COMPENSATORY REPRODUCTION IN FERAL HORSES

JAY F. KIRKPATRICK, Department of Biological Sciences, Eastern Montana College, Billings, MT 59101
JOHN W. TURNER, JR., Department of Physiology, Medical College of Ohio, Toledo, OH 43699

Abstract: We estimated fetal loss rate in 2 separate herds of feral horses (*Equus caballus*) with significantly different foaling rates that inhabited the same barrier island. We estimated pregnancy rates for 40 feral mares from Assateague Island National Seashore (NS), where the foaling rate was 32.5% and for 48 mares from Chincoteague National Wildlife Refuge (NWR) where the foaling rate was 62.5%. Fetal loss rates were estimated by comparing fall pregnancy rates with foaling rates during the following spring and summer. The estimated fetal loss for mares from Assateague Island NS and Chincoteague NWR was 7.1 and 6.2%, respectively. Ten of the 40 mares from Assateague Island NS (25%) were lactating and only 2 produced foals, whereas 2 of the 48 mares from Chincoteague NWR (4.1%) were lactating and neither produced foals. These data indicate that (1) the differential foaling rates are not the result of fetal loss after 90-days postconception, (2) lactational anestrus is a contributing factor to differential foaling rates, and (3) the annual removal of foals from the Chincoteague NWR herd results in compensatory reproductive mechanisms and higher foaling rates.

J. WILDL. MANAGE. 55(4):649–652

Compensatory reproduction might be an important adaptive response to various natural, population-limiting pressures such as predation, food availability, and disease. Human intervention into wildlife populations by means of hunting or removal of animals can also affect population growth. Two populations of feral horses inhabiting Assateague Island, a barrier island off the Maryland/Virginia coast, provide an excellent model for the study of compensatory reproduction. The island's feral horses are maintained in 2 separate herds, one on the Maryland portion of the island and the other on the Virginia portion. Peak breeding activity for both herds is May and June, with peak foaling activity during April and May (Keiper and Houpt 1984). Weaning occurs at age 1 year for mares foaling 2 consecutive years but often occurs at ages 2 or even 3 years for mares that do not foal on consecutive years.

The Maryland herd consists of approximately 150 horses living on Assateague Island National Seashore, and, in keeping with National Park Service policies of nonintervention, management is minimal. The Virginia herd consists of approximately 200 horses inhabiting Chincoteague NWR; these horses are intensively managed through the annual removal of approximately 80% of the foals, a practice dating back >30 years. In an 8-year study of reproduction among the Assateague Island horses conducted between 1975 and 1983, Keiper and Houpt (1984) reported an annual foaling rate of 74.4% among sexually mature mares on the Chincoteague NWR. In contrast, the foaling rate for the unmanaged Assateague Island NS horses was only 57.1%, with an age-specific range of 40–70%. Since 1986, the Assateague Island NS foaling rate has dropped below 50% (J. F. Kirkpatrick, unpubl. data).

The purpose of our study was to examine fall pregnancy rates in the 2 herds and to compare these with respective foaling rates during the following spring and summer, thereby determining the extent of fetal loss between the 2 herds. We hypothesized that the physiological stresses of concurrent pregnancy and lactation among the Assateague Island NS horses cause a greater incidence of fetal loss than among the horses of Chincoteague NWR, where the physiological stress of lactation is removed annually.

The authors gratefully acknowledge the logistical support provided by G. Olson. We also thank B. L. Lasley and S. E. Shideler for assistance in establishing the urinary steroid assays. Our study was supported in part by National Park Service grant CA-1600-30005.

METHODS

Forty mares whose home ranges were exclusively confined to Assateague Island NS and 48 mares whose home ranges were exclusively confined to Chincoteague NWR were included in our study. All mares were sexually mature and ≥3 years old. The ages of 29 of the Assateague Island NS mares were known, but the ages of the Chincoteague NWR mares were not known exactly. Ten of the 40 Assateague mares (25%) and 2 of the Chincoteague mares (4.1%) had foals at their sides and were lactating.

Table 1. Pregnancy and foaling rates (%) for lactating and nonlactating feral mares in 2 separate herds.

	Assateague Island National Seashore		Chincoteague National Wildlife Refuge	
	n	%	*n*	%
Total mares tested	40		48	
Diagnosed pregnant	14	35.0	32	66.6
Live foals	13	32.5	32	66.6
Lactating mares	10	25.0	2	4.1
Diagnosed pregnant	2	5.0	0	
Live foals	2	5.0	0	

During October 1989 urine and/or fecal samples were collected from each mare as described by Kirkpatrick et al. (1988, 1990*b*). Urine was aspirated directly from the ground immediately following elimination by a mare, or it was hand-centrifuged from sand, placed on ice at the time of collection, and stored frozen at the end of each day. Fecal samples were placed in plastic bags, kept on ice during the day and frozen each evening. For the 40 Assateague mares, we collected urine samples from 18 mares, fecal samples from 17 mares, and both urine and fecal samples from 5 mares. For the Chincoteague mares, urine samples were collected from 23 animals and fecal samples from 25. All horses had distinctive markings which we recorded on drawings or with photographs for later identification.

Unextracted urine samples were assayed for (1) creatinine (Cr), (2) estrone conjugates (E_1C) by enzyme immunoassay as previously described by Shideler et al. (1990) and modified for use in the horse (Kirkpatrick et al. 1990*b,c*), and (3) nonspecific immunoreactive progesterone metabolites (iPdG) as described by Kirkpatrick et al. (1990*a*). The reliability for the E_1C assays and the 100% accuracy for predicting pregnancy, which has been tested in domestic horses and confirmed by rectal palpation (Evans et al. 1984, Kasman et al. 1988) and has been demonstrated in feral horses (Kirkpatrick et al. 1990*a,b,c*, 1991), have been reported elsewhere. Urinary steroid metabolite concentrations were indexed to urinary Cr to account for differences in urine concentrations, and they were reported as ng/mg or μg/mg Cr. We considered concentrations of E_1C in excess of 1.0 μg/mg Cr (Evans et al. 1984, Kasman et al. 1988, Kirkpatrick et al. 1988) and iPdG in excess of 100 ng/mg Cr (Kirkpatrick et al. 1991) as indicative of pregnancy.

We used methods described by Kirkpatrick et al. (1991) to measure fecal E_1C and iPdG concentrations. Fecal total estrogens were assayed by radioimmunoassay as described by Bamberg et al. (1984) and Kirkpatrick et al. (1990*c*). Fecal steroid metabolites and free estrogens were reported as ng/g feces. Pregnancy was predicted on the basis of >1.0 ng/g E_1C, >150 ng/g iPdG, and 5.0 ng/g total estrogens (Kirkpatrick et al. 1990*c*, 1991). During the summer and fall of 1990 we located all pregnancy-tested mares and recorded the presence or absence of foals. Ownership of foals was based on witnessed lactation. We used a binomial probability distribution (Freedman et al. 1978) to test for differences in pregnancy, lactation, and foaling between the 2 herds.

RESULTS

A significantly ($P < 0.001$) greater proportion of Chincoteague mares tested positive for pregnancy, and a significantly ($P < 0.001$) greater number of foals were produced by Chincoteague mares than by Assateague mares (Table 1). There was a 7.1% and a 6.2% fetal loss rate among the 40 Assateague and 48 Chincoteague mares, respectively, with no significant difference between the 2 herds. Annual foal removal resulted in a significant ($P < 0.01$) difference in lactating mares between the 2 herds, with only 2 lactating Chincoteague mares and 10 lactating Assateague mares. Collectively, the 12 lactating mares produced only 2 foals.

DISCUSSION

Early neonatal death is almost impossible to detect on Assateague Island habitat because of dense vegetation and the pregnant mares' behavior of isolating themselves at parturition. Thus, we could not distinguish between fetal loss and neonatal loss. Nevertheless, the nearly doubly great pregnancy rate for Chincoteague horses indicates that the differential foaling rates between the 2 herds is determined by October pregnancy rates, and not by fetal loss after approximately 90–150 days postconception.

Among domestic mares, Ginther (1979) reported an 80% seasonal pregnancy rate and a 70% live foal crop. Van Niekerk (1965) reported a 12.5% pregnancy loss among domestic mares, with greater pregnancy loss during the first half of pregnancy. The suggested critical period for pregnancy loss was Days 25–31. Estimates of abortion rates in the domestic mare, after Day 45 of pregnancy, range from 7 to 12% (Platt

1973, Irwin 1975, Sullivan et al. 1975, Chevalier and Palmer 1982), and major causes of this loss are thought to include foal heat conceptions in lactating mares (Platt 1973) and periglandular fibrosis of the uterine mucosa (Kenney 1978). In our study fetal loss after Day 90 postconception in both herds of feral mares was not different from that reported for domestic mares after Day 45 postconception.

Among island feral horses, age has also been shown to be a major factor in fetal loss rates. Lucas et al. (1990) demonstrated that fetal loss among mares of Sable Island, Canada, between Days 120 and term was 9.7, 40.3, 25.0, and 26.3% annually over 4 years. The fetal loss rates were age-dependent, with a 16.7% loss for 3 year olds and a 5.6% loss for 4 year olds. In our study, only mares ≥3 years old were included, thus it is unlikely that age had a significant effect upon the 2-fold difference in pregnancy and foaling rates. Furthermore, an environmental basis for the differences seems unlikely, because the 2 herds inhabit the same island. Photoperiod, climate, and food supplies are equivalent, and both herds originate from the same genetic forebearers.

The most probable cause for the differences in pregnancy and foaling rates is lactational anestrus, a condition in mares during which ovulation does not occur (Day 1939, Burkhardt 1948, Roberts 1971, Lieux 1973). In domestic mares, this condition persists in a large percentage of lactating mares until the foal is weaned, usually at 4–6 months. This period of an ovulatory lactational anestrus has been characterized by very small or absent ovarian follicles (Day 1939). In controlled experiments with domestic mares, removing the foal at parturition hastened the return of estrus in 3 of 4 mares, whereas all 4 mares that nursed their foals normally were anestrus (Ginther et al. 1972). On Assateague Island, weaning seldom occurs sooner than 1 year, is fairly common at 2 years, and in some instances has been observed at 3 or 4 years. In contrast, about 80% of the foals of Chincoteague NWR mares are removed annually in July.

Our results differ significantly from those of Wolfe et al. (1989), who examined pregnancy rates among 553 feral mares >2 years old, in Nevada, Oregon, and Wyoming. The pregnancy rates for horses in these states were 57.0, 61.0, and 81.4%, respectively, with no differences between lactating and nonlactating mares. Some of the differences between the results of our study and those of Wolfe et al. (1989) could be the result of different pregnancy testing procedures and the accuracies of these tests. Wolfe et al. (1989) reported accuracy rates of 81.8% for plasma progesterone concentrations, 63.0% for plasma estrogen, and 53.7% for plasma pregnant mares' serum gonadotropin (PMSG). The use of only plasma progesterone measurements for pregnancy detection in horses is potentially inaccurate (Hyland 1990), and the same is true for urinary iPdG measurements alone, largely because of the high incidence of persistent corpora lutea in mares. Urinary E_1C concentrations, however, reflect the presence of a viable embryo and drop precipitously within hours of the death of the fetus (Kasman et al. 1988). Consequently, accuracy of pregnancy detection in mares approaches 100% with urinary E_1C concentrations alone (Evans et al. 1984, Kasman et al. 1988), 100% for urinary E_1C and iPdG concentrations together (Kirkpatrick et al. 1990*a*), and 95% for total fecal estrogens (Bamberg et al. 1984, Kirkpatrick et al. 1990*c*).

MANAGEMENT IMPLICATIONS

Control policies for feral horses have historically centered around the removal of horses, particularly young horses. Because our results suggest that feral horses increase conception rates in response to the removal of foals before weaning, a policy of removing young, unweaned horses can lead to greater fecundity among their mothers. Conversely, the removal of weaned horses will be unlikely to have any significant effect upon fecundity of the mothers. Future management policies for the control of feral horse populations should consider compensatory reproductive responses of the mares. Regardless of whether actual removal or contraception is employed as the control method, efforts should focus on mares >3 years old, and those without foals. Conversely, the removal of foals or yearlings should be avoided because of the probability of increasing fecundity among their mares.

LITERATURE CITED

BAMBERG, E., H. S. CHOI, E. MOSTL, W. WURM, D. LORIN, AND K. ARBEITER. 1984. Enzymatic determination of unconjugated oestrogens in faeces for pregnancy diagnosis in mares. Equine Vet. J. 16:537–539.

BURKHARDT, J. 1948. Some clinical problems of horse breeding. Vet. Rec. 60:243–246.

CHEVALIER, F., AND E. PALMER. 1982. Ultrasonic echography in the mare. J. Reprod. Fert. (Suppl. 32):423–430.

DAY, F. T. 1939. No. 2-sterility in the mare associated with irregularities of the oestrous cycle. Vet. Rec. 51:1113–1119.

EVANS, K. L., J. P. HUGHES, M. COUTO, L. H. KASMAN, AND B. L. LASLEY. 1984. Pregnancy diagnosis in the domestic horse through direct urinary estrone conjugate analysis. Theriogenology 22:615–620.

FREEDMAN, D. B., B. PISANI, AND R. PURRES. 1978. Statistics. W. W. Norton, New York, N.Y. 506pp.

GINTHER, O. J. 1979. Reproductive biology of the mare. McNaughton and Gunn, Ann Arbor, Mich. 413pp.

———, H. L. WHITMORE, AND E. L. SQUIRES. 1972. Characteristics of estrus, diestrus, and ovulation in mares and effects of season and nursing. Am. J. Vet. Res. 33:1935–1939.

HYLAND, J. H. 1990. Reproductive endocrinology: its role in fertility and infertility in the horse. Br. Vet. J. 146:1–16.

IRWIN, C. F. P. 1975. Early pregnancy testing and its relationship to abortion. J. Reprod. Fert. (Suppl. 23):485–488.

KASMAN, L. H., J. P. HUGHES, G. H. STABENFELDT, M. D. STARR, AND B. L. LASLEY. 1988. Estrone sulfate concentrations as an indicator of fetal demise in horses. Am. J. Vet. Res. 49:184–187.

KEIPER, R., AND K. HOUPT. 1984. Reproduction in feral horses: an eight-year study. Am. J. Vet. Res. 45:991–995.

KENNEY, R. M. 1978. Cyclic and pathologic changes of the mare endometrium as detected by biopsy with a note on early embryonic death. J. Am. Vet. Med. Assoc. 1:241–263.

KIRKPATRICK, J. F., L. H. KASMAN, B. L. LASLEY, AND J. W. TURNER, JR. 1988. Pregnancy determination in uncaptured feral horses. J. Wildl. Manage. 52:305–308.

———, B. L. LASLEY, AND S. E. SHIDELER. 1990*a*. Urinary steroid evaluations to monitor ovarian function in exotic ungulates: VII. Urinary progesterone metabolites in the Equidae assessed by immunoassay. Zoo Biol. 9:341–348.

———, I. K. M. LIU, AND J. W. TURNER, JR. 1990*b*. Remotely-delivered immunocontraception in feral horses. Wildl. Soc. Bull. 18:326–330.

———, S. E. SHIDELER, B. L. LASLEY, AND J. W. TURNER, JR. 1991. Pregnancy determination in uncaptured feral horses by means of fecal steroid conjugates. Theriogenology 35:753–760.

———, ———, AND J. W. TURNER, JR. 1990*c*. Pregnancy determination in uncaptured feral horses based on steroid metabolites in urine-soaked snow and free-steroids in feces. Can. J. Zool. 68: 2576–2579.

LIEUX, P. 1973. Reproduction and genital diseases. Pages 117–137 *in* E. J. Catcott and J. F. Smith-Cors, eds. Equine medicine and surgery. Second ed. American Veterinary Publ., Inc., Wheaton, Ill.

LUCAS, Z., J. I. RAESIDE, AND K. J. BETTERIDGE. 1990. The incidences of pregnancy and pregnancy loss in the feral horses of Sable Island based on field observations and determination of fecal oestrogen concentrations. Pages 146–147 *in* Proc. fifth international symposium on equine reproduction, Deauville, France.

PLATT, H. 1973. Aetiological aspects of abortion in the thoroughbred mare. J. Comp. Pathol. 83:461–467.

ROBERTS, S. J. 1971. Veterinary obstetrics and genital diseases. Second ed. Edwards Brothers, Inc., Ann Arbor, Mich. 542pp.

SHIDELER, S. E., L. TELL, G. OWITI, L. SHAHNAZARIAN, R. CHATTERTON, AND B. L. LASLEY. 1990. The relationship between serum estradiol and progestrone concentrations to the enzyme immunoassay measurements of urinary estrone conjugates and immunoreactive pregnanediol-3-glucuronide in *Macaca mulatta*. Am. J. Primatol. 22:133–122.

SULLIVAN, J. J., P. C. TURNER, L. C. SELL, H. B. GUTTERIDGE, AND D. E. BARTLETT. 1975. Survey of reproductive efficiency in the quarter horse and thoroughbred. J. Reprod. Fert. (Suppl. 23): 315–318.

VAN NEIKERK, C. H. 1965. Early embryonic resorption in mares. J. South Afr. Vet. Med. Assoc. 36:61–69.

WOLFE, M. L., L. C. ELLIS, AND R. MACMULLEN. 1989. Reproductive rates of feral horses and burros. J. Wildl. Manage. 53:916–924.

Received 7 November 1990.
Accepted 8 May 1991.
Associate Editor: Conner.