In the second breeding season, S5 maintained his condition of dominance over the other stallions; he also got experience and sustained the greatest harem at the end of the three observation periods.

Factors concerning the differences in harem size are: age of stallion (Khalil and Murakami, 1999b), corporal weight and fight ability (Berger, 1986) and dominance and aggressive behavior (Murakami *et al.* 1978). In the present study, significant differences in the number of mares in harems were found, since stallion S5 maintained a higher daily average number of mares in the group than stallions older than 12 years. Similar results were reported by Kaseda and Khalil (1996) during 12 years of a study where the biggest harems belonged to stallions aged 6 and 9 years old, which became smaller with the advance of their age.

Dominance relationships were identified among stallions and inside the harems. In both years, S5 was considered the first member of the dominance order and the younger stallions were the last members. During confrontations with other stallions he demonstrated superiority having his rivals returned to their own harems and keeping them away, avoiding other approaching episodes. His fight ability, as well as his physical superiority must have been important factors for the formation and maintenance of his harem even with a high number of the mares in the group. Kaseda *et al.* (1982) observed a higher stability tendency in smaller harems, since the relationship between certain mares and stallions repeated for many years. In some wild stabilized populations the stallions dominate females (Feist and McCullough, 1976), while in other populations mares are dominant (Berger, 1977; Houpt and Keiper, 1982). This difference was also evidenced in this study. In the harem of S12a (Year I) one mare was identified as the dominant member.

The social units stabilized on the fourth day of observation in the first year, the same period described by Ginther *et al*. (2002), when observing a group of one stallion and eight pony mares in 0.8 ha observation paddock during 5 days. To identify the group stabilization, the authors noticed a smaller distance among the components and a decreasing number of herding movements and snaking behaviors accomplished by the stallion.

To evaluate the mating activity of stallions,

three aspects were considered: harem size (average number of mares/harem/day), composition (average number of receptive mares/harem/day) and average number of matings/stallion/day. In Year I a significant difference was only found in harem size for stallion S5 when compared to the other stallions; however, the mating activity did not differ among them. In Year II, stallion effect was also observed in harem size, but the average number of receptive mares/day in the harems was not statistically different. However there was a difference in the number of matings performed by the stallions. Based on these results, the highest number of matings registered for stallion S5 denoted his greatest sexual activity.

The models of herding and snaking behavior were similar to the wild (Tyler, 1972; Klingel, 1975; Feist and McCullough, 1976) and domesticated populations (Bristol, 1982; Steinbjörnsson and Kristjansson, 1999; Ginther *et al.*, 2002), as well as the elimination/marking sequence (Pellegrini, 1971; Tyler, 1972, Feist and McCullough, 1976; Berger, 1977; Miller, 1981) and the flehmen posture (McDonnell and Haviland, 1975; Stahlbaum and Houpt, 1989). The precopulatory interactions generally followed models found for domestic horses mating in pasture-breeding systems (Bristol, 1982; Steinbjörnsson and Kristjansson, 1999).

The highest frequency of teasing (subjectively evaluated in Year I) by stallion S5 compared to S12a and, in some occasions with pregnant mares, associated with the highest number of mounts with penetration (9; 1.8:1) without ejaculation, could be related to his inexperience in identifying mares with a major degree of sexual receptivity, since it was his first breeding season. In the second year, stallion S5 demonstrated major capacity to identify mares in estrus. Waring (1983) associated the sexual inexperience with higher number of mounts per mating. The average number of mounts without erection/mare, considering the two stallions (2.0:1 for G12a and 1.1:1 for S5) and per mating (2:1) was similar to that obtained by Wierzbowisk (1.4; 1959), Bristol (1.7; 1982) and Tyler (1.6; 1972).

Mares demonstrated the typical signs of estrus of wild (Tyler, 1972) and domesticated females mating in pasture-breed systems (Bristol, 1982; Ginther *et al*., 1983; McDonnell, 1992; Steinbörsson and Kristjansson, 1999). The tendency performed by the receptive mares to be apart from the other females and close to the stallions was also observed in others studies and it may be a way to attract the stallions (Ginther *et al*., 1983). The formation of the sexually active groups by females identified in the second and third observation periods in Year II, is common among donkeys (Henry *et al.*, 1998). A sexually active group was identified by Bristol (1982) in mares whose estrus were synchronized. Nevertheless, the author did not observe heterotypical sexual behavior. Bristol (1982) reported that 82% of the mares daily observed were in estrus. In the second year of the present study the daily mean number of mares in estrus was 51.6%. This high percentage of females in estrus would be related to the behavior reported above.

It has been accepted that mares have primary role in the determination of the mating moment (Tyler, 1972; Klingel, 1977; Ginther *et al*., 1983; McDonnell, 2000); however, in this study as well as in the study by Bristol (1982), most of the matings occurred by the initiative of stallions and when mares approached them showing signs of estrus, in many occasions they did not show interest or even chased them aggressively.

The chasing episodes involving non receptive mares reported in Year I have already been described in wild and domesticated horses (Tyler, 1972; Bristol, 1982; McDonnell, 1992; Steinbjörnsson and Kristjansson, 1999). This behavior was observed by Tyler (1972) in wild ponies at the beginning of the breeding season, similarly to this study, because stallion S12a was previously in sexual rest and the number of mares in estrus in his harem was small (3; 27%).

The copulation behavior had little variation among stallions. The lateral mounts observed for S5 in his first breeding season are considered normal, mainly for young and inexperienced stallions (McDonnell, 1992).

Greater mating activity has been reported for stallions and donkeys breeding at pasture (Bristol, 1982; Henry *et al.*, 1991; Steinbjörnsson and Kristjansson, 1999), while those submitted to a hand-breed system could have their libido and fertility decreased when mounts are accomplished more frequently than once or twice a day (McDonnell, 2000). In the first year when the daily observations lasted about 8.1 h, the average number of matings/day was 1.2. This value could be considered low concerning mating at pasture, since it is very close to the daily frequency used for stallions under controlled mating (McDonnell, 2000) and for stallions submitted to exhausting tests repeated daily (1.5 mating/day; Wierzbowski, 1959). In the second year, when observations lasted 9.1 h, the average number of matings/day was 2.1. Nevertheless, considering only the stallions that maintained their harems this value was 2.9.

The average number of matings/mare in Year I was 1.9; however, in Year II it was 2.2. The differences observed between the 2 years can be due to smaller average number of receptive mares/day in Year I compared to Year II (8.5 vs. 20.1); the accomplishment of gynecologic exams in four occasions (Year I) involved the management of the animals, what must have interfered in the mating activity of stallions and to the fact that the stallions and some mares showed symptoms of Equine Influenza in the first year and became very prostrated, mainly in the fourth and fifth days of observation, when a reduced number of matings was recorded.

The mating activity of stallions observed in the present study was smaller than that reported by Bristol

(1982: 4.6 matings/mare) and Steinbjörnsson and Kristjansson (1999: 5.8 matings/mare). However, the first author observed the stallions during a period of 16.5 h and Steinbjörnsson and Kristjansson (1999) for 24 h, including nocturnal matings. The stallions of the present study were observed at night only in two opportunities in the first year and once in the second year to verify nocturnal sexual activity. Bristol (1982) observed that the stallions unusually mated a mare more than twice per day (62.3% mated once, 24.5% twice, 9.4% three times and 3.8% four times). Although the same tendency reported by Bristol (1982) concerning the number of matings/mare was observed in the total number of matings/mare in the present study (Year I) where 42.8% were mated once, 14.2% twice, 42.8% three times and 7.1% four times, the number of mares mated three times was higher. However, as the number of mares in estrus/day was smaller, the stallions looked for the same mares more often.

The copulation time average (38.8 sec, year I; 30 sec, Year II) was similar to that reported by Bristol (1982: 30 s); McDonnell (1986: 25-30 sec) to stallions in semen program and similar to Henry *et al.,* (1991: 25-30 sec) in donkeys and was inferior to the maximum observed by Noue *et al.* (2001: 40-65 sec) to stallions in hand-breed system and semen collection. The average interval between matings/day (79.8 min) recorded in the first year was similar to that reported by Bristol (1982: 72.8 min). In the second year, this value was slight superior (104.1 min). The interval between matings varied among stallions.

Although reports about wild stallions confirm their preferences for adult mares (McDonnell, 2000), relation between average number of matings and the age of mares was not verified in the present study (Year II). The pregnancy rates obtained in the first and second years are similar to those reported in pasture-breed systems: 85% (Bristol, 1982), 80% (van Buiten *et al.*, 1998), 76-82% (Steinbjörnsson and Kristjansson, 1999) and 50-100% (Pimentel *et al.*, 2003).

The study of reproductive behavior in this domesticated pony population allowed for the following conclusions: the age of stallions and the dominance relationship between them seem to be determinant in the formation and maintenance of the harem composition; the dominant stallions retain a larger number of mares in their harems and do not seem to accept other stallions in their groups. The mating activity of stallions denotes an individual factor not directly related to daily average number of receptive mares in the harem; the stallions mated at night and the mares can form a sexually active group including heterotypical sexual behavior when there is a high rate of mares in estrus in the group.

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