# Birth rate and offspring survival in a free-ranging wild boar *Sus scrofa* population

**András Náhlik & Gyula Sándor**

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We estimated birth rates in wild boar *Sus scrofa* by counting embryos in the uterus of females killed in individual or drive hunts. Counting *corpora lutea* in the ovaries gave information on embryo:*corpus luteum* rate, which can be useful for estimating birth rates in early stages of pregnancy. Birth rates were estimated separately for the different age groups. Age was estimated by means of teeth wear. Survival was estimated by direct observations counting the piglet:female ratio in matrilineal groups. The method is suitable for assessing summer survival only, as 8-9 months after birth, matrilineal groups begin to disintegrate. Average estimated birth rate was 6.7 ± 2.1 (N = 51).We found a positive linear relationship between conception rate and age of female, conception rate and body mass, and conception rate and body length, respectively. In late stages of pregnancy, embryo:*corpus luteum* rate proved to be 0.83 ± 0.15. Recruitment of piglets to the female population was low; more than half of the piglets had perished by the end of September. The highest mortality rate occurred in the first weeks of the piglets' lives.

*Key words: birth rate, mortality, pre-natal mortality, recruitment, wild boar*

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In the course of planning the population number of big game, such as wild boar *Sus scrofa*, we generally start from the estimated economic carrying capacity, the estimated number of individuals and the recruitment to the female population. Partly due to the unreliability of data on population parameters, e.g. density, birth rate and recruitment, planning is extremely simplified in the overwhelming majority of cases. Usually, an empirical population growth index is used to calculate the recruitment to the population. However, differences in litter size are too large to neglect in the course of planning. Large differences exist not only on a large scale, varying along a latitudinal gradient throughout Europe (Sáez-Royuela & Telleria 1987), but also on a nationwide scale (Andrzejewski & Jezierski 1978, Heltay, Mátrai, Sugár & Kovács 1981, Köhalmy 1979).

On the other hand, as pregnancy and birth rates vary according to age (von de Vos & Sassani 1977, Pedone, Mattioli, Mattioli, Siemoni, Lovari & Mazzarone 1991), the age structure of the population cannot be neglected.

Furthermore, it is well known that the annual fluctuation in survival of the offspring is high and depends on mast availability (Briedermann 1971, Ahrens 1984, Aumaitre, Quere & Peiniau 1984, Groot Bruinderink & Hazebroek 1994).

All the above statements suggest, that annual data on birth and mortality rates cannot be ignored, especially in cases where offspring are more heavily influenced by early destruction (Martys 1982, Boisaubert & Klein 1984).

We aimed at finding applicable methods for game management practice in estimating the birth rate. We also aimed at determining the scale of neonatal mortality and summer survival of the offspring.

## Material and methods

### Study area and period

The study was conducted in a 47,030 ha flat area, constituting 11,880 ha of forest and 35,150 ha agricultural land. The hard broadleaved forests, the large area of cereal crops, and the 220 ha of cultivated game fields provide an ideal habitat for wild boar. With a canal and some lakes located in the area, the water supply is plentiful. All year round, significant quantities of supplemental food are provided, mainly consisting of maize and wheat, for hunting purposes. The quantity of grain supplied is high, amounting to an estimate of 1,400 kg/day/500 wild boar, 400 red deer *Cervus elaphus* and 500 roe deer *Capreolus capreolus*. The average number of snowy days with a thin snow cover is 20, and the mean winter temperature is 3°C. The investigation was carried out over two years: 1997/98 and 1998/99.

### Estimation of birth rate

We determined the number of foetuses in females shot during the hunting season in late December and January. After the bagging of the game, the following organs were collected: uterus, ovaries and the lower jawbone. We examined and measured the ovaries and *corpora lutea*. Number, sex and weight of foetuses found in the uterus were determined. Time of gestation was estimated from the weight of the foetus, by use of the formula: $T = (W^{1/3} + 2.3377)/0.097$ (Vericad 1983). For the estimation of birth rate, we assumed that after nearly two months of gestation (and a foetus weight of 35 g), the probability of pre-natal mortality was minimal. This presumption was most probably substantial, as we did not find dead foetuses heavier than 35 g (being approximately 12 cm long). The conception rate should therefore roughly correspond to the actual birth rate.

### Body measurements

After having bagged the females, we took the following body measurements: 1) body length from the tip of the nose to the base of the tail, 2) height of shoulders, 3) size of waist and 4) circumference of the neck under the lower jaw as shown in Figure 1; all measurements were estimated to the nearest cm. Thereafter, we measured the weight of the eviscerated body estimated to the nearest kg.

### Age

To estimate the age, we examined the teeth wear of the molars (Habermehl 1985), and distinguished between the following age groups: 1, 2, 3, 4, 5, 6, 7, 8 and 9 years.

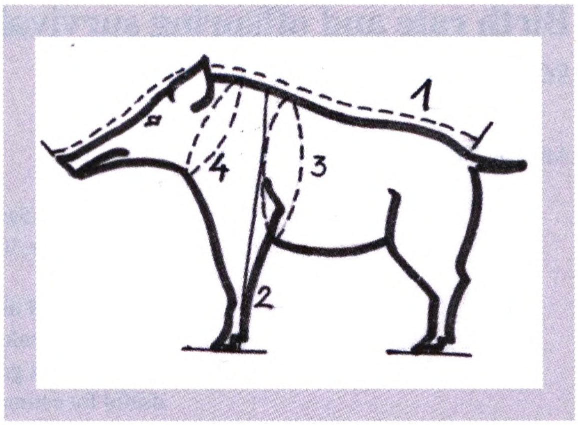

Figure 1. The body measurements used in the study of wild boar were 1) body length from tip of nose to base of tail, 2) height of shoulder, 3) size of waist and 4) circumference of the neck.

### Estimation of recruitment to the female population

Survival was estimated by direct observations of the animals on feeding grounds and crop fields. We counted the females and offspring in the groups observed, and calculated the offspring: female ratio. Photo- and video techniques were applied.

For observation purposes we divided the investigated area into five subunits of 6,000-15,000 ha each. We made observations in three of the five subunits. The observations were performed once every fortnight from January to May. The duration of an observation was three days. Each day another of the three subunits was used.

Estimation of neonatal survival caused us difficulties due to the extended parturition period. However, we could estimate the neonatal period (two weeks after birth) by evaluating the development of the piglets seen. Offspring probably younger than two weeks or older than four weeks were not considered.

Estimation of survival until the end of September was performed in the last five days of September in all the five subunits each day. We used 3-5 observation points within each of the subunits.

Hence we calculated the neonatal mortality and mortality until the end of September. This method of estimating the recruitment was suitable for assessing summer survival only, because matrilineal groups begin to disintegrate 8-9 months after birth (Spitz 1992).

Using this method, we had observed about 20% of the female population between January and May, and more than 40% by the end of September.

### Data analysis

Estimation of the conception rate was performed according to age groups. We examined the evaluation of the

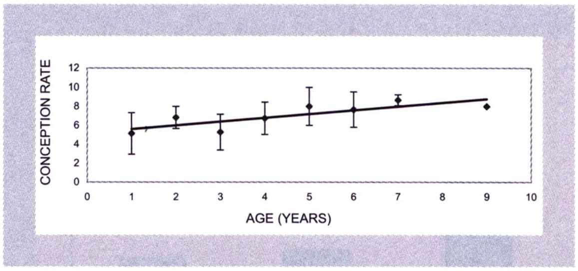

Figure 2. Relationship between the age of the mother and the conception rate ($y = 0.396x + 5.2127$; $r = 0.8176$; $N = 37$).

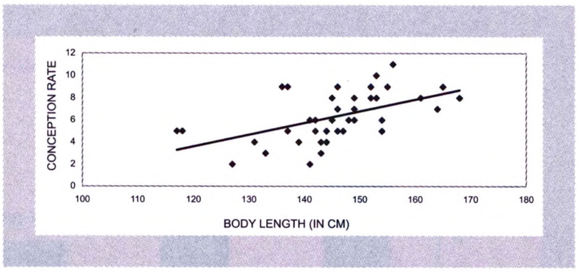

Figure 4. Relationship between the body length of the mother and the conception rate ($y = 0.106x - 9.1162$; $r = 0.5416$; $N = 47$).

embryo:female ratio as a function of the age, weight and body length of the female. In doing this, we used linear and logarithmic regression. To find any relation between the numbers of *corpora lutea* and embryos, a linear regression was used. Sex differences at birth were tested by chi-square test. Neonatal mortality was determined as the difference between the estimated recruitment to the female population after the neonatal stage and the estimated birth rate. Similarly, we calculated summer mortality as the difference between the recruitment to the female population at the end of September, and the estimated recruitment to the female population after the neonatal stage. Differences between the two years' estimated conception rates and recruitment were tested using t-test.

## Results

When estimating the birth rate, we assumed that in the late stages of pregnancy, prenatal mortality is minimal. Birth rate as conception rate was $6.7 \pm 2.1$ ($N = 51$).We did not find any significant difference between the conception rates of the two years examined ($P > 0.05$).The foetus sex ratio was 1:1.2 (♂ : ♀), but did not differ significantly from 1:1 ($P > 0.05$).

The conception rate increased with age ($CR = 0.396 * Age + 5.2127$; $F = 12.09$, $P = 0.01$; Fig. 2), and age explained 67% of the observed variations in the average conception rate.

We also found a connection between the number of *corpora lutea* (CLN) and the number of foetuses ($FN = 0.7374 * CLN + 0.7316$; $F = 62.56$, $P = 0.000$), and the number of *corpora lutea* explained 56% of the observed variations (Fig. 3). In the late stages of pregnancy, the ratio of foetuses: *corpora lutea* was on average 0.83, and the number of *corpora lutea* explained 56% of the variation in the number of foetuses.

In only three cases, we found dead, but still not absorbed embryos in the uterus, but none of them was longer than 12 cm (weighing ≤ approximately 35 g). In fact, there were two cases in which we found living embryos of two different sizes within one uterus; in one of them two among the four smaller-sized embryos were dead.

We could not find any relation between conception rate and the body measurements height of shoulders, size of waist and circumference of neck, respectively. However, we found a close connection between body length (BL) and conception rate ($CR = 0.106 * BL - 9.1162$; $F = 17.02$, $P = 0.000$; Fig. 4), and eviscerated body weight (BW) and conception rate ($CR = 3{,}7457 * Ln(BW) - 10.075$; $F = 20.14$, $P = 0.000$; Fig. 5), respectively.

We estimated a relatively high neonatal mortality rate. While in the first year of our study we had a low-

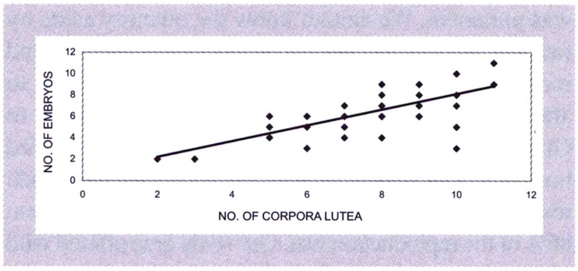

Figure 3. Relationship between the number of *corpora lutea* and the number of embryos ($y = 0.7374x + 0.7316$; $r = 0.7489$; $N = 31$).

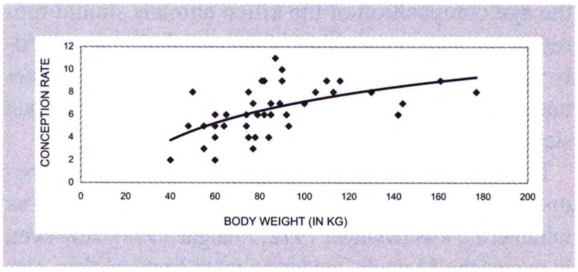

Figure 5. Relationship between the eviscerated body weight of the mother and the conception rate ($y = 3.7457Ln(x) - 10.075$; $r = 0.5648$; $N = 41$).

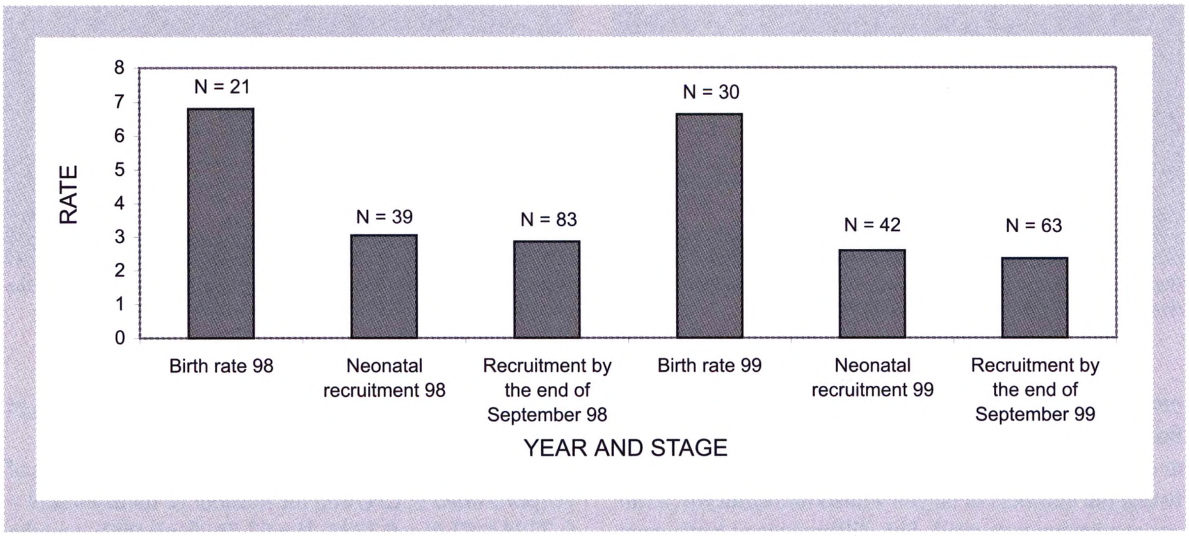

Figure 6. Estimated birth rate and recruitment to the female population during the two years of the investigation.

er neonatal mortality rate (3.75 offspring/female, or 55.1% of the born offspring) than in the second year (4.04 offspring/female, or 60.9% of the born offspring), the summer mortality was higher in the second year (0.19 and 0.24 offspring/female, or 6.2% and 9.3% of the offspring perished during the summer) than in the first. In consequence, recruitment to the female population after the neonatal stage was 3.05 ± 1.64 (N = 39) in the first year, and 2.59 ± 1.33 (N = 42) in the second year. However, the difference did not prove to be significant ($P > 0.05$). We also had minor differences between the two years' recruitment to the female population at the end of September (2.86 ± 1.54, N = 83 and 2.35 ± 1.41, N = 63), but this difference was not supported by the t-test ($P > 0.05$; Fig.6).

## Discussion

The accuracy of the estimation of birth rate in wild boar by counting foetuses in the uterus of killed animals could be reduced by two factors. First, the condition that the age composition of the killed animals should represent the age composition of the population was hardly met. Secondly, the estimation error could be further undermined by the eventual prenatal mortality in the late stages of the pregnancy.

In general, 100 * (No. of *corpora lutea* - No. of foetus or embryo)/No of *corpora lutea* is interpreted as intrauterine loss (Mauget 1972, Abaigar 1992). However, in two of the 31 cases, we found more foetuses than *corpora lutea*. If we suppose, that a higher number of foetuses than of *corpora lutea* is a consequence of the occurrence of identical twins, we should expect a slightly higher embryo:foetus mortality rate than the one calculated on the basis of foetus: *corpus luteum* ratio.

In our study, we had approximately 12% less foetuses than *corpora lutea*. This value lies fairly close to the result of -14% reported by Mauget (1972), but lies much lower than the -30.6% reported by Abaigar (1992). The results of Aumaitre, Quere & Peiniau (1984) show that in years with good versus bad acorn availability, an embryonic mortality of 11-11.3% and 13.8-14.6%, respectively, should be expected. Thus, it seems likely that embryonic mortality depends on food availability, and may fluctuate between the various populations.

Our results suggested that prenatal mortality will be higher in females with more numerous embryos. In females with 11 *corpora lutea*, prenatal mortality reached on average 20% of the number of embryos.

It is questionable whether the supplemental feeding with grain significantly affect the prenatal mortality or not. Groot Bruinderink & Hazebroek (1994) reported that negative effects of mast deficiency were masked by supplementary feeding. The quantity supplied in our study area was high, although the *de facto* eaten share was unknown. We neither know the quantity eaten by red deer and roe deer nor the quantity eaten by birds and rodents, and we also have to consider losses due to 'trampling' and other losses. Moreover, according to Groot Bruinderink & Hazebroek (1994), if non-fed boar in a poor mast year still had access to man-made resources, in particular game meadows, it could explain 86% of the reproduction rate. Our study area offered wild boar a wide spectrum of resources even in winter, such as agricultural fields, meadows and game fields. How-

Table 1. Birth rate of wild boar as reported in various case studies from seven European countries.

| Source | Birth rate | Country |
|---|---|---|
| Martys (1982) | 5.8 | Austria |
| Mauget (1972) | 4.62 | France |
| Aumaitre et al. (1984) | 4.6 | France |
| Briedermann (1971) | 6.0 | Germany |
| Köhalmy (1979) | 3.5-6.7 | Hungary |
| Heltay et al. (1981) | 6.6 | Hungary |
| Náhlik & Sándor (present study) | 6.7 | Hungary |
| Pedone et al. (1991) | 4.9 | Italy |
| Andrzejewski & Jezierski (1978) | 1.6-5.5 | Poland |
| Sáez-Royuela & Tellería (1987) | 4.3 | Spain |
| Abaigar (1992) | 4.1 | Spain |
| Garzon-Heydt (1992) | 4.2 | Spain |

ever, further investigation based on analysis of stomach content is needed to determine the quantity of grain eaten by wild boar.

Theoretically, birth rate estimation should in practice be performed by examining the uterus of wild boars killed as close to the parturition time as possible. However, this is impeded by ethical and legislative rules. As an alternative, the estimation can be made by counting *corpora lutea* and correcting by use of the equation that relates the numbers of *corpora lutea* and foetuses.

Many estimates have been made for the birth rate of wild boar from different European countries (Table 1), the majority of which gives a litter size of 4-5 piglets. Hungarian data are in general higher, exceeding six per female. We suppose this to be a consequence of the combination of good habitat quality, favourable climate in the investigated areas and possibly supplemental feeding. Our investigated population most probably consists of 'pure' wild boar, as there are no signs, such as light colour or short nose, of interbreeding with domestic pigs. Similar high litter sizes were recorded by Martys (1982) in Austria (5.8) and in the better German habitats, where both the average litter sizes of sows and one-year-old females exceeded 6.0 (Briedermann 1971).

The foetal sex ratio was slightly skewed towards females (1:1.2; N = 27) in our research area, while Abaigar (1992) found it to be 1:1.6 in Spain, Aumaitre, Quere & Peiniau (1984) obtained a 1:1 ratio in France and Heltay et al. (1981) reported it to be 1:0.88 in Hungary. Though the deviation from a 1:1 foetal sex ratio in Hungary was not significant, other data have shown that the birth sex ratio can vary from one year to another within the same territory (Mauget 1980).

Our results on age dependent birth rate were in concordance with those reported by von De Vos & Sassani (1977), Jezierski (1977) and Pedone et al. (1991) in as far as the birth rate was increasing as a function of increasing age of the mother (Table 2). However, our estimations of the birth rate were higher in every age group examined if compared with the results of the above-mentioned authors.

Like Mauget (1972) and Sáez-Royuela & Tellería (1987), we also found a relation between body weight and birth rate estimated by conception rate, although in all the models, the explanatory capacity was low; i.e. 16-41%.

The same body weight in our study resulted in a higher birth rate. As we had a higher mean birth rate than Mauget (1972) and Sáez-Royuela & Tellería (1987), and since this was most probably a consequence of the better living conditions in our study area, we can assume that in good habitats, the same birth rate will occur at a lower body weight than in less good habitats.

These results seem to be in concordance with the hypothesis put forward by Gaillard, Brandt & Jullien (1993) stating that in good quality habitats and at similar body weights, a higher percentage of one-year-old females will get pregnant than in low quality habitats.

We obtained a quite close linear relationship between body weight and conception rate. However, a logarithmic equation explains the relation more adequately: the increased conception rate should level off as the body weight increases due to fat as a consequence of the biological potential of the species. Indeed, we found an even closer relationship between body weight and conception rate by using the logarithmic regression which was also used by Mauget (1980).

As the close relation between body weight and body length is obvious, we expected to find a relation between body length and conception rate. The connection proved to be close enough to be of practical use. It could be used to only measure the body length of the killed females to obtain a rough estimate of birth rate.

Martys (1982) stated that the mortality of piglets during their first weeks of life can reach 17%. We found a much higher mortality rate (55.1 and 60.9, re-

Table 2. Estimated birth rate of wild boar according to age groups as reported from various sources.

|  | Age groups (in years) |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|
| Source | 1 | 2 | 2-3 | 3 | 4-5 | 6-7 | ≥ 7 |
| Jezierski (1977) | 1.00 |  | 3.40 |  | 4.00 | 5.00 |  |
| Náhlik & Sándor (present study) | 5.14 |  | 6.00 |  | 7.29 | 8.00 | 8.00 |
| von De Vos & Sassani (1977) | 4.20 | 5.60 |  | 6.50 |  |  |  |
| Pedone et al. (1991) | 3.64 | 5.07 |  | 5.60 |  |  |  |

spectively) in the early life stage, although the accuracy of the estimation of neonatal mortality was probably reduced by the imprecise estimation of the age of the offspring. Compared with the neonatal mortality, summer mortality of piglets was low, and we can thus support the findings by Boisaubert & Klein (1984) and Gaillard, Vassant & Klein (1987) that young animals to a great extent are exposed to mortality.

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