The Reproductive Characteristics of the Mare in Subtropical Taiwan

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ABSTRACT : The objectives of this study were to document the reproductive traits of mares as influenced by the month of the year in Taiwan. Reproductive records, lactation traits, foal birth weight (FBW) and foal height (FBH) were collected from Holi Equine Station of Taiwan. The effects of month on these parameters were analyzed. The length of estrus (LE) was shortest in December each year. The increasing trend was recorded from January to September with a significantly ($p<0.05$) longer period of 12.4±0.4 days in September than in January and February. A gradual shortening in LE was observed from September to December (10.1±0.6 days, $p<0.05$), when the shortest period of the year was observed. Mares showed signs of estrus throughout the year, but more than 80% were found in estrus during March through October. The FBW was significantly ($p<0.05$) affected by the breeding month of the year. The lowest foal weights were recorded in both September (36.7±0.7 kg) and December (36.8±0.9 kg), which were also significantly lower than those in other months except in March, August, and November. A trend of lower FBH from September to December (93.5-93.8 cm) than those from January to August was observed. The greatest FBH was in June (96.2 cm). Breeding months and onset of estrus of the mares exerted a significant effect on the incidence of agalactia during the lactation period. These analyses provide fundamental information on adaptive processes in respect to reproductive characteristics of mares, which indicated an extent of acclimation by these animals in subtropical Taiwan. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 4 : 494-499)***

Key Words : Estrus, Gestation Period, Birth Weight, Birth Height, Agalactia, Mare

INTRODUCTION

Horses are seasonal breeders with extensive sexual activity in spring, summer, and autumn. The reproductive cycle of the mare is subjected to the greatest variability among the domestic animals. Therefore, mares can be roughly classified into three types based on their breeding season. They are (1) the defined seasonal breeders (type 1): the estrous cycle of most wild breeds coincides with the longest days of the year and foaling during a restricted season; (2) transitory seasonal breeders (type 2): some breeds manifest estrous cycles throughout the year, but ovulation only occurs during the breeding season; (3) year-round breeders (type 3): some domestic mares show estrous cycle accompanied by ovulations throughout the year (Hafez, 1993). Nevertheless, most mares are seasonally polyestrous and many of them show behavioral estrus in February, March, and April without accompanying ovulation (Hafez, 1993). Low pregnancy rates occur in these months in contrast to the better conception rates in May, July, and August. It has been reported that 75-80% of mares showed seasonal or winter anestrus in autumn and winter (Osborne, 1966; Ginther, 1974; Hughes et al., 1975). On the contrary, about 90% of mares show regular estrous cycle and ovulate during the long daylength period. However, the duration of the breeding season has increased due to domestication of this species and some mares even show sexual activity throughout the year in contrast to some wild and semi-wild breeds, which have a more restricted breeding season (Gordon, 1983). The animal may have acclimated to local environments to a certain degree. However, to our knowledge, no reliable information is available concerning the reproductive parameters of the mare after acclimation. We have initiated documenting major background information for future development of the horse industry in Taiwan (Fan et al., 1992; Ju et al., 1993). In the present study, we investigated the reproductive performance of crossbred mares throughout the year. This information would be of value for horse owners or farm practitioners in Taiwan and other subtropical countries.

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Received May 23, 2001; Accepted December 4, 2001

MATERIALS AND METHODS

Data collection

In this study, extensive analyses of 843 records from 239 mixed breed mares including Anglo-Arabians, Mongolians, Thoroughbred, Quarter horses and their hybrids, were collected from 1953 to 1989 from the Holi Stud Station, Taiwan. Reproductive records including length or duration of estrus (LE), gestation period (GP), parturition and lactation conditions, and birth weight (FBW, kg) and birth height (FBH, cm) of foals, were collected. Sire effects on those reproductive traits were also analyzed.

The LE was considered to be from the first day of onset estrus until the disappearance of the behavioral or physiological signs of heat (Back et al, 1974; Squires, 1993). In addition to accumulation of watery mucus in the vagina

and swelling of the vulva, the mares on heat also show some major behavioral signs such as urinating, squatting, and eversion of vulvar labia or winking vulva (figure 1). The GP is the period between the first day of mating and delivering a young foal to term. Normal lactation is without any pathological or physiological problems of the mare. Agalactia (AGA) is the condition lacking milk secretion of the mare during the nursing period. The FBH of the foal was the vertical measurement from the wither to the ground and the FBW was measured using an animal scale.

The intensity of the estrus (INE) of the mares was arbitrarily classified into four levels, 0, 1, 2 and 3, based on subjective observations on the intensity of the observable sexual activities and the degree of swelling and/or the color changes of the mare's external genitalia.

Statistical analysis

All the data were calculated, transformed, and analyzed under the effect of the month of the year using the General Linear Model (GLM) in the Statistical Analysis System software (SAS, 1989).

RESULTS

The LE and GP of the mares as well as the FBW and FBH of the foal were analyzed from 239 animals. Some of these reproduction-related characteristics are shown in table 1. Average LE, GP, FBW and FBH of the foals were 11.2±3.5 days, 327±30 days, 38.7±5.3 kg, and 94.7±5.1 cm, respectively, regardless of the month of the year (table 1).

LE (figure 2) increased from January to August with a significantly ($p<0.05$) longer duration in September (12.4 days) when compared to those in December, January and February (10.1-10.6 days, $p<0.05$). LE gradually shortened from October to December, when the shortest LE of the year was observed (figure 2). Signs of behavioral estrus were similar throughout the year. More than 80% of these animals were in estrus during March through October.

Figure 1. Mare showing a stance of urination (squatting) and a swelling and winking of the vulvar lips (arrow), a prolonged rhythmic exposure of clitoris, considered to be typical signs of estrus.

Table 1. Average reproductive parameters of mares in subtropical Taiwan

Parameters	N	Mean±SEM
Length of estrus (LE), days	843	11.2±3.5
Gestation period (GP), days	812	327±30
Body measurements of foals		
Birth weight (FBW), kg	767	38.7±5.3
Birth height (FBH), cm	770	94.7±5.1
Sex ratios (M/F)[1]	770	0.92

N: The number of total records available.

[1] No significant difference was detected in the sex ratio of the foals.

Effects of breeding month (BM) and parturition month (PM) of the mares on FBW and FBH of the foals at birth were analyzed and are presented in figures 3 and 4. The FBW ranged from 36.7 to 40.2 kg, and was significantly affected by both the BM and PM of the mares. The lowest FBW recorded in September and December (36.7 and 36.8 kg), were significantly ($p<0.05$) lower than the FBW recorded in other months of the year except in March, August, October and November. A trend of lower FBH was also observed during the period from September to December (93.5-93.8 cm) than from January to August, with the greatest mean in June (96.2 cm, figure 3). This showed that the influences of PM of mares on the body measurements of their foals were not as obvious as that of BM.

The months also have affected the percentages of animals showing estrus, pregnancy and parturition. A close similarity in the pattern of mares during estrus, pregnancy and parturition was observed (figure 5).

The effects of BM, PM, and month of estrus (EM) of mares on GP are shown in figure 6. Comparisons among each month within each variable were made, by which a similar profile in each criterion was observed. It appeared that the length of gestation period also varied in different seasons. Generally, a longer GP was observed in early spring (January) to the beginning of summer (June) as shown in figure 6.

During the nursing period, most mares showed normal lactation. However, the incidence of mares exhibiting AGA in each month differed significantly under the influences of EM, BM and PM of the mares (figure 7). The effects of EM and BM on the incidence of AGA shared a similar oscillation pattern, which occurred with the higher months in January, April, July to August, October or November. Likewise, under the influence of PM, the incidences of

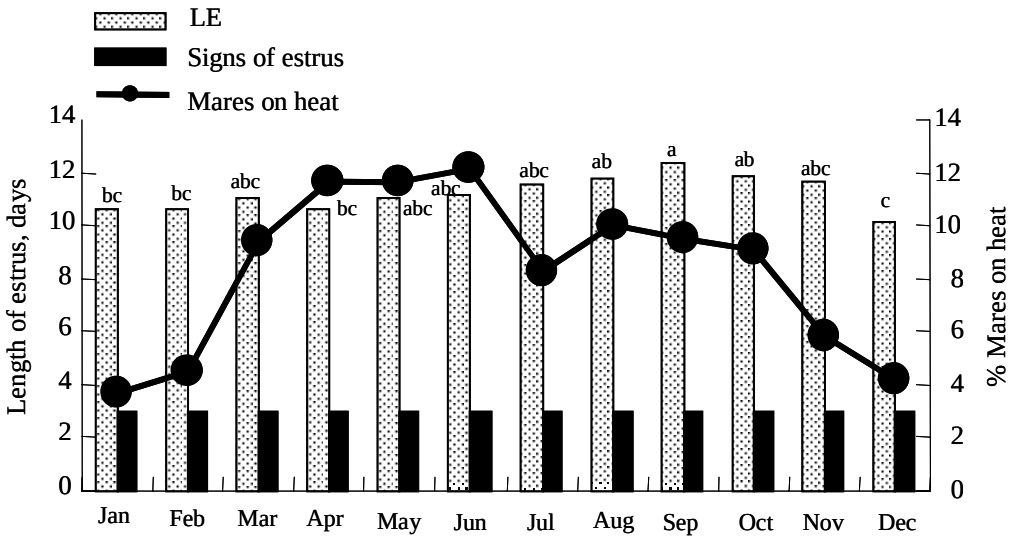

Figure 2. The effect of month on the length of estrous cycle, signs of estrus and percentages of mares on heat in Taiwan. The observable signs of estrus were defined as 0, 1, 2, 3 levels of intensity (total records of mares N=843). Common letters (a, b, c) on top of the chart represent no significant differences in length of estrus (LE) ($p<0.05$).

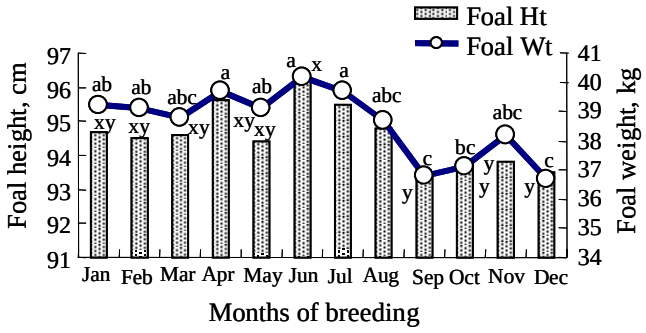

Figure 3. Effects of breeding month of the mare on the birth weight and height of the foal. Common letters on top of the chart represent no significant differences in birth weight (a, b, c) and height (x, y, z) of the foal ($p>0.05$).

AGA oscillated with a similar pattern as that in the other two variables, but the peak of AGA was shifted one month to the left of the X-axis as that in figure 5.

Sire effect on gestation and foal measurements

The effects of sires on pregnancy conditions, gestation periods, parturition status, and body measurements of the foal were also analyzed using the General Linear Model in SAS. No effect of stallions was found on GP and parturition status ($p>0.05$). On the contrary, highly significant influences of stallions were observed on pregnancy status ($P<0.0008$) as well as the birth weight ($p<0.0001$) and height ($p<0.0001$) of the foal (table 2).

Table 2. Analysis of variance of the stallion effect on the reproductive traits of mares and body measurements of the foals in Taiwan

Independent variable	Degrees of freedom	Mean square	F value	P level
Pregnancy status[1]	26	0.332	2.15	0.0008
Gestation period, days	26	444.0	0.48	0.9872
Parturition status[2]	26	0.0788	0.42	0.9954
Foal weight (FBW), kg	26	254.4	13.87	0.0001
Foal height (FBH), cm	26	228.6	10.58	0.0001

[1] Pregnancy status: 1: normal; 0: abnormal.
[2] Parturition status: 1: normal; 0: abnormal; -1: abortion.

DISCUSSION

The estrus cycle of the mare

Multiple factors including photoperiod, temperature and availability of food, affect the reproductive cycle of horses. Of these, photoperiod may be one of the most important factors (Burkhardt, 1947; Nishikawa, 1959), by which an endogenous circannual rhythm is synchronized with seasonal climatic and dietary changes (Bronson and Heideman, 1994). Duration or length of estrus (LE) of mares may vary among individuals and also among the estrous cycle of the same mare. As a consequence, the LE is influenced by the age of mares, nutritional or feeding conditions during the early stage of the breeding season,

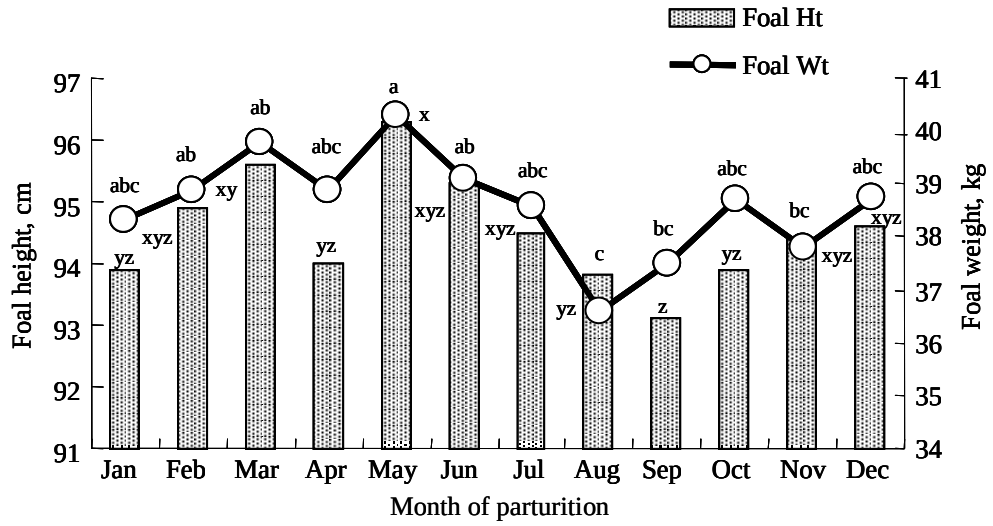

Figure 4. The effect of month of parturition of the mare on the birth weight and height of the foal in subtropical Taiwan. Common letters on top of the chart represent no significant differences in birth weight (a, b, c) and height (x, y, z) of the foal ($p>0.05$).

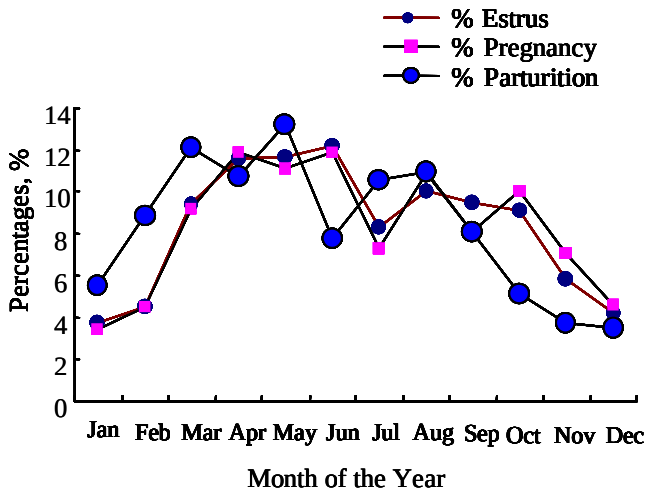

Figure 5. The effect of month on percentages of estrus, pregnancy and parturition of mares in subtropical Taiwan

and physiologic status such as twin ovulations (Hafez, 1993). In this investigation, LE of the mares was 11.2±3.5 days (table 1), which is much longer than that of other species (*cf.* 1-2 days in pigs, 2-3 days in cows). The length of estrus cycle in most domestic species, such as sows, cows, and mares is around 21 days. Long duration of the estrus in the mare may be due to the following factors: (1) Follicles have to migrate to the ovulation fossa prior to rupture; (2) The ovaries are less sensitive to exogenous FSH than in other species; (3) Low level of LH may delay ovulation (Hafez and Hafez, 2000). Observations recorded during the present investigation reveal that the LE of mares in Taiwan is shorter during December and April and gradually increases afterwards with the longest duration in September (figure 2). In other areas, although duration of estrus typically decreases as the season progresses, the shortest duration of is estrus observed in summer (Ginther et al., 1972; Hughes et al., 1972; Hughes et al., 1980). Shortening of the estrus most likely represents an acceleration of folliculogenesis prior to ovulation with increasingly favorable photoperiod. Furthermore, average LE of the mares in Taiwan (12.1 days) is different from the LE in other areas (4-8 days), which may be affected by the ambient temperature as well as the daylength of the breeding season, which in turn lengthened the duration of estrus leading to a longer LE of the mare in Taiwan (Hughes et al., 1972; Stabenfeldt et al., 1972).

The main part of the breeding season occurs during April through June or May through July in the northern hemisphere (Andrews and McKenzie, 1941; Hutton and Meacham, 1968; Hafez, 1993), whereas in the southern hemisphere, it is from November to January (Osborne, 1966). In Taiwan, as presented in figure 2, although not necessarily conceived during all estrous periods, mares exhibited an estrus cycle all the year round (polyestrous) with more than 80% of mares in heat during March through October.

Environmental temperature seems to be a key variable that influences the estrous cycle in mares. Elevated ambient temperature accompanied with high humidity has been a problem for reproductive performance in domestic species in Taiwan and other warm areas (Ron et al., 1984; Monty and Racowsky, 1987; Putney et al., 1988). Therefore, the onset of estrus may be ambiguous in the hot season, which occurs around June till the end of August in this island. Interestingly, the distribution of the animal showing estrus over the year is bimodal (figure 2), which may be one of the unique reproductive phenomena for mares in Taiwan. Other

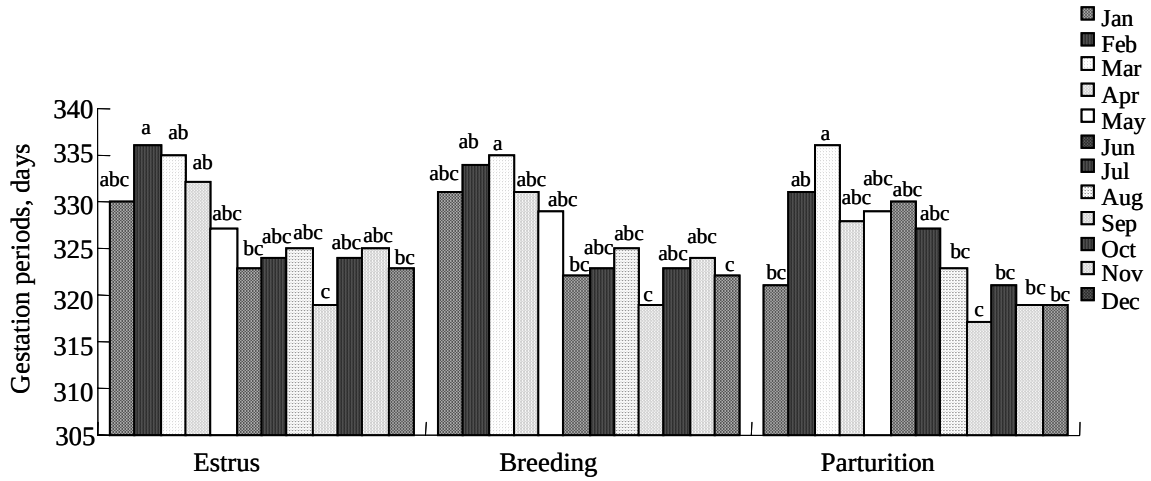

Figure 6. The effect of month of heat, breeding, and parturition on the gestation period of the mare in subtropical Taiwan. Common letters (a, b, c) on top of the chart represent no significant differences for each criterion.

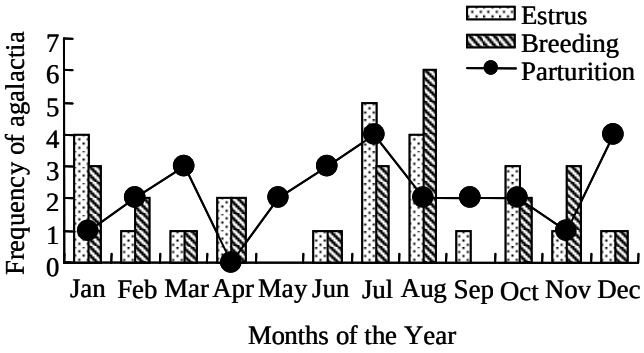

Figure 7. Effects of estrus, breeding and parturition month of the year on the frequency of agalactia of nursing mares in subtropical Taiwan

factors such as species will certainly influence the reproductive cycle of the mare. For instance, half of the Welsh and Shetland ponies were found to breed throughout the year, while the others refused to breed from October to March in the UK (Gordon, 1983). Unfortunately, detailed records of the breed were not available in this investigation, which may confound with the effect of other factors such as daylight and temperature.

Gestation period of the mare

Gestation period (GP) in the mare ranges from 315 to 360 days and is influenced by maternal size, fetal genotype, and the stage of the breeding season when conception occurs (Hafez, 1993). The average gestation period of the mares presented in this study is 327±30 days (table 1), which fall within the range of GP reported in equines (Jainudeen and Hafez, 1993). Interestingly, when the effect of behavioral estrus, breeding, or parturition under the influence of month were analyzed, length of GP in relation to those variables differed between months of the year with a similar trend (figure 6). Generally, a longer GP was found during January through May and shorter ones during June through December. A significantly shorter GP was found in September than in February or March in all criteria examined (figure 6). Similar results were also found by Howell and Rollins (1951) and Hodge et al. (1982), in which mares bred early in the spring appeared to undergo longer gestations than those bred later in the year. However, exposure of bred mares to artificially lengthened daylight during the latter third of gestation resulted in a shorter gestational period than observed in mares exposed to natural daylight. Although the mechanisms are not yet clear, the photic signals might have indirectly influenced the hormonal profile of the mare (Sharp et al., 1993). Whether photoperiodic information is somehow conveyed directly to the fetus to alter the timing of parturition initiation or to alter the course of growth and development requires further study.

Although the frequency of mares in estrus was not affected by the month, other reproductive traits such as parturition, lactation or AGA may have been greatly affected.

ACKNOWLEDGEMENTS

The authors wish to thank Holi Stud Station and Director Lee, I-Jay, who provided valuable information for this analysis. Dr. Chi-Fong Chen and Mr. Jen-Sian Lee, who helped in photographing the mare, are also greatly appreciated. This study was supported by grants from Council of Agriculture, Executive Yuan, ROC.

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