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A Method for Forecasting the Dates of Mass Calving and Some Characteristics of the Rut and Calving in the Kalmyk Population of Saiga (*Saiga tatarica* L.)

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Abstract—A method for forecasting the dates of calving in the saiga population on the basis of average fetal body weight is proposed. The method is based on the relationship between the number of days before calving and the average weight of fetuses, which obviates the necessity of determining fetal age and exact gestation period in this species. The average length of gestation, the dates of the rut in the years studied, and the age of females that have mated immediately upon the onset of the rut and before its cessation have been determined. It is shown that the duration of mass calving depends on the proportion of mature males in the population.

Key words: saiga, forecasting method, population, dates of calving, the rut.

The saiga belongs to the ungulate species that are of great commercial importance in Russia. According to the results of censuses, however, the abundance of this species decreased from 434 000 animals in the end of 1997 to only 96 000 in 1999 because of mass poaching. In controlling the state of the saiga population, an important role is played by the prognosis of the dates of mass calving. In the Kalmyk population, the first newborns appear on April 25–27, and mass calving usually occurs in the first ten-day period of May (Lavrovskii, 1950; Adol’f, 1954; Dal’ *et al.*, 1958; Fandeev, 1960, 1961; Bannikov, 1961). The interval between the first and last births is about one months, and the period of mass calving is three to five days or, in some instances, up to seven days (Bannikov, 1961; Fandeev, 1961; Bliznyuk, 1982; Zhirnov, 1982).

Further observations showed, however, that the dates of calving may vary within a wider range. Mass calving in 1969 took place on April 27–29 (Perovskii, 1974); between 1970 and 1978, this process lasted from April 24 to May 14. The earliest recorded date of finding newborn saigas is April 15, 1970; most of them appeared in this year between April 20 and 30 (Bliznyuk, 1982). The latest recorded dates of mass calving are May 16, 1959 (Fandeev, 1961; Zhirnov, 1982) and May 18, 1993 (Bliznyuk and Bukreeva, 1993). Only a few females calve in the second half of May (Fandeev, 1961; Zhirnov, 1982). In Kazakhstan, mass calving usually takes place between May 4 and 20 (Sludskii and Fadeev, 1974). The dates of calving in each year depend on conditions of the rut, the efficiency of mating, and the physiological state of males (Zhirnov, 1982).

Between 1970 and 1978, up to 90% of Kalmyk saigas during mass calving gathered in one to three large groups (66 000–275 000 animals) in the area of 40–370 km^2 (Bliznyuk, 1982). In Kazakhstan, saiga populations did not form such dense aggregations, and calving in most regions, except for the Ustyurt Plateau and western Kazakhstan (Fadeev, 1975), occurred somewhat later (Bannikov, 1961; Zhirnov, 1982).

Before the onset of mass calving, saigas continuously migrate and cover a distance of 10–20 km (in some cases, up to 60 km) each day. Migrating groups are very compact and difficult to locate. When the exact dates of mass calving are unknown and no special measures are taken to find animal aggregations in due time, the search for them is often successful when mass calving has already been completed (migrations cease only upon the onset of this process). Locating these aggregations is important for organizing the summer census of saigas. Such censuses were taken in the 1970s by an original method (Bliznyuk, 1975, 1977), and this work was resumed in 1994.

The factors determining the dates of the rut have not yet been identified with certainty, although it is known that commercial hunting in the end of the season can delay this process. Hence, to estimate the dates of mass calving from the dates of the rut, it is necessary to perform continuous observations throughout December, when the rut occurs, but this does not ensure correct determination of its onset and cessation.

The problem of forecasting the dates of mass calving in the saiga has not been seriously considered in available publications. The main reason is that the precise data on the gestation period in this species are still lacking. In nature, this period has been estimated at 138 days (Sludskii and Fadeev, 1974), 140–145 days (Zhirnov, 1982), and approximately five months (Adol'f, 1954; Bannikov, 1961; Fandeev, 1961). Estimations for captive animals are as follows: 135–141 days, averaging 138.2 days (Tsaplyuk, 1966); 139–152 days (Fandeev, 1961); 145 days (Bannikov, 1961); and even about six months (Vasenko, 1950). This is why in papers by Petrishchev (1996, 1997), which deal with data on the body weight of saiga fetuses at different ages, the gestation period is taken to be 145 days in one case and 150 days in the other.

The purpose of this study was to develop a method for predicting the dates of mass calving in the saiga. The plan was as follows: to determine the average fetal body weight in the sample taken from pregnant females on a certain date, to estimate the peak of mass calving in the same year, and to calculate the number of days between sampling and calving; after accumulating data for different stages of gestation over several years, to analyze the relationship between the average fetal body weight and the remaining number of days before delivery and to compile a table for predicting the time of mass calving. Such an approach could obviate the need for determining the exact dates of the rut, fetal age, and the average duration of gestation.

MATERIAL AND METHODS

Field studies were performed in the Kalmyk Republic from 1995 to 1998. Pregnant female saigas (a total of 243 animals) were taken in March and April, one to two months before calving. In 1995 and 1997, two samples of females at different stages of gestation were taken each year (98 and 132 fetuses); one sample (74 fetuses) was taken in 1996, and another one in 1998 (39 fetuses). The average weight and body length of male fetuses (n = 171) and female fetuses (n = 173) were determined in each sample separately. In 1997, the body length of five more embryos was measured 62 days before the peak of calving, and their body weight was taken to be equal to that of fetuses of the same size from the previous samples. Calving was assumed to reach a peak in the middle of the corresponding period. When this period was over, the elapsed time (in days) between sampling and the peak of calving was determined. To make experimental material more representative, pregnant females were hunted in different areas of the range for one or three days (in the latter case, the second day was regarded as the date of sampling). In 1998, the purpose of field studies was to estimate the accuracy of predicting the dates of calving by the proposed method. The material was collected for two days, but most fetuses were weighed on the first day, which was taken as the date of sampling.

Fetal body length was measured along the dorsal surface, from the upper edge of the nostrils to the base of the tail, to an accuracy of 1 cm (Fandeev, 1961). The fetuses were weighed on a fulcrum balance to an accuracy of 5 g. In addition, body weight and length were determined in live newborns (0.3–4 h after birth) found in the period of mass calving. In this case, spring scales were used, and measurements were accurate to 50 g. From 1994 to 1998, 605 male and 639 female newborns were studied.

The dates of mass calving, the areas occupied by animal aggregations, their size, and the number and density of animals in these aggregations were estimated in the periods from 1970 to 1978 and from 1993 to 1998. To determine the number of mature males in the population in June and July, animal censuses with regard to sex and age were taken in these periods (n = 49746 and n = 32459, respectively). The age of females in the samples was determined from the degree of molar tooth wear by the method proposed by Bannikov and Fandeev (1961). As age classes for animals older than five years are delimited at two-year intervals, gradations of tooth wear within the same class were taken into account to estimate animal age with an accuracy of one year.

To predict the number of days before the peak of calving, a special table was compiled. It showed the values of body weight in male and female fetuses at different ages and the periods before calving that correspond to these values. These data were obtained by comparing the samples taken at some interval and calculating fetal weight gain (g/day), which made it possible to estimate the average fetal weight on any day before the peak of calving. As the duration of mass calving averages five days, its peak was assumed to occur on day 3.

For determining the gestation period, the following method was used. For each sample of fetuses, the average number of days before the peak of calving was estimated. Note that a strong negative correlation between fetal weight and the period before calving (r_{xy} = –0.97) confirms the accuracy of the proposed approach. For the same samples, fetal age was calculated on the basis of data obtained by Petrishchev (1997). The weight and age of fetuses strongly correlate as well, but this correlation is positive (r_{xy} = 0.97). However, the results of determining the difference in age between two consecutive samples by these two methods proved to differ by three days (in one case, by five days). In my opinion, Petrishchev's approach is less accurate: he determined the age of saiga fetuses by comparing them with precisely dated sheep fetuses, assuming that the duration of intrauterine development in the saiga is 150 days, as in sheep. In addition, he estimated fetal age with reference to the peak of the rut, assuming that the latter occurred in the second half of December (a fairly rough approximation).

Consider the following stages of this procedure. Beginning from the sample with the minimal fetal weight, add the estimated number of days before calving to the age of fetuses calculated by Petrishchev's

Table 1. Table for forecasting the number of days before the peak of calving

Days before calving	Fetuses					
	male			female		
	n	body weight, g ($X \pm S_X$)	weight gain, g/day	*n*	body weight, g ($X \pm S_X$)	weight gain, g/day
62–52	3–5	193.3 ± 17.8–404.0 ± 37.1	21.3	2–6	190.0 ± 44.2–386.7 ± 29.0	19.7
52–45	5–51	404.0 ± 37.1–667.6 ± 22.6	37.7	6–37	386.7 ± 29.0–602.4 ± 27.3	30.8
45–41	51–32	667.6 ± 22.6–887.4 ± 10.8	55.0	37–42	602.4 ± 27.3–844.3 ± 37.1	60.5
41–31	32–58	887.4 ± 10.8–1226.1 ± 32.7	33.9	42–63	844.3 ± 37.1–1218.0 ± 27.4	37.4
31–24	58–5	1226.1 ± 32.7–1948.0 ± 102.5	103.1	63–6	1218.0 ± 27.4–1788.3 ± 48.9	81.5
24–0	5–604	1948.0 ± 102.5–3307.0 ± 19.0	56.6	6–639	1788.3 ± 48.9–3117.0 ± 18.0	55.4

method to obtain the period of gestation (in this study, 143 days). Assume that this value is true, and, hence, no corrections of fetal age are needed (correction factor is zero). In fact, estimations of fetal age are not very precise (see above) and should be corrected with regard to the length of gestation period: if this period is 144 days, fetal age should be increased by one day (+1); if it is 145 days, by two days (+2); and so on. When the gestation period is shorter than 143 days, a minus sign is assigned to the correction factor. In this way, correction factors are then calculated for other samples (except for cases when the gestation period is 143 days). These results are pooled in a table to determine the length of the gestation period at which the minimal corrections of fetal age are necessary (i.e., its real length).

As it was shown that more than 90% of females mate within ten days at the peak of the rut, the duration of the rut and the age of animals that mated before and after this ten-day period were estimated. The age ratio among females participating in the rut at its initial and final stages were determined. In addition, the relative index of involvement was calculated. To this end, the percentage of females belonging to a given age group among all females involved in the rut was divided by the percentage of the corresponding age group among all females in the population (the ratio of different age groups in the population was calculated from the results of age determination in 3278 females taken between 1995 and 1998, which are not considered in this study). The greater this index, the higher the proportion of females belonging to a given age group (relative to their total number in the population) is involved in the rut at a given stage. Data were processed statistically by conventional methods (Lakin, 1980).

RESULTS AND DISCUSSION

Forecasting the Period of Mass Calving

In the table for predicting the number of days before calving (Table 1), this parameter is estimated from the average weight of male and female fetuses. In practice, the weight of male and female fetuses is determined in the sample taken on a certain date. Thereafter, the values of weight gain are used to calculate the average fetal weight on each day within the range of interest. By comparing the results, the number of days before calving is determined. However, the table data allow such prognosis to be made not earlier than 62 days before the peak of calving. If the sample size is small, it is possible to use the average weight of fetuses without taking into account their sex and to make calculations by the table assuming that the sex ratio is 1 : 1.

For the first time, calving dates were forecasted in 1998. When female fecundity was estimated on April 8 and 9, the weight of female fetuses (n = 20) averaged 881.5 ± 22.9 g (variation range 665–1040 g), and that of male fetuses (n = 19), 756.3 ± 35.8 (340–880) g. The difference in these results showed that the average weight of female fetuses was underestimated, as the sample was small and included two very small fetuses taken from the same female. Hence, the data on male fetuses were only used for forecasting. According to calculations, the onset and peak of calving were to take place on May 17 and 19, respectively, and the error proved to be only one day (Table 2). In another group, which was not examined in detail, mass calving was at its peak on May 20 and continued on May 21, and its onset took place on May 17.

Analysis of Factors Determining Calving Dates

Forecasting the dates of calving five to six months before its onset is now impossible: they are determined by the dates of the rut, and methods for predicting these dates have not yet been developed. There are data that the rut begins depending on the situation in the preceding period (in particular, the cessation of hunting in due time), the proportion of mature males in the population, the physiological state of animals, and the weather (Bliznyuk, 1982; Zhirnov, 1982). In the 1980s and 1990s, the rut in the saiga occurring relatively late was a more frequent phenomenon than in the 1970s. Sokolov *et al.* (1998) supposed that this species may have two ecomorphs differing in calving dates, and the

Table 2. Dates and characteristics of mass calving

Year	Date of calving (May)	Groups of saigas			Population size, thousand ind.
		number	area, 10^3 ha	density, ind./ha	
1970	24–26*	1	4.0	28.0	190.0
1971	5–7	3	–	–	–
1972	9–12	3	–	–	212.0
1973	5–7	3	36.6	6.2	260.0
1974	6–8	3	24.7	9.0	235.0
1975	9–11	2	3.8	86.0	340.0
1976	12–14	3	19.7	18.1	390.0
1977	8–10	4	6.3	56.8	390.0
1978	9–12	2	27.4	14.9	440.0
1993	12–18	2	15.5	6.4	100.0
1994	11–20	3	9.2	12.2	112.7
1995	11–18	1	4.9	22.7	125.4
1996	3–7	2	9.6	19.4	196.1
1997	4–8	1	9.1	28.5	270.4
1998	16–20	2	28.3**	4.4	125.2**

* April.

** Area, size, and dates of calving for one of the two groups.

shift of these dates is explained by the increased proportion of the "late" ecomorph. If this had been true, the shift in dates would have been observed in 1986 and 1987, the years of depression that occurred after a 14-year period of intensive population harvesting (including net trapping in the last six years). Under such conditions, the decrease in the proportion of the normal ("early") ecomorph and the resulting delay in calving would have been natural. However, using the method described above and the data on the weight of fetuses and dates of sampling from the paper by Petrishchev (1997), it is possible to determine that the peak of calving was on May 4 in 1986 and on May 17 in 1987. Moreover, mass calving in early May 1986 was noted by Petrishchev (1996). Thus, very early calving in 1986 was followed by very late calving in 1987. Such a shift of dates is difficult to explain in terms of the proposed hypothesis, and the ratio of ecomorphs in the population is unlikely to change so drastically within such a short period of time. Note that similar shifts were also recorded in the 1990s (Table 2).

It is now clear that the dates of the rut and, hence, calving largely depend on some global factors that determine the weather in the corresponding periods. This knowledge is insufficient for estimating the dates of the rut in advance; hence, they cannot be used as a basis for predicting the dates of mass calving, and data on average fetal weight should be used for this purpose. As follows from Table 2, mass calving in 1998 began very late. This was probably explained by the effect of some natural factors determining the dates of the rut. Note that the rut ceased between December 15 and 19, 1997, because of severe cold: air temperature was –16 to –20°C and rose slightly only some time later. In 1955, mass calving was recorded on May 2–5 (Dal' *et al*, 1958); in 1970–1978, from April 24 to May 14 (Table 2). In 1999, this period (longer than usual) was in the second half of May. As follows from data discussed above, calving in the 1980s and 1990s often occurred in the second ten-day period of May, including the last days of this period.

In Kazakhstan, the dates of mass calving in saiga populations also varied considerably. In the 1960s and 1970s, saigas calved in the first and, rarely, second ten-day period of May; in the 1980s and 1990s, this occurred in the second and third ten-day periods (Fadeev and Sludskii, 1982; Zhirnov *et al.*, 1998). Thus, changes in the dates of calving in the Kalmyk Republic and Kazakhstan have the same trend, which apparently reflects the influence of some global factor determining changes in climatic conditions. Having analyzed fluctuations in the Caspian Sea level and the centennial cycle of solar activity, I predicted the worsening of living conditions for the saiga in the late 1970s (Bliznyuk, 1976). This prognosis proved to be true both with regard to the rise of the sea level and the decline of the saiga population. Apparently, the worsening of living conditions entails not only a higher mortality among saigas in increasingly severe winters, but also a shift of calving to a later period as an attempt to choose more favorable conditions for producing the offspring.

Table 3. Calculation of fetal age and gestation period in the saiga

Average fetal weight, g	Time before calving, days	Fetal age according to Petrishchev (1997)	Correction factors (+, –) at a given length of gestation period, days					Corrected fetal age at a gestation period of 145 days
			143	144	145	146	147	
192.0	62	81	0	+1	+2	+3	+4	83
394.6	52	88	+3	+4	+5	+6	+7	93
640.2	45	100	–2	–1	0	+1	+2	100
862.9	41	107	–5	–4	–3	–2	–1	104
1221.9	31	114	–2	–1	0	+1	+2	114
1860.9	24	124	–5	–4	–3	–2	–1	121
Sum of deviations			–11	–5	+1	+7	+13	

In the years with late dates of calving, such as 1994 and 1998, the minimal indices of fecundity and newborn weight and a high mortality among newborns in the first two days after delivery were recorded (Bliznyuk, 1999; Bliznyuk and Bukreeva, 2000). The respective mortality rates in the progeny were 16.8 and 12.9%, compared to 4.6–5.4% in 1995–1997, when conditions were favorable. The weather in the period of calving in those years was bad. Moreover, as followed from a generally low fatness of females, climatic conditions in the previous seasons (winter and autumn) were also unfavorable. Thus, in the absence of intensive commercial hunting (except in 1996) and other external factors affecting the state of saigas, their delayed calving, high mortality, decreased fecundity, and reduced weight of the offspring and mature females were explained by adverse climatic conditions. Other factors no more than enhanced or attenuated their effects.

The period of mass calving in 1993–1995 was fairly long, seven to ten days, probably because of a small proportion of mature males in the population (6.4–10.3%; on average, 8.2%) and, consequently, an extended period of the rut. In 1996–1998, this proportion increased to 12.3–14.4% (on average, 13.0%), and mass calving was accomplished within five days. Between 1972 and 1978, when the proportion of mature males varied from 16.4 to 24.0% and averaged 18.5%, mass calving lasted for three to four days (Table 2).

In the 1970s and 1990s, changes were also observed in other population parameters, such as the number of animal aggregations in the calving period, their area, and the number and density of animals in them (Table 2). These parameters were mainly dependent on population size. In 1998, an increase in the area in which saigas concentrated was explained by the presence of many immature females in the population. These females tended to migrate even after the onset of calving, thus reducing animal density in the aggregation.

In the years of 1972–1978 and 1995–1997, the proportion of saigas included in the calving aggregations varied from 87.0 to 96.2%. In 1970, one aggregation included 59.0% of the total population, and the remaining animals were scattered. In 1993 and 1994, virtually all saigas gathered in groups.

Estimating the Dates of the Rut from the Age of Fetuses

To determine the gestation period, a table was compiled by the method described above (Table 3). It is seen that the minimal correction of fetal age is necessary when the gestation period is 145 days. If we accept the period of 144 days, five days should be subtracted from the fetal age in all the samples; conversely, if this period is 146 days, seven days should be added. Still longer or shorter periods of gestation imply even greater corrections. In other words, 145 days is the average length of the gestation period in the saiga, as correction factors in this case have either only a plus sign or only a minus sign, depending on direction. Moreover, overestimation and overestimation of fetal age at the gestation period taken as 145 days were minimal.

On the basis of these data, the age of all fetuses and the dates of mating for each female in the samples were calculated in order to determine the dates and intensity of the rut. In the season of 1994/1995, the rut continued from December 14 to January 8; in the next year, from December 1 to 24; in 1996/1997, from December 2 to January 2; and in 1997/1998, from December 21 to January 7. The peak of mating lasted for five days: on December 18–22 in 1994, December 10–14 in 1995, December 10–14 in 1996, and December 23–27 in 1997 (Table 4).

Assuming that an average of 92 ± 0.9% of females mated within ten days at the peak of the rut (Table 4), we can estimate that the interval between the first mating and the beginning of this period was one to nine days. Analysis of the age ratio among females that mated at the initial stage of the rut showed that 77.8% of them belonged to the first three age groups (0.5–2.5 years), which are most abundant in the population, and 22.2% of these females were 5.5–6.5 years old (Table 5). The relative indices of involvement in the rut for different

Table 4. Duration of the rut and its intensity

Parameter	1995	1996	1997	1998	1995–1998
Date of sampling	March 29–31 April 20	March 25–27	March 14–16 April 4–6	April 8–9	March 14–April 20
Number of fetuses	98	74	132	39	343
Proportion of females (relative to total number, %) mated over:					
5 days	78.6	74.3	74.2	84.6	77.9 ± 2.7
7 days	84.7	79.7	81.1	89.7	83.8 ± 2.2
10 days	91.8	91.9	90.9	94.9	92.4 ± 0.9
Duration of the rut	26	24	32	18	25.0 ± 2.9

Table 5. Involvement of females of different age groups in the rut at the initial and final stages

Age	Initial stage			Final stage		
	n	proportion of the total number involved in the rut at this stage, %	relative index of the involvement of different age groups in the rut	*n*	proportion of the total number involved in the rut at this stage, %	relative index of the involvement of different age groups in the rut
0.5	2	22.2	0.9	5	41.2	1.6
1.5	3	33.4	1.7	5	41.2	2.0
2.5	2	22.2	1.7	2	11.7	0.9
3.5	–	–	–	–	–	–
4.5	–	–	–	1	5.9	2.7
5.5	1	11.1	8.5	–	–	–
6.5	1	11.1	15.9	–	–	–
0.5–6.5	9	100	–	17	100	–

age groups showed that a major proportion of 6.5- and 5.5-year-old females mate at its initial stage.

These data slightly differ from those on the saiga from Barsa-Kelmes Island: in that population, middle-aged females were the first to come in estrus and mate, and then followed 4.5-year-old females (Rashek, 1974). In late April, only mature female saigas delivered the progeny in Kazakhstan (Sludskii, 1955; Rakov, 1956), and the same was observed in the Kalmyk Republic (Fandeev, 1961).

The final stage of the rut is longer. Judging from the age of fetuses, some females continue mating for 8–17 days after the ten-day peak period. Among them, 94.1% belong to the first three age groups (0.5–2.5 years). However, the relative indices of involvement show that 4.5- and 1.5-year old females mate at this stage more frequently. If the total number of females participating in the rut at the initial and final stages (see Table 5) is taken as 100%, the respective proportions will be 34.4 and 65.6%.

Evidence that the period of mass mating in the Kalmyk saiga population is about ten days between December 15 and 25 has been published previously. As follows from the dates of calving, mass mating in some years may take place approximately one week earlier or later (Bannikov, 1961; Fandeev, 1961; Bliznyuk, 1982). For example, the peak of the rut occurred in the first ten-day period of December in 1985 and in late December in 1986 (Petrishchev, 1997). Even in the case of mass calving in late April, as in 1969 and 1970 (Bliznyuk, 1982), the peak period of the rut began on December 1. Thus, it is unreasonable to further reduce the hunting season, as saigas have enough time to prepare themselves for the rut.

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