# Determination of time of conception of fallow deer in a Hungarian free range habitat

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**Abstract.** Our research examined the time of conception of fallow deer in the DALERD South Plains Forestry Private Limited Company's Gyulai Forestry Area. We collected data from pregnant females who had been shot in the hunting season. At the time of evisceration the uterus was removed and dissected; and sex and body weight of embryos were recorded. We were able to collect and analyze 149 samples for our study. Based on the sex and body weight of embryos, we calculated the fertilization date for each animal within our sample group. There were no significant statistical differences found between mean fertilization dates of adult does and yearlings ($t = -0.72$, $p = 0.47$). The mean fertilization date of does (with a gestation period of 231.5 days) was October 25$^{th}$ (SD = 13.82, n = 120); whereas, for yearlings this date was October 24$^{th}$ (SD = 12.97; n = 29). Based on embryonic development, results showed that in the population we examined, 2 % of females were impregnated in December, 1.3 % in September (at the end of September), 24.2 % in November and the majority, 72.5 % were fertilized in October.

**Key words:** reproduction, mating season, fertility period, fertilization date, yearling

## Introduction

Reproductive biology of free range fallow deer is shaped by evolutionary adaptations which ensure species survival as influenced by specific habitat characteristics. One key factor in evolutionary adaptation in deer species is that the birth of their young needs to be synchronized with those times when lactating females have access to abundant food sources (Putman 1988). In deer of the temperate and Palearctic climatic zones, the photoperiod of the circannual rhythm, which is a key eco-ethological stimulus, controls the reproductive biological processes (Asher 2011). This extended stimulus over the period of months triggers those neurohormonal changes which are responsible for seasonally occurring physiological characteristics (Lincoln, 1985). Fallow deer does are reproductively mature as early as their second year of life, more specifically by 16-17$^{th}$ months of age (Szabolcs 1968, Chapman & Chapman 1982, Vegnušt & Kosec 2000). The mating season of fallow deer in Europe characteristically takes place in October (Chapman & Chapman 1970, Fletcher 1986, Reinken et al. 1990, Apollonio et al. 1992, San José & Braza 1997, Fabio 2010). The strongest bucks, who are also the most likely to reproduce, regrow their antlers by the middle of August. In the middle of September they start to revisit their traditional breeding territories which also commences the mating season (rut) of the fallow deer (Fabio 2010). The time of the rutting season is influenced by such factors as the sex ratio, age distribution of animals and weather conditions (Komers et al. 1997). First the older, heavier body weight bucks go into rut, only later followed by younger males (McElligott et al. 2001). Szabolcs (1968) however, suggests that yearling females induce mating, followed by females without any young; females with young go into rut only in the second half of the mating season. These results are in contradiction with the statement of Asher (1986), according to whom yearlings in New Zealand come into estrus later than does. Accordingly, mate selection in the fallow deer is governed by female choice where females preferentially select bucks whom they feel to be superior quality males who can produce the most viable offspring (Thirgood et al. 1999).

The time of conception and consequently the time of births are key influencing factors in the survival potential of fawns. The length of gestation lasts 226-237 days (Prell 1938, Asdell 1946, Chapman & Chapman 1975, Asher 1986, Fletcher 1986, Heidemann 1986, Griffiths & Campbell 1993). The survival potential of fawns born in unfavorable weather conditions is significantly reduced (Ciuti et al. 2006). Early birth of fawns at the time where there is not enough forage to adequately nourish their mothers can greatly increase potential fawn mortality. Similarly cold and wet weather conditions directly reduce survival of fawns (Linnel et al. 1995). Birgersson et al's (1998) research conducted in enclosed habitat type also indicated that the most critical time of survival for fawns is immediately after birth as 4 % of fawns died within the first week of birth. In open habitat studies, Kjellander et al. (2012) found a significantly higher (23.6 %) death rate of fawns. Pélabon (1997) also indicates this early life stage as the most critical time for fawn survival. Does are more successful in rearing their offspring than yearling mothers. According to the results of Náhlik & Sándor (2000) the neonatal survival of does' fawns was 0.88, while in the case of yearlings it was only 0.38. In contrast, late births can result in difficulties during winter when fawns may be delayed in development due to the shorter available maturation period.

In our study we have determined the time of conception for individual animals, the first and last date of conception (i.e. the time span of the rut), and we calculated the peak time of conception within the population when most females are impregnated. All these factors yield information about the time of birth of fawns which in turn greatly determine their survival potential. The hypothesis we examined was that does are typically impregnated at different times from yearlings (Szabolcs 1968, Asher 1986). For confirmation we studied whether the fertilization period of does and yearlings show any notable differences in our study area.

## Study Area

Our research was conducted in the DALERD South Plains Forestry Share Holding Company's Gyulai Forestry Area, on an 8250 ha hunting ground. The study site is located on the Great Hungarian Plains, East of Békés County, at the Hungarian-Romanian border, at these coordinates: 46°38′42.79″ N latitude and 21°16′49.63″ E longitude. The site is situated 87 m above sea level (as specified by the World Geodetic System). The region is characterized by a continental climate highly variable weather and large annual and monthly temperature fluctuations, low humidity, erratic precipitation and a strong potential for summer droughts. The mean annual precipitation is 563 mm; in terms of annual distribution lowest levels are in January-February, while maximum levels are normally seen in June. The mean annual temperate is 10.9 °C and the mean temperature of the rutting season is 18.2 °C with frequent early and late freezing temperatures. There are 31-36 days snow cover with a mean maximum snow depth of 18 cm.

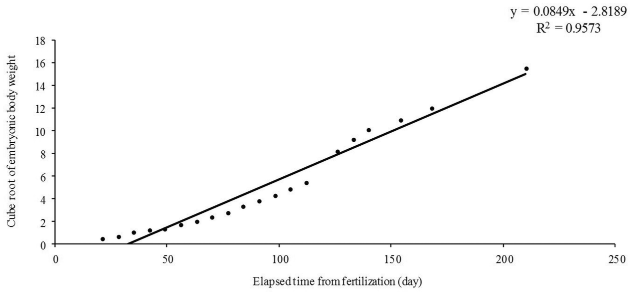


**Fig. 1.** Relationship between embryonic weight and elapsed time from date of fertilization based on data from Ahrens & Liess (1987).

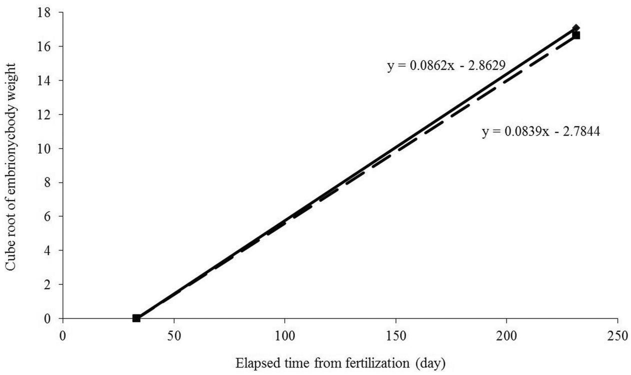


**Fig. 2.** Relationship between embryonic weight and elapsed time from date of fertilization determined separately for each sex. The coefficient for "x" is equal to the value of "a" (growth coefficient) in Huggett & Widass' (1951) equation.

**Table 1.** Number of collected samples according to period of collection.

| Time of the collection | Number of samples |
|---|---|
| December | 34 |
| January | 69 |
| February | 46 |
| total | 149 |

## Material and Methods

In order to determine time of conception in the species, we examined the sex and body weight of embryos present in the uterus of dissected does and yearlings, shot during one year's hunting season on the latest possible dates. The first sample was from December 1, the last from February 18 (Table 1). Sample collection closer to birthing times ensured that we were able to analyze data with greater accuracy and certainty. We analyzed a total of 149 samples (120 does and 29 yearlings). We removed the reproductive

**Table 2.** Embryonic weight development in fallow deer from date of conception as function of elapsed time (Ahrens & Liess, 1987).

| Elapsed number of weeks from time of conception | Number of samples | Mean embryonic body weight (g) |
|---|---|---|
| 3 | 2 | 0.13 |
| 4 | 8 | 0.30 |
| 5 | 4 | 1.15 |
| 6 | 4 | 1.76 |
| 7 | 4 | 2.50 |
| 8 | 5 | 5.29 |
| 9 | 16 | 8.07 |
| 10 | 16 | 14.10 |
| 11 | 15 | 21.37 |
| 12 | 8 | 37.23 |
| 13 | 5 | 57.00 |
| 14 | 7 | 81.00 |
| 15 | 10 | 114.75 |
| 16 | 7 | 162.73 |
| 18 | 5 | 544.00 |
| 19 | 2 | 794.00 |
| 20 | 3 | 1036.67 |
| 22 | 1 | 1330.00 |
| 24 | 1 | 1730.00 |
| 30 | 1 | 3730.00 |

organs (uterus and ovaries) from the sampled fallow deer females. We dissected the uterus and removed the embryo or embryos for analysis. We measured body weight to within 0.1 gram for each embryo, after separation from the embryonic sac and water, and we recorded sex of the embryos. Depending on fetal development, determination of sex of an embryo of fallow deer was possible once the embryo measured at least 5 cm in body length (Sándor 2005). Sexual differentiation was possible through examination of the outer genital organ differences as well as the inchoate of the antler pedicle on the male fawn's forehead. To examine the conception times of fallow deer and temporal characteristics of their reproduction, we analyzed body weight of embryos. In open range habitats, determination of the time of conception and birthing times are difficult to observe and complicated to study. The developmental status of embryos can be determined at any given stage from the gestation period of fallow deer and from the known embryonic body weights for each developmental stage (Table 2) (Ahrens & Liess 1987). For our calculations we used the mathematical mean of frequently reported (Prell 1938, Asdell 1946, Chapman & Chapman 1975, Asher 1986, Fletcher 1986, Heidemann 1986, Griffiths & Campbell 1993) gestation periods (231.5 days); however, in our evaluation we also took into consideration the two most outlying values (226-237 days) and their effect on fertilization dates.

In placental mammals there is an almost linear relationship between the cube root of embryonic body weight (W) and elapsed time from fertilization (T). This relationship exists from the moment of conception until the birth of the embryo $T = (W^{1/3}/a) + t_0$ (Huggett & Widass 1951), where "a" – growth constant and "$t_0$" – hypothetical time of zero size. The above relationship was proven true for several cervids such as for the American elk (*Cervus canadensis*) (Morrison et al. 1959), and for red deer (*Cervus elaphus*) (Mitchell & Lincoln 1973, Sugár & Horn 1986, Szabó 2001).

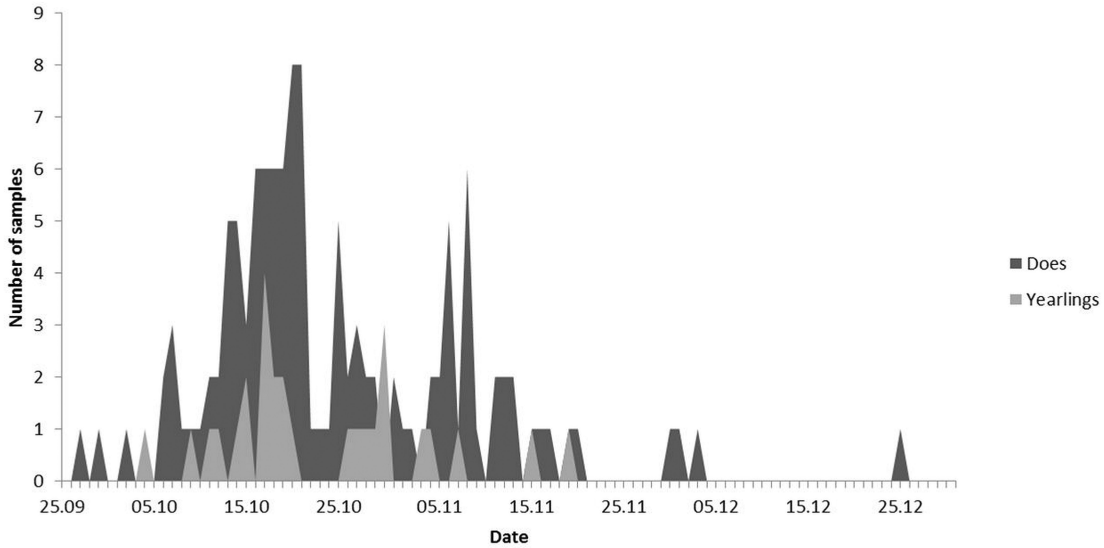


**Fig. 3.** Calculated fertilization dates of does (n = 120) and yearlings (n = 29).

Based on data from Ahrens & Liess (1987), we determined the linear regression line describing the cube root of embryonic body weight and elapsed time from conception for the species of fallow deer (Fig. 1). We calculated the hypothetical time of zero size (Horwood 1987) of fallow deer, the "$t_0$" value, which is at the intersection of the regression line and time axis (x axis).

The growth constant of fawns was determined separately for each sex to account for developmental differences between the sexes (Sándor 2005). We constructed a graph (Fig. 2) where the origin of our lines was plotted at the already established value of "$t_0$"; while, the birth weights for each sex (male: 5.0 ± 0.5, female: 4.6 ± 0.5) specific to a 231.5 day gestational period was based on data reported by Birgersson & Ekvall (1997). Thus we were able to determine the coefficient for "x" as the slope of the plotted lines of the two sexes which corresponds to the value of "a" in Huggett & Widass' (1951) equation.

Based on these values and our own observations (fetal birth weight and sexes), we were able to specify the typical fertilization dates of fallow deer; and to determine whether there are any significant differences between fertilization dates of does versus yearlings. Comparison of these values was done by a t-test which used the mean values of independent data sets. We used the STATISTICA version 11 to analyze our data.

## Results and Discussion

By substituting the results of these calculations into the formula of Huggett & Widass (1951) and taking into consideration the body weight of embryos at any given stage we calculated the number of days elapsed from the time of conception. We also incorporated our calculated hypothetical time of zero size value ($t_0$ = 33 days) and the calculated growth constant value (a = male: 0.0862, female: 0.0839).

We determined conception times based on the established functions (Fig. 3). Based on the 149 samples and the parameters measured (body weight and sex of embryos), the following results were obtained: most conceptions occurred in October which was 72.5 % of the time, 24.2 % occurred in November, 2 % in December and only 1.3 % occurred in September.

While the typical conception period of fallow deer in Europe is October, which is also supported by our observations, we also noted, similarly to other data (Chapman 1974, Chapman & Chapman 1978, Feldhamer et al. 1988), that conception can often occur as late as November. During the mating season the presence of mature, high ranking, older bucks can induce fertility in females; whereas, the absence of such males or even the larger representation of younger bucks can prolong the fertility period of females (Komers et al. 1999).

We were unable to support Szabolcs's (1968) and Asher's (1986) argument that yearlings have different fertilization periods from does. There were no significant differences found between mean fertilization dates of adult does and yearlings ($t = –0.72$ $p = 0.47$). The mean fertilization date of does (with a gestation period of 231.5 days) was October 25th (SD = 13.82, n = 120); whereas, for yearlings this date was October 24th (SD = 12.97, n = 29). Taking into consideration the outlying values (226-237 days) of some reported gestationals, we calculated the mean fertilization date for does to be between October 23 (SD = 14.25, n = 120) and 26 (SD = 13.41, n = 120), while for yearlings it was calculated to be between October 23 (SD = 13.72, n = 29) and 27 (SD = 12.96, n = 29). Similarly to our results, Rhodes et al. (1991) also found no significant differences in fertilization times of yearlings and does in the white tailed deer species.

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