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Daytime rest behavior of the Welsh pony (*Equus caballus*) mare and foal

Sharon L. Crowell-Davis

*Department of Anatomy and Radiology, College of Veterinary Medicine, The University of Georgia,
Athens, GA 30602, USA*

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Abstract

Upright and recumbent rest of 15 Welsh pony foals and their mothers was studied over a 2 year period. During their first week of life, the foals spent 32% of the time in recumbent rest. Subsequently, the percentage of time spent in recumbent rest decreased, but was still greater than for the foal's mother by Week 21, when the foals spent 6.5% of their time in recumbent rest. Adults spent little time in recumbent rest. Foals rested upright only 3.5% of the time during their first week of life. Mares rested upright more than foals did to Week 13, at which time peak values for time spent in upright rest occurred for both mares (32.5%) and foals (23%). Subsequently, mares and foals spent equal, but decreasing, amounts of time resting upright. The total time spent resting by the foals decreased gradually, and was characterized by a transition from recumbent rest to upright rest. Foals were more likely to be resting, either recumbent or upright, if their mother was resting upright. During the late spring, summer, and early autumn, mares and foals were most likely to be resting upright between 09:00 and 17:00 h.

Keywords: Horse; Behavior; Rest; Sleep; Pony; Foal

1. Introduction

Most, but not all, mammals and birds spend a part of each day sleeping. Adult ungulates spend 4-9 h sleeping out of every 24 h. It is not yet clear exactly why animals sleep. The two primary theories are that sleep is a physiologically necessary restorative process and that it serves to maintain immobility in animals at times when immobility is an optimal survival strategy (Webb, 1974; Meddis, 1975; Zepelin, 1989).

Meddis (1975) identified the characteristics of sleep which are consistent between families as “prolonged inactivity (1) which is often organized on a circadian (or tidal) basis (2). Very frequently it is accompanied by raised response thresholds (3) and it often occurs in a species-specific site (4) (usually a safe place) and in a species-specific posture”.

Correlations between electroencephalographic patterns and the postural states of standing and recumbency of horses have been investigated in several studies. Paradoxical sleep (PS), characterized by low voltage, fast activity (LVFA) and complete loss of postural tone, occurs entirely during recumbency. Part of a horse’s slow wave sleep (SWS) also occurs during recumbency. A standing horse may be in alert wakefulness with LVFA, or it may be in SWS with high voltage, slow activity (HVSA). Also, standing horses may be drowsy, with intermediate voltages and activity or alternating LVFA and HVSA. Alert wakefulness occurs while a horse’s attention is drawn to some event, either an activity it is carrying out itself, or an external stimulus such as the neighing of another horse (Ruckebusch et al., 1970; Ruckebusch, 1972; Dallaire and Ruckebusch, 1974a,b; Hale and Huggins, 1980).

In this study, behaviors which usually resulted in prolonged immobility were defined as resting. They were separated into the categories of recumbent rest and upright rest. Time-budgets were examined to describe developmental changes, time-of-day changes, and the interdependence of resting behavior by the mare and the foal.

2. Methods

The resting behavior of 11 adult pony females (mares) and their 15 foals, 11 females (fillies) and four males (colts), was recorded during 585 h of focal samples (Altmann, 1974). The foals, born over a 2 year period (1980–1981) were studied at the GlanNant Welsh Pony Farm in Ithaca, New York, between April and October. The subjects were maintained on pasture; other ponies, including stallions, geldings, mares without foals, and juveniles, were usually present. Each mare and her foal were observed weekly as the focal dyad of a series of focal samples which totaled 2 h (Altmann, 1974). The day was divided into four sections: 05:00–09:00 h; 09:00–13:00 h; 13:00–17:00 h; 17:00–21:00 h. Each week, two 15 min samples were taken on each pair at random times during each division of the day. Observations were made until the foals were weaned at 19–24 weeks of age.

During a focal sample, a continuous record of behavioral states that lasted at least 0.03 min was kept to the nearest 0.01 min. The complete and mutually exclusive set of behavioral states recorded was mutual grooming, self-grooming, feeding, drinking, nursing, resting upright, resting recumbent, playing and active. Non-resting behaviors have been reported previously (Crowell-Davis, 1985, 1986a,b, 1987; Crowell-Davis and Houpt, 1985; Crowell-Davis et al., 1985a,b, 1987). Subjects were usually observed from a distance of 3–4 m, but could be

approached more closely when necessary, as they were habituated to the presence of neutral observers. Transitions of state were recorded on a tape recorder and subsequently transcribed.

A pony was considered to be resting upright if it was standing still with any two of the following behaviors also occurring: one hind limb flexed; ears turned to the side and partly lowered; lower lip flaccid; eyes partly or fully closed. Ponies were considered to be in recumbent rest if they were in either sternal or lateral recumbency. The pony was considered to be in lateral recumbency only if the head was in contact with the ground. This criterion was necessary because, although the foals usually rested in the lateral and sternal recumbent postures described by Littlejohn and Munro (1972), they occasionally rested in intermediate postures.

For Weeks 1, 5, 9, 13, 17, and 21, the complete records of transitions of state for both mare and foal were input into computer files. Total rest time, time-of-day rest time and conditional time-budgets for percentage time that the foal rested recumbent or upright when its mother was resting upright, feeding, or active were then calculated for the mares and foals. Four of the 11 mares foaled during both years of the study. Data for these mares were evaluated separately for each year, with the mares' conditional time-budget being calculated from the foal of that year. The resting time-budgets of the foals and their mothers were compared using the Wilcoxon matched pairs signed rank test (WMPSR). All statistics were conducted at $P < 0.05$.

3. Results

3.1. *Recumbent rest*

The foals were observed to lie in each of the four positions of equine recumbency described by Littlejohn and Munro (1972): sternal or lateral and on the left or on the right. During the first week of life, recumbent rest was the second most common behavioral state of foals, taking up 31.8% of their total daytime time-budget.

Over the next 4 months, a steady decline in the percentage of time spent in recumbent rest occurred, with the greatest decline occurring during the second month of life. During Week 5, the foals spent 27.5% of the time in recumbent rest. By Week 9, they spent 15.1% of the time in recumbent rest (Fig. 1). By Week 17, the foals spent only 5.1% of the time in recumbent rest. There was little change during Month 6.

In contrast, mares were rarely observed in recumbent rest. Of the few occasions on which mares were observed in recumbent rest, most were either at dawn or on dry ground on sunny days after prolonged cold and/or rainy weather. Values for the percentage of time spent by mares in recumbent rest ranged from 0 to 2%. Foals invariably spent more time in recumbent rest than did their mothers (WMPSR, $P < 0.005$ for all ages).

During the first weeks of life, foals invariably lay down immediately next to

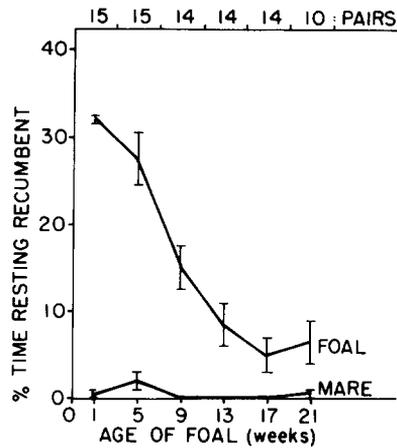


Fig. 1. The mean percentage of time the mares and foals spent resting recumbently. Values were calculated from the continuous data records of the indicated weeks. Standard error of the mean is shown as a vertical bar.

their mothers. Sometimes lying down was preceded by sniffing or nosing the ground, pawing, and/or circling. At other times the foals simply abruptly lay down. Occasionally a foal would lie down, then get up and lie down again one or more times in short succession, effecting a slight change in position as it did so.

Recumbent resting bouts by foals varied in length, but were often longer than 15 min and were usually censored by the limit of focal sample time. In spite of the length of the resting bouts and the large amount of time young foals spent recumbent, their mothers remained close to them, usually within 5 m, during these periods for the first 5-7 weeks of life (Crowell-Davis, 1986b). Older foals were occasionally observed to be in recumbent rest in a group.

On one occasion a foal was observed to be in right lateral recumbency, back to back with its mother, who was in left lateral recumbency. Later, the same foal, having gotten up, lay down between the fore and hind limbs of its mother. However, this was the only occasion on which physical contact between mare and foal was observed during recumbent rest by both of them. On two occasions a foal appeared to be attempting to nurse from its mother while she was in recumbent rest.

On many occasions, recumbent ponies were observed to engage in brief periods of movement. Their ears or facial muscles would twitch. When they were observed closely, movements of nystagmus beneath the closed lids could be clearly seen. They also vocalized and/or moved their limbs. Most notably, when they were in lateral recumbency, they sometimes moved their forelimbs back and forth. The upper forelimbs moved more extensively than did the lower ones.

The foals' reactions to environmental stimuli during these periods were not recorded quantitatively. In general, there was a great degree of variation. Sometimes foals in recumbent rest, either with their eyes open or closed, would jump up swiftly when another pony even walked nearby. At other times, foals contin-

ued to lie still even when several ponies were in the immediate vicinity engaging in social interactions or switching their tails and kicking at flies. On no occasions were any of the ponies observed to step on a recumbent foal, although mares sometimes walked in tight circles around their recumbent foals, grazing with their hooves only a few centimeters from some part of their foal's body.

3.2. Upright rest

Foals began resting upright as early as Day 1. During Week 1, foals spent 3.6% of the time resting upright. Their mothers spent 13% of the time resting upright during the same period, or about four times as much time as the foals (WMPSR, $P < 0.025$). During Weeks 5, 9, and 13, the mares continued to spend significantly more time in upright rest than did their foals (WMPSR, $P < 0.005$). The amount of time that either animal spent in upright rest peaked during Week 13, when the mares spent 32.7% of the time in upright rest and the foals spent 23.0% of the time in upright rest (Fig. 2). During Weeks 17 and 21, there was no significant difference in the percentage of time mares and foals spent in upright rest.

Resting upright, especially by the adults, was very clearly a herd activity. Either as a group, or in close temporal sequence, the ponies would cease their feeding behavior and walk, trot, or occasionally canter to one of their resting sites. Such resting sites were first described by Tyler (1972), who referred to them as shades. The shades included sheds, large trees, groups of trees, open barns, and a favored area on an open hillside which was used so frequently that the grass was worn away. There the ponies would stand close together. The predominant behaviors

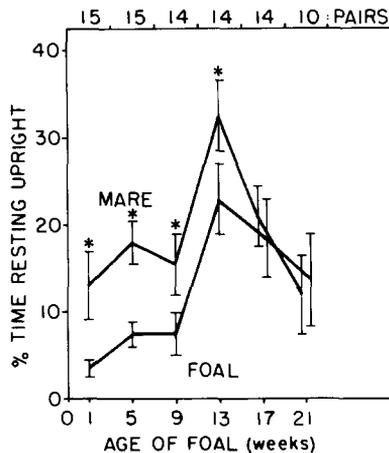


Fig. 2. The mean percentage of time the mare and foal spent resting upright at various ages of the foal. Values were calculated from the continuous data records of the indicated weeks. For Weeks 17 and 21, the values for mare and foal were separated slightly to improve clarity. Standard error of the mean is shown as a vertical bar. (*) indicates a significant difference between mares and foals ($P < 0.05$).

for periods of up to 4 h and occasionally longer were resting upright, resting recumbent in the case of foals, and self-grooming.

This pattern of herd behavior was most commonly observed during July and August, when the flies were most numerous and the ambient temperature was highest. Week 13 occurred during one of these 2 months for all but one mare, for which Week 13 was split between the end of June and early July. During these periods of upright rest, the ponies switched their tails back and forth almost constantly and frequently made self-grooming movements which were, to an observer, essentially instantaneous, and too short in duration to be recorded as a transition of state. These included self-biting, stamping, kicking at the belly, shaking the head and neck, and vigorously swinging the head against the side. All of these movements served briefly to relieve the ponies of the presence of flies.

For the most part, individual ponies had preferred upright resting sites within the area in which the herd gathered. These sites persisted from year to year when ponies were returned for extended periods of time to the same pastures.

3.3. Total rest

During Weeks 1, 5, and 9, the foals spent more time resting, either recumbent or upright, than did their mothers (WMPSR, $P < 0.005$, $P < 0.005$, $P < 0.001$). During Week 1, mares spent 14.6% of the time resting while their foals rested 35.4% of the time, more than twice as much. There was little change during Month 1, but during Month 2 there was a marked decrease in the total time spent resting by foals. This was entirely due to decrease in recumbent rest time, as upright rest time remained stable during this period. During Week 9, mares rested about the same amount of time as they had during Week 1, or 15.7%. Foals, on the other hand, rested 22.6% of the time, a 36% decrease (Fig. 3). During Month 3, the total time spent resting by mares and foals increased. This was entirely due to upright rest. Foals were continuing to spend decreasing amounts of time in recumbent rest whereas mares maintained their usual low values. On the other hand, the percentage of time spent in upright rest roughly tripled for foals and doubled for mares between Weeks 9 and 13. During Week 13, there was no significant difference between the total rest time of mares and foals. During Months 5 and 6, the total rest time decreased for both mares and foals. It decreased more rapidly for mares, and at Week 21 mares again spent significantly less time resting than did their foals (WMPSR, $P < 0.025$).

3.4. Conditional time-budgets

Throughout the study, foals were more likely to be in recumbent rest if their mother was resting upright than if she was feeding or active. The shape of the curve for developmental changes in foal recumbent rest if the mare was resting upright paralleled the shape of the total time-budget curve for foal recumbent rest. During the first 2 months of the study, this was due to the mares ceasing other activity to rest upright beside the foal when it was recumbent. Later, foals

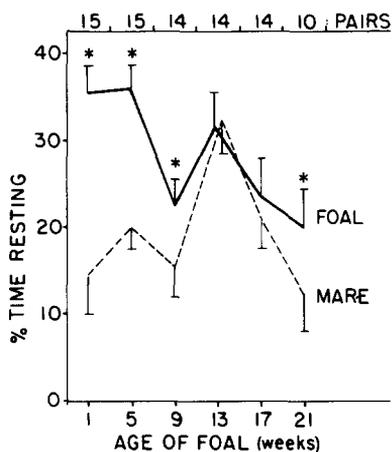


Fig. 3. The mean percentage of time the mares and foals spent in any form of rest at various ages of the foal. Values were calculated from the continuous data records of the indicated weeks. Standard error of the mean is shown as a vertical bar. (*) indicates a significant difference between mares and foals ($P < 0.05$).

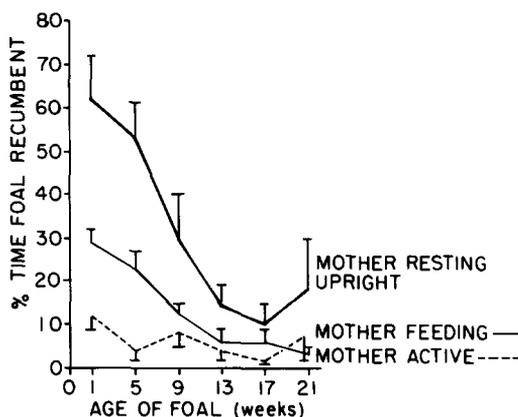


Fig. 4. Foal recumbency. The mean percentage of time the foals spent resting recumbent when their mother was feeding, active, or resting upright. For example, during Week 1, the foal was recumbent 62% of the time when the mare was resting upright. Values were calculated from the continuous data records of the indicated weeks. The number of foals observed for each mare state and each week varied from nine to 15. Standard error of the mean is shown as a vertical bar.

would often have periods of recumbent rest during the periods when the herd was huddled in the shade (Fig. 4).

The developmental time-budget for foal recumbent rest when the mare was feeding was similar to that for the periods when the mare was resting upright, although values were never high and the curve was less steep. Maximum values of 28.6% and 22.9% occurred during Weeks 1 and 5. These were an effect of the large percentage of time foals spent in recumbent rest during this period, coupled

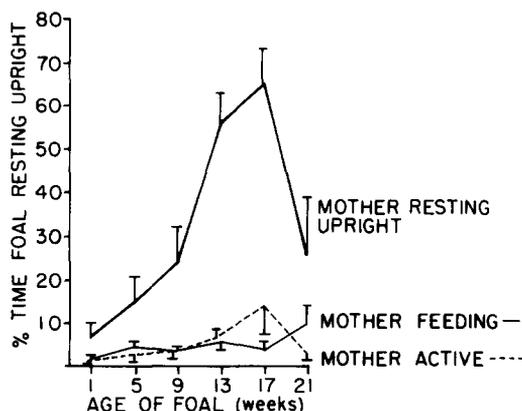


Fig. 5. Foal upright rest. The mean percentage of time the foals spent resting upright when their mother was feeding, active, and resting upright at various ages of the foals. For example, during Week 9, the foal was resting upright 24% of the time when the mare was resting upright. Values were calculated from the continuous data records of the indicated weeks. Standard error of the mean is shown as a vertical bar. The numbers of foals observed for each mare state and each week varied from nine to 15.

with the large percentage of time the mares spent feeding. Mares would have had to decrease their total feeding time if they had always immediately ceased feeding when the foal lay down. They usually continued feeding immediately next to the recumbent foal for several minutes. Recumbent rest by foals during mare activity was rare and did not change as foals grew up.

Foals were always more likely to be resting upright if their mother was resting upright than if she was feeding or active (Fig. 5). Except for Week 17, the foal's time-budget for resting upright if its mother was resting upright paralleled its total time-budget for resting upright. During Week 17, the mares and foals both spent less time resting upright than they had during Week 13. However, during Week 17, the foals spent more time resting upright if their mother was resting upright than they had during Week 13. Thus, during the period when the percentage of time ponies spent resting was decreasing, the dependence of the foal's time-budget on the mare's time-budget for this behavior was increasing. Upright rest by foals when the mare was feeding or active was rare, but increased somewhat after Month 3. This occurred when the foal alternately followed its mother, walking behind her in the active state, and rested upright for brief periods while she walked ahead, before resuming activity and catching up.

3.5. Time of day

Throughout most of the study, mares did the majority of their resting upright during the late morning and afternoon (Fig. 6). During Week 1, which for most mares occurred when the evenings, nights, and mornings were still cool, most upright rest occurred before 09:00 h and after 17:00 h. Once the sun was up and

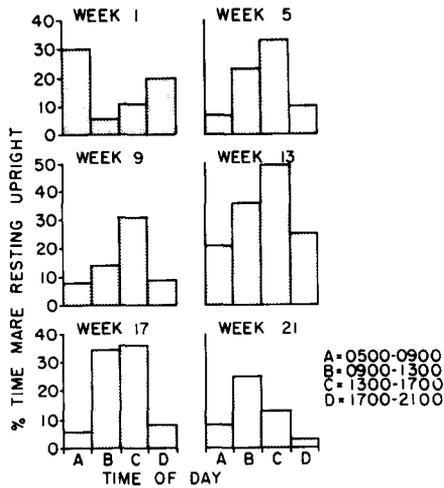


Fig. 6. The mean percentage of time mares spent resting upright at various times of the day, at various ages of their foals.

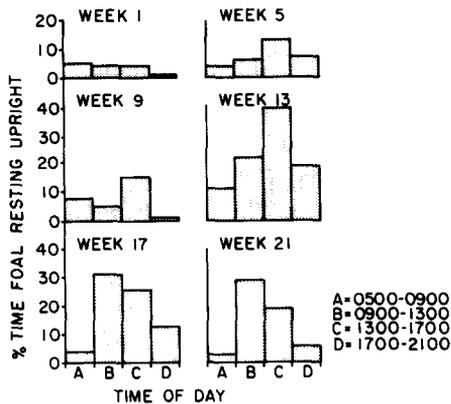


Fig. 7. The mean percentage of time foals spent resting upright at various times of the day and various ages.

the ambient temperature was rising, they spent most of their time feeding. During Weeks 5, 9, 13, 17, and 21, however, most upright rest occurred after 09:00 h and before 17:00 h. During Week 13, mares spent half of the time between 13:00 h and 17:00 h in upright rest. This occurred because of the rest–feeding cycle characteristic of warm weather.

In general, when I first arrived at 05:00 h, some or all of the ponies would be resting. They had regular predawn resting sites. The consistent use of a given site was often the only reason they could be found on dark, foggy mornings. Sometime during the hour before or after dawn they would leave their resting site and begin feeding. About mid-morning they would retreat to a shade and rest. Throughout the middle part of the day they would alternately feed and rest. Ex-

ceptions to this occurred during the hottest days of July and August, when temperatures sometimes rose above 25°C and they sometimes retreated into the shades at 09:00 h or 10:00 h and spent almost all of their time there, resting, until about 16:00 or 17:00 h. When the temperature began to drop in the late afternoon or early evening, they would leave the shade and resume feeding. The ponies had not resumed resting by 21:00 h.

For foals the bias towards resting upright between 09:00 and 17:00 h was not quite as consistent and extreme as in the mares. Nevertheless, this was the time of day when most upright rest occurred (Fig. 7).

4. Discussion

The resting time-budgets of foals were found to be very different from the those of adults during the first week of life. As the foals grew, their time-budgets gradually became more and more like those of the adults. This finding was in agreement with studies on the New Forest pony (Tyler, 1972), domestic horses (Martin-Rosset et al., 1978), and the Camargue horse (Boyd and Duncan, 1979). A notable feature of this difference is that whereas the foals were more likely to engage in recumbent rest than the adults, they were less likely to engage in upright rest.

The time-budgets for the Welsh pony foals were very similar to those of foals of *Equus przewalski*. The greatest amount of recumbent rest was observed during the first week in both groups: 35% for *E. przewalski* and 32% for *E. caballus* (Boyd, 1988). In both, there was a progressive decrease in the percentage of time spent resting. Przewalski foals also exhibited upright rest on Day 1 of life. However, upright rest was far more common in older foals of *E. caballus* than *E. przewalski*, which, for example, spent only 7% of their time in upright rest during Month 4 (Boyd, 1988). Controlled studies would be required to determine if this difference is due to species or management conditions.

In other mammals, it has been found that paradoxical sleep first emerges in the fetus. Its incidence then decreases rapidly following birth (Roffwarg et al., 1966; Jouvet-Mounier, 1969; Ruckebusch and Barbey, 1971). Roffwarg et al. (1966) have proposed that PS causes maturation of the nervous system in the fetus by supplying long periods of internally induced, artificial excitation of the nervous system. Assuming that recumbent rest in the Welsh foals was the behavioral correlate of PS, as has been found in Potttock ponies and grade ponies (Ruckebusch et al., 1970; Hale and Huggins, 1980), these results are in agreement with that theory. It is notable that the nystagmus, muscle twitching, flicking of the ears, and vocalizations seen during recumbent rest in this study are comparable to the motor movements seen during recorded PS. If the purpose of PS is stimulation of maturation of the nervous system, it follows that as the animal matures it would need less PS.

Adult equids spend very little time lying down, particularly during daylight, and hence little time in PS, as they cannot enter PS while standing. This has been

noted in several studies. Hartmann zebras rarely lie down except when they are going to dust bathe (Joubert, 1972). Adult Pryor Mountain horses and New Forest ponies also are rarely recumbent and do most of their resting while standing (Feist, 1971; Tyler, 1972). Recumbent rest and PS are not entirely absent in adult equids, however. Assateague ponies are recumbent 9.89% of the night during June, July, and August (Keiper and Keenan, 1980). Adult Camargue horses are recumbent 1.23–13.02% of the time out of every 24 h, depending on sex and season (Duncan, 1980). Polish primitive mares are recumbent 3.6% of the time (Kownacki et al., 1978). Three Potttock pony stallions spent 3.3% of a 24 h day in PS (Ruckebusch, 1972). Meddis (1975) has suggested that the function of PS may change soon after birth.

Fishbein and Gutwein (1977) have suggested that PS is necessary for conversion of learned responses into stable, long-term memory traces and for active maintenance of the stability of an established memory trace. This theory would be consistent with a high level of PS in young foals, which must rapidly assimilate a large amount of information during the first few days and weeks after birth. In support of this, Boy and Duncan (1979) have found that Camargue horse foals show a direct correlation ($P < 0.001$) between time spent standing alert and time spent in lateral recumbency, which is presumably PS.

Resting upright is basically an adult behavior. It was not commonly observed in foals during their first day of life, although it did occur. The general patterns of resting upright seemed most congruent with Webb's (1974) theory that "sleep is adaptive non-responding and that the sleep characteristics of particular species reflect the adaptive requirements for non-responding in the ecological niche of the species". Ponies left the direct sunlight and remained relatively immobile in the shade for long periods of time when continued movement in the heat would have been stressful. Riding ponies on the same farm, which were required to move about during the periods when the broodmares stood in the shade, were observed to sweat profusely on numerous occasions. Thus, interrupting feeding to spend long periods resting in the shade is probably a form of behavioral thermoregulation. New Forest ponies (Tyler, 1972) and Appaloosas (Stebbins, 1974) have also been observed to spend large amounts of time huddling in shaded areas, usually under trees, during the hottest times of the year and when the fly density was also the greatest.

Two other adaptations may be occurring during these standing huddles. First, the ponies provide each other with some protection from fly harassment by standing against each other and swishing their tails. Foals were often observed to crowd between two adult ponies, which allowed them to remain there, or to stand with their head in their mother's tail. Second, it is notable that these long periods are spent (1) standing and (2) in a huddle. In the wild state, both of these behaviors would be predicted to evolve as a result of selection against predation. A pony engaging in upright rest rather than recumbent rest does not have to stand up before running away from a predator. It also has a more extensive field of vision during brief surveys of the surrounding area. An individual which is part of a group has less chance of being selected as prey by an approaching predator

than an animal which is located peripherally or partly separated from the group (Hamilton, 1971).

When the alpha mare that died after the first year's study was alive, all the foals consistently crowded around her during herd rest periods. When another mare replaced the alpha mare in the central rest position, the foals stood around the new alpha mare or beside the stallion. They would leave the more central part of the shade to nurse their mothers, then return. The two alpha mares and the stallion were very tolerant of all the foals crowding around them during these periods. At other times it was rare for a foal other than her own to be close to a mare, or for a foal to be close to a stallion. Systematic studies of position during huddles among feral and wild equids should be made to determine whether foals are, indeed, regularly allowed into the center, or if this pattern was unique to this herd.

The congruence of foal recumbent rest and mare upright rest is due to the mare's recumbency response, in which she changes her behavior when her foal lies down (Crowell-Davis, 1986b). From the development of the foal's time spent resting upright during periods of resting upright by their mother, it is possible that foals learn their resting upright time-budgets from their mothers. As with feeding, this is logical in terms of efficiency of adaptation. The adult mares have already learned to feed during the least stressful times of the day, i.e. when the temperatures are not extreme, and to remain immobile at other times of the day. Rather than learn this by trial and error, the foals may simply imitate their mothers.

An alternative explanation is that there is an underlying physiological-behavioral mechanism in adult ponies that causes them to respond identically to the same given environmental stimuli and that the physical development of foals gradually makes their responses more and more like their mothers. As with feeding, directly comparable studies on mothered and non-mothered foals are necessary to clarify this point.

One of the most notable features of the resting behavior of the ponies was that they usually chose a shaded area to rest in so long as one was available. This selection became most obvious during July and August, when the weather was often hot and the flies dense. Many riding stables tie horses in direct sunlight for long periods of time, even when they are sweating. This is also common at horse shows. Assuming that animal preferences correlate with physiological needs or have other adaptive value, restraining horses for prolonged periods in direct sunlight in hot weather may be psychologically and physically stressful and compromise their welfare.

Consideration of horse's needs for appropriate resting conditions also applies to the custom of shipping mares and their newborn foals to a stable where the mare is to be bred a few days after the birth of the foal. For any trip longer than a couple of hours, the foal should have a space available in which it can safely lie down for extended periods of time.

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