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Introduction

This study is part of a larger, comprehensive investigation of the roe deer *(Capreolus capreolus)* in Denmark.

The primary purpose of the work described here is to clarify the extent to which the number of Corpora lutea can be taken as representative of the number of embryos in roe deer from Denmark. Usually it is only possible to collect larger amounts of roe deer material during the shooting season, from October 1 to December 31. Due to the delayed implantation of roe deer, there are no visible embryos in the uterus during this period. However, there are Corpora lutea in the ovaries, resulting from ovulation which takes place during heat in August. It is therefore usually necessary in studying reproductive capacity to base the collection of material on the animals' ovaries. As a result, it is of considerable importance to know the relationship between the number of Corpora lutea and the number of embryos.

To investigate this point, a number of roe deer of more than 1 year of age were shot outside the normal shooting season, in February and March 1970. At this time the embryos in the uterus can be discerned. As the material also provided the possibility of estimating embryonic development, this was considered at the same time, and related to previously collected data on the time of birth of the fawns.

With regard to the collection of material, the Game Biology Station is indebted to all those who provided roe deer for the study, and especially to E. Due, forest superintendent, Løvenholm; Lt.-Col. M. Tønsberg, Borris; and J. Frydenlund, forester, Borris. Special thanks are due to stud. scient. Helge Christensen, Århus Universitet, who performed the statistical analysis of the data. Finally I thank professor, dr. phil. K. G.Wingstrand, Københavns Universitet, for reviewing the manuscript and Robert Russel, Århus, for translating it.

Corpora lutea and embryonic development

The material analyzed was collected from two districts in East Jutland and one in West Jutland, and comprises a total of 24 animals.

THE LOCALITIES

The three districts from which the material was taken represent three quite different habitats.

Kalø in East Jutland comprises a wooded and cultivated area, in typical terminal moraine country. The soil on the whole is fertile clay, and forestry and agricultural production are quite considerable.

Løvenholm in East Jutland is a wooded area. The soil is mostly sandy, and rather poor in minerals. Within the area are considerable raised-bog formations.

Borris in West Jutland is a heath and plantation area, within a heath plain. The soil is very sandy, very poor, and with exceptionally poor water retention.

COLLECTION OF MATERIAL

The material from the areas in East Jutland is from animals which were shot for the investigation, by dispensation from the Game Laws. Material was taken from 10 animals in each area. The material from Borris concerns 4 animals which died during capture. The date of each animal's death is given in Tables 2–4.

Each animal was weighed immediately after shooting, and again after evisceration (dressed weight). The genitalia of each animal were removed and preserved, and the lower jaw was removed for ageing of the animal. This was done on the basis of tooth wear. The ovaries were preserved for 3 days in 4 % formalin, after which they were cut into 5–6 slices, and the Corpora lutea counted. The right and left ovaries were kept separate, and the embryos in the uterus were weighed, measured, and sexed where possible, before preservation. The position of the embryos in the uterine horns was also noted.

Composition and distribution of the material

In a total of 24 sexually nature roe deer, there were 48 Corpora lutea and 46 embryos. The distribution in each district is given in Table 1.

Kalø

In 8 roe deer there were 2 Corpora lutea and 2 embryos in each animal, while 1 had 3 Corpora lutea and 2 embryos, and 1 had 3 Corpora lutea and 3 embryos.

The distribution of Corpora lutea in the ovaries is given in Table 2. The occurrence of twin embryos is of special interest here. Only in 2 roe deer was there one Corpus

District *Distrikt*	No. of does *Antal råer*	No. of Copora lutea *Antal Corpora lutea*	No. of embryos *Antal fostre*	No. of Corpora lutea per doe *Antal Corpora lutea pr. rå*	No. of embryos per doe *Antal fostre pr. rå*
Kalø	10	22	21	2.2	2.1
Løvenholm	10	18	17	1.8	1.7
Borris	4	8	8	2.0	2.0

Table 1. The number of Corpora lutea and embryos in sexually mature female roe deer shot during February and March 1970.

Tabel 1. Antallet af Corpora lutea og fostre hos kønsmodne råer nedlagt i februar–marts 1970.

Табл. 1. Число *Corpora lutea* и зародышей в достигнувших половой зрелости самках косули, убитых в феврале и марте 1970 г.

luteum in each ovary, whilst in 6 there were 2 Corpora lutea in one ovary and non in the other. In spite of this, all these females had one fawn in each uterine horn. A roe deer with triplets had 2+1 Corpora lutea, but the embryos occurred as 1+2, i.e. the left ovary had only one Corpus luteum but there were 2 embryos in the left uterine horn.

Løvenholm

Similar data from Løvenholm is given in Table 3. In contrast to the results from Kalø, Corpora lutea were more evenly

Date	Parent		Total no. of embryos	No. of embryos in right and left uterine horns	No. of Corpora lutea in right and left ovaries	Weight g.	Length mm	Sex
	age	dressed weight						
Dato	*Moderdyrets* *alder*	*opbr. vægt*	*Antal fostre i alt*	*Antal fostre i højre og venstre børh.*	*Antal Corpora lutea i højre og venstre børh.*	*Foster-vægt gr.*	*Foster-længde mm*	*Fosterets køn*
5/2	4	12.7	2	1 1	2 0	2.96 3.00	38 40	– –
6/2	>6	13.0	2	1 1	2 1	4.20 3.95	48 46	– –
7/2	4	14.5	2	1 1	2 0	3.17 3.71	41 42	– –
9/2	4	13.8	2	1 1	1 1	31.80 32.01	102 105	♂♂
11/2	6	13.7	2	1 1	1 1	39.47 39.08	108 108	♀♀
11/2	3	11.8	2	1 1	2 0	3.05 3.01	47 43	– –
21/3	5	12.5	2	1 1	2 0	390.00 360.00	232 238	♂♂
21/3	4	12.0	2	1 1	0 2	175.00 148.00	172 163	♀♂
22/3	6	12.5	2	1 1	0 2	Embryos dead Resorption begun		
22/3	>6	16.0	3	1 2	2 1	361.00 243.00 321.00	227 193 215	♂♀♀

Table 2. The distribution of Corpora lutea and embryos in female roe deer shot at Kalø during February and March 1970. The embryonic weight is also included.

Tabel 2. Fordelingen af Corpora lutea og fostre hos råer nedlagt på Kalø i februar–marts 1970. Skemaet viser samtidig fostervægten.

Табл. 2. Распределение *Corpora lutea* и зародышей в самках косули, убитых в Калё в феврале и марте 1970 г. Указан также и вес зародышей.

distributed in the ovaries of these animals. However, the conclusion is the same, whether both eggs come from the same or a different ovary, the embryos will position themselves one in each uterine horn.

Borris

Distribution in this material is given in Table 4. The deer which had 3 embryos had all 3 Corpora lutea in the right ovary, but only 1 embryo in the right uterine horn. However, the placenta of one of the

Date	Parent		Total no. of embryos	No. of embryos in right and left uterine horns	No. of Corpora lutea in right and left ovaries	Weight g.	Length mm	Sex
	age	dressed weight						
Dato	*Moderdyrets alder*	*Moderdyrets opbr. vægt*	*Antal fostre i alt*	*Antal fostre i højre og venstre børh.*	*Antal Corpora lutea i højre og venstre børh.*	*Foster-vægt gr.*	*Foster-længde mm*	*Fosterets køn*
12/2	2	12,0	2	1 1	2 0	39,00 37,54	108 109	♀♀
13/2	2	14,0	1	1 0	1 0	11,18	74	♀
13/2	6	14,0	2	1 1	1 1	10,75 11,25	73 74	♀♀
17/2	5	17,5	2	1 1	2 0	10,76 11,10	67 67	♂♂
17/2	3	15,0	2	1 1	1 1	73,74 76,86	135 133	♀♂
4/3	5	15,0	1	1 0	1 1	58,83	108	♀
7/3	2	11,0	1	1 0	1 0	26,00	87	♀
18/3	5	16,0	2	1 1	1 1	133,20 126,50	156 157	♂♀
19/3	>6	8,0	2	1 1	1 1	112,00 94,00	146 145	♂♀
						Embryos dead		
19/3	>6	12,5	2	1 1	1 1	83,0 82,0	131 131	♂♂

Table 3. The distribution of Corpora lutea and embryos in female roe deer shot at Løvenholm. The embryonic weight is also included.

Tabel 3. Fordelingen af Corpora lutea og fostre hos råer nedlagt på Løvenholm. Skemaet viser samtidig fostervægten.

Табл. 3. Распределение *Corpora lutea* и зародышей в самках косули, убитых в Лёвенхольме. Указан также и вес зародышей.

two embryos in the left uterine horn was attached to the right uterine horn.

Corpora lutea as an expression of the number of embryos

On the basis of the material presented here, it is evident that dissection of roe deer ovaries can lead to important information on the reproductive capacity of the species. 48 ovulations led to the development of 46 embryos.

In 2 females, the embryos were found dead. In the female from Kalø, the embryos had died early, probably around the beginning of February. The estimated length of the embryos was 50 mm, and resorption was advanced when found in this animal, and the Corpora lutea were of normal appearance.

The other female was from Løvenholm, and in this case the embryo had apparently died a few days before the female was shot. The parent was greatly undernourished, and it is presumed that the death of the embryo was due to the poor condition of the mother. In connection with this, it should be pointed out that the winter of 1969/1970 was a very long one according to Danish standards, with much snow.

Analysis of embryonic development

The weight of the embryos in relation to the date of shooting is given in Tables 2–4. Even though there is considerable variation in embryonic weight within each district, it appears to be fairly evident

Date	Parent		Total no. of embryos	No. of embryos in right and left uterine horns	No. of Corpora lutea in right and left ovaries	Weight g.	Length mm	Sex
	age	dressed weight						
Dato	*Moderdyrets alder*	*Moderdyrets opbr. vægt*	*Antal fostre i alt*	*Antal fostre i højre og venstre børh.*	*Antal Corpora lutea i højre og venstre børh.*	*Foster-vægt gr.*	*Foster-længde mm*	*Fostrets køn*
14/2	3	15,8	2	1 1	1 1	7,54 7,21	63 63	♀ ♀
25/2	4	16,5	2	1 1	1 1	7,89 6,90	59 58	♂ ♀
24/3	4	12,5	1	1 0	1 0	75,00	143	♂
1/4	4	16,0	3	1 2	3 0	232,00 176,00 238,00	189 175 194	♂ ♀ ♀

Table 4. The distribution of Corpora lutea and embryos in female roe deer shot at Borris, West Jutland. The embryonic weight is also included.

Tabel 4. Fordelingen af Corpora lutea og fostre hos råer nedlagt på Borris (Vestjylland). Skemaet viser samtidig fostervægten.

Табл. 4. Распределение *Corpora lutea* и зародышей в самках косули, убитых в Боррис, в Западной Ютландии. Указан также и вес зародышей.

that at any one time the embryos from the East Jutland animals are larger than those from West Jutland animals.

A statistical analysis has been performed on the data, to determine whether the observed differences in embryo weight are due to an actual difference in time, in embryonic development.

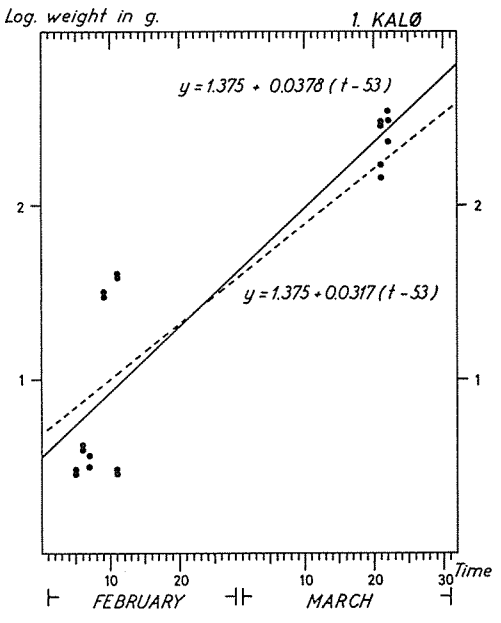
This is discussed in Appendix I, p. 18. As in much other biological material, the logarithm of embryo weight has been used on the basis that with sufficient nutrition, each cell will develop and divide more or less independently of the others, and that the number of cells and thus the weight each day will increase by a fixed percentage of the number of cells present.

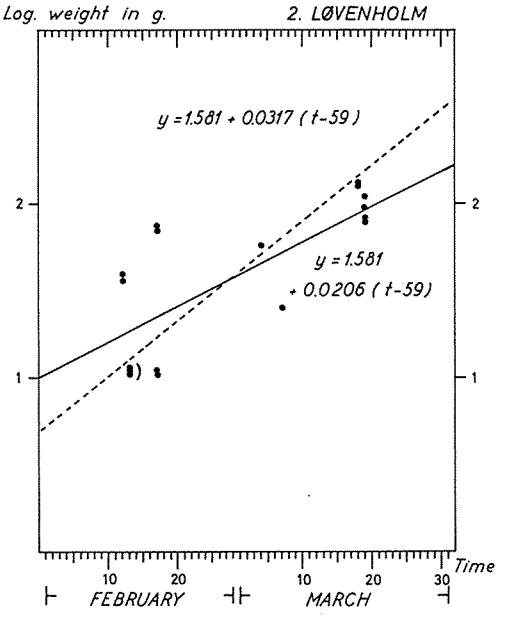
In Figs. 1–3, the logarithm of embryo weight in relation to the date of shooting is shown, for each of the three districts concerned. The corresponding regression lines are drawn in as continuous lines. The slope of a line is an expression of the rate of embryonic development, and as the slopes can here be considered identical, it is evident that the rate of embryonic development is similar in the three districts (broken lines in Figs. 1–3).

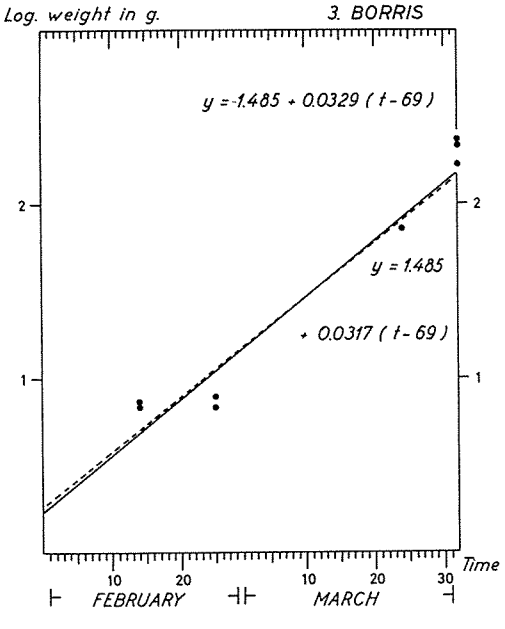
Similarly, the separation of the lines from each other is an expression of a difference in time of embryonic development. From the diagrams it is clear that the lines for Kalø and Løvenholm districts are very close; nor was any statistical difference discovered in the material from these areas (Appendix I, p. 18). The data on embryonic development for these districts are given in Fig. 4, and corresponding data for Borris district in Fig. 5. The regression lines which are drawn as continuous lines, show that embryos of deer from Borris will reach a given weight 13 days later than embryos of East Jutland deer.

Figs. 1–3. The development of embryos of roe deer killed or shot of 1) Kalø, 2) Løvenholm and 3) Borris, in February and March 1970. Regression lines represent the relationship between log. embryo weight and date of shooting of parent. Continuous lines are the estimated regression lines for each district alone. Broken lines are the regression lines of same slope which fit best. All estimates and tests of the regression model are based on the method of maximum likelihood. The rate of embryo development is the same in the 3 districts when the lines have identical slopes. To check which embryos are singles, twins or triplets see Table 2–4.
Note: The three embryos from February 13th (Fig. 2) are from two different does (the heaviest and lightest embryo are from the same doe, see table 3).

Fig. 1–3. Fosterudviklingen hos råer, nedlagt på 1) Kalø, 2) Løvenholm og 3) Borris i februar–marts 1970. Regressionslinierne angiver sammenhæng mellem log til fostervægten og skuddato. De fuldt optrukne linier er de estimerede regressionslinier for hver lokalitet for sig. De stiplede linier er de regressionslinier med samme hældning, der passer bedst. Alle regressionsmodellens beregninger og prøver er baseret på maximum likelihood metoden. At hældninger er identiske er udtryk for, at fosterudviklingen forløber parallelt i de tre områder.
Antal fostre hos den enkelte rå fremgår af tabel 2–4.
N.B.: De tre fostre fra den 13. februar (fig. 2) er fra to forskellige dyr (det tungeste og letteste foster fra det samme dyr, se tabel 3).

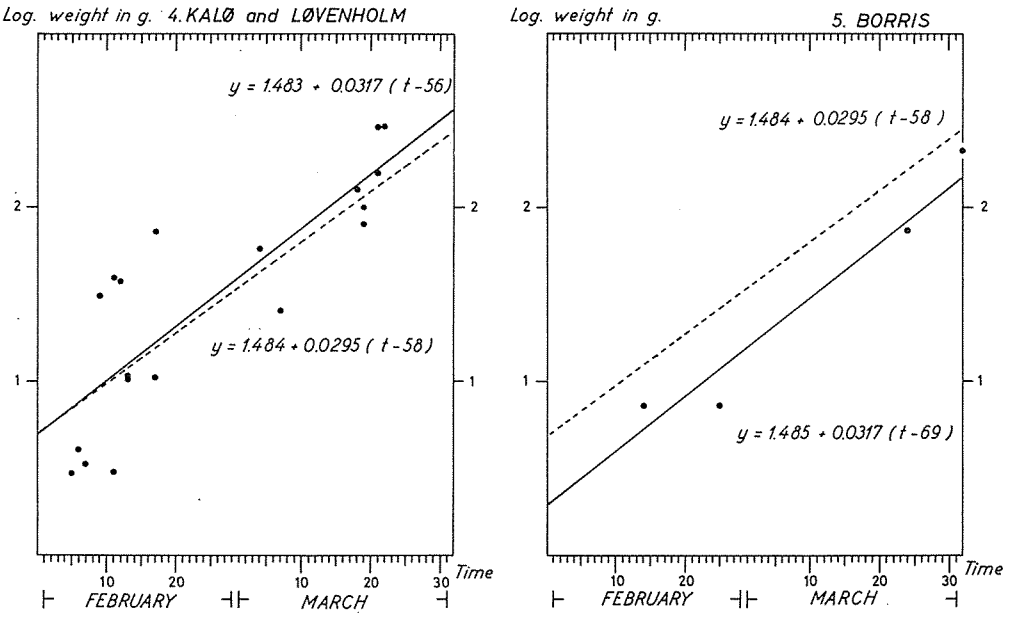






Фиг. 1–3. Развитие зародышей косуль, убитых в 1) Калё, 2) Лёвенхольме и 3) Боррис в феврале и марте 1970 г. Линии регрессии указывают соотношение между логарифмом веса зародыша и датой отстрела родительницы. Непрерывные линии представляют собой предполагаемые линии регрессии для каждого отдельного района. Пунктирные линии показывают наиболее подходящие из линий регрессии с одинаковым уклоном. Все вычисления и исследования на регрессивной модели основаны на способе максимального правдоподобия. Одинаковый уклон линий является выражением того, что развитие зародышей в трех районах происходит параллельно.

Примечание: Три зародыша от 13 февраля (фиг. 2) получены от двух разных животных (самый тяжелый и самый легкий из этих зародышей от одной и той же самки, см. табл. 3).



Figs. 4–5. Data from 4) Kalø and Løvenholm, East Jutland, and 5) Borris, West Jutland: Embryonic development in relation to time. The difference in time between the 2 parallel regression lines (continuous lines) is 13 days. The broken line in Figs. 4 and 5 is the same line, and represents the regression line which is obtained when the East and West Jutland data are grouped together.

Fig. 4–5. Data fra 4) Kalø og Løvenholm, Østjylland, og 5) Borris, Vestjylland: Fosterudvikling i forhold til tid. Den tidsmæssige forskydning mellem de to parallelle regressionslinier (fuldt optrukne) er 13 dage. Den stiplede linie på fig. 4 er den samme som på fig. 5 og angiver den fælles regressionslinie, man ville få, hvis Øst- og Vestjylland blev slået sammen til én gruppe.

Фиг. 4–5. Данные из 4) Калё и Лёвенхольма в Восточной Ютландии, и 5) из Боррис в Западной Ютландии: Эмбриональное развитие в зависимости от времени. Разница во времени между двумя параллельными линиями регрессии (непрерывными) составляет 13 суток. Пунктирные линии в Фиг. 4 и 5 тождественны; они представляют собой ту линию регрессии, которая получилась бы при объединении данных из Восточной и Западной Ютландии в одну группу.

THE TIME OF BIRTH OF FAWNS

From two districts, a series of observations of very young fawns exists, which can be used in determining the time of birth of fawns. The information was mainly gathered during ear-tagging of fawns in the summer months. Tagging was done at both Kalø and Borris.

With regard to the ageing of fawns, it was only possible to know the exact time of birth in those cases where the birth was observed directly, or where evidence of birth such as the placenta or amniotic fluid was found at the same place as the fawn. The majority of fawns were quite dry when found, and the age of these animals is then based on such criteria as the umbilical cord and the degree of mobility. The size of the fawns is an unsuitable indicator of age, as the weight of newly-born fawns varies from 900 to

1200 g. There is no reason to believe that errors in estimating age exceed more than a couple of days.

On an average, fawns are estimated as being four days old when being tagged. Normally fawns of more than 10–12 days of age do no longer remain still on the ground and are thus not easily tagged.

In Kalø district, the earliest date on which fawns were tagged was May 5, in 1967. These fawns were newly-born. The latest date was July 8 in 1970, and this fawn was estimated as being 8 days old.

However, within these limits, there is a strong tendency at Kalø for the majority of births to occur in the last week of May and the first week of June, although there may be some variation from year to year. The mean date for each year is given in Table 5. This date is calculated from the number of days on which tagging took place in a year, and the number of fawns tagged.

At Borris, the earliest and latest tagging dates were May 24 (1967, 1970), and July 11 (1961) respectively. The majority of fawns are born at Borris in the second and third week of June.

In Fig. 6 the number of fawns tagged at Kalø and Borris respectively is shown for the period 1958–1970. The mean date for tagging in these years is June 2 at Kalø and June 14 at Borris. It is thus clear that fawns from the West Jutland area of Borris are born about 2 weeks later than those from Kalø in East Jutland. This difference is in agreement with the difference in embryonic weights found previously.

Year *År*	*Kalø* No. of fawns tagged *Antal mærkede rålam*	*Kalø* Mean date *Middeldato*	*Borris* No. of fawns tagged *Antal mærkede rålam*	*Borris* Mean date *Middeldato*
1958	19	June 5	8	June 6
1959	28	May 28		
1960	20	May 29		
1961	5	May 17	9	June 13
1962	23	May 31	8	June 10
1963	25	June 9	14	June 15
1964	15	June 5	4	June 12
1965	9	June 8	5	June 18
1966	16	June 1	14	June 12
1967	15	June 3	25	June 11
1968	22	May 30	24	June 12
1969	13	June 4	27	June 19
1970	17	June 10	53	June 15
1958–70	227	June 2	191	June 14

Table 5. The mean date of tagging of roe deer fawns at Kalø and Borris districts, 1958–70.

Tabel 5. Middeltidspunktet for mærkning af rålam på Kalø og på Borris i perioden 1958–70.

Табл. 5. Средняя дата пометки молодых косуль в районах Калё и Боррис, 1958–70 г.

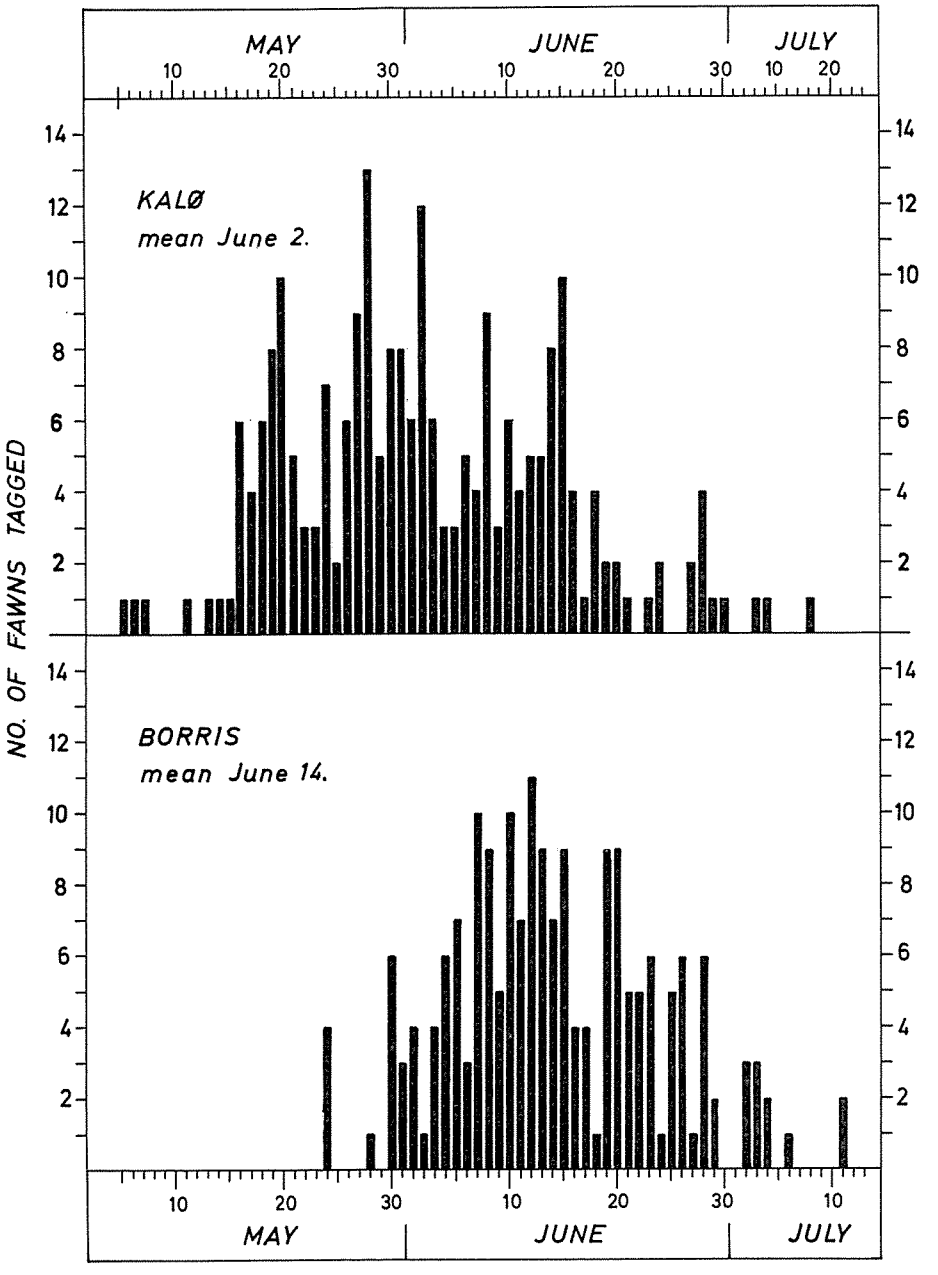


Fig. 6. Marking data for 227 roe deer fawns tagged at Kalø from 1958–1970, and 191 roe deer fawns tagged at Borris in 1958 and 1961–1970. Mean date Kalø 2nd June, Borris 14th June.

Fig. 6. Mærkningsdata for 227 rålam mærket på Kalø i årene 1959–1970, og 191 rålam mærket på Borris i 1958 og 1961–1970. Middeldato Kalø 2. juni, Borris 14. juni.

Фиг. 6. Даты пометки 227 молодых косуль, помеченных в Калё с 1958 по 1970 г., средняя дата 2 июня, и 191 молодой косули, помеченных в Боррис в 1958 г. и с 1961 по 1970 г., средняя дата 14 июня.

Discussion

CORPORA LUTEA

The significance of Corpora lutea cannot yet be understood in all its details. Studies of the mechanism of formation have especially been done with domestic sheep *(Ovis aries)* (ASDELL 1946), and in deer, with red deer *(Cervus elaphus)* (VALENTINCIC 1958), wapiti *(Cervus canadensis)* (MORRISON 1960) and white-tailed deer *(Odocoileus virginianus)* (CHEATUM 1949, HAUGEN & TRANGER 1962, TRANGER & HAUGEN 1965), as well as moose *(Alces alces)* (MARKGREN 1969). According to these authors, the formation of a Corpus luteum is such that the space which arises in the ovary is filled up with cells, which in the case of conception and pregnancy develop to a »yellow body«, the Corpus luteum of pregnancy. Studies on the white-tailed deer and the moose are of special interest here, as these species often give birth to more than one young, just as the roe deer does. In these studies, it appears that in pregnancy one Corpus luteum develops per ovum released, whether one or more ova is fertilised, although this is not stated explicitly. It must normally be accepted that the number of embryos will be less than or at most, as many as, the number of Corpora lutea. The presence of two embryos and one Corpus luteum in deer has only been found once in white-tailed deer (HAUGEN & TRANGER 1962), and once in roe deer (BORG 1970); these must be taken as cases of monovular twins.

MARKGREN (1969) describes the relationship between Corpora lutea of ovulation and Corpora lutea pregnancy in the moose. In the roe deer material described here, only Corpora lutea of pregnancy were found. This is to be expected when the long interval between ovulation in August and the time of investigation in February–March is considered. Similarly, in previous collections of ovaries during the shooting season (October 1 – December 31) in Denmark, only Corpora lutea of pregnancy were found. In some roe deer from this material, the ovaries had no Corpora lutea (ANDERSEN 1953). This could either be due to the animals concerned not having ovulated, or to the released ovum not having been fertilised. In material collected during the season or later in winter, there were no cases in which Corpora lutea of ovulation were found in Danish roe deer. Corpora lutea apparently disappear from the ovaries shortly after birth of the young. Confirming this is the fact that in one roe deer killed by a car on July 18, no Corpora lutea were found; the animal, which was tagged, had given birth to 2 fawns one month previously.

BORG (1970) gives the number of Corpora lutea of roe deer from Sweden. In these animals, an average of 2.5 Corpora lutea were found per female, whilst in the present material from Denmark only 2.0 Corpora lutea per female were found (Table 1). ANDERSEN (1953) also gives 2.0 as the average for all sexually mature females in the Kalø population in 1950. The higher average production of ova in roe deer from Sweden is explained by a larger number of animals having had 3 ovulations, just as cases of 4 ovulations per female have been noted from the Swedish material. MYRBERGET & RAIBY (1971) reports a case of 5 embryos in a female roe deer from Norway. The distribution of Corpora lutea per animal in Danish and Swedish roe deer is given in Appendix II, p. 19. The number of Corpora lutea per animal is significantly higher in Swedish animals, in all age-groups.

Concerning the relationship between the number of Corpora lutea and the number of embryos, in the material from Denmark 48 Corpora lutea gave rise to 46 embryos. For 179 roe deer from Sweden, BORG gives a »loss« of embryos of 9.4 %. The difference may be due to random variation, but if it is an actual difference it could well be due to the Swedish study being based on animals found dead, whereas the animals studies in Denmark were specially killed for examination. Also it was found that the loss increases with age in the Swedish material (see Appendix II, p. 22).

In spite of the fact that no visible embryos can be found in roe deer during their open season, it is possible to collect ovaries of roe deer in Denmark and establish a basis for estimates of the reproductive capacity of a population. In the material examined here, an embryo developed in 96 % of the cases of ovulation. The number of Corpora lutea can thus be considered as extremely indicative of the number of embryos.

THE AGE OF THE MOTHER AND THE NUMBER OF EMBRYOS

The data here is probably insufficient for an analysis of the relationship between the age of the mother animal and the number of embryos. Two-year old animals (the age at which reproduction first takes place) were only found among the individuals shot at Løvenholm. In spite of this, it is striking that two of the three females in this age-group only carried one embryo. It should also be stressed that these two females had only one Corpus luteum. The data indicates therefore that single births of fawns is mainly found in animals giving birth for the first time, i. e. two-year olds.

This conclusion, which is considered statistically in Appendix II p. 19, is also supported by information from other materials. ANDERSEN (1953) examined 46 females and found only 4 with one Corpus luteum each, and on the basis of tooth wear these 4 animals were all estimated to 1½ years of age. The other 42 animals, which each had either 2 or 3 Corpora lutea, consisted of 5 which were 1½ years old and 37 older than two years.

In roe deer shot at Kalø during 1955–1968, only two cases of a single Corpus luteum per animal were found in 46 females, and one animal had no Corpus luteum at all. The material consisted of 9 1½ year-olds, amongst which the animal with none and one of the animals with one Corpus luteum occurred. The remaining 37 animals 2½ years old or more, contained the other animal with only one Corpus luteum.

Similar relationships were found by BORG (1970) in Swedish roe deer, although differences here seemed less defined.

EMBRYONIC DEVELOPMENT AND THE TIME OF BIRTH

Although the difference in the stage of development of embryos found in animals from East and West Jutland is barely significant, it can be considered as a real difference when considered together with the similar difference in the time of birth.

In general, spring in western Denmark occurs considerably later than in the eastern regions of the country. The difference is so stiking that it can be seen in the grass growth during a drive across the country, but in spite of this, there do not appear to exist any studies in agricultural or plant cultivation literature, con-

cerning the beginning of plant growth in different regions.

The extent to which the difference in embryonic development can be traced to differences in the period of heat or differences in the start of embryonic development cannot be determined. At Kalø, all observations of copulation occurred between August 1 and August 22, but as yet no similar information from Borris has been obtained.

Summary

During the winter 1970, 24 pregnant roe deer *(Capreolus capreolus)* were shot in three different districts of Denmark, to enable a study of the relationship between the number of Corpora lutea of pregnancy and the resulting number of embryos to be made.

No visible embryos can be found in roe deer shot during the open season in Denmark (October 1 – December 31), due to the delayed implantation of roe deer. However, it is often only possible to obtain larger amounts of material in the shooting season, and it is then necessary to base studies of the reproductive capacity of the species on ovaries collected. With this in mind, it is of considerable importance to know the relationship between the number of Corpora lutea and the number of embryos.

The 24 deer shot contained altogether 48 Corpora lutea, and 46 embryos were found. This corresponds to an embryo developing from 96 % of the ova released. In collecting the material, a note was made of the left and right ovaries, together with the position of the embryos in the uterus. It was found that in females with two embryos, there was always an embryo in each horn of the uterus, whether both ova came from the same ovary or one from each. A female which had produced 3 ova in the right ovary had one embryo in the right uterine horn and two in the left. Embryos position themselves at the greatest possible distance from each other, without regard to the ovary in which the ova were produced.

The development of the embryos proved to be similar in the three districts. However, there was a delay of 13 days in development between embryos in animals from East and West Jutland (spaced 125 km apart); embryos from animals in West Jutland reach a given weight 13 days later than those from animals in East Jutland. A study of the time of birth of fawns, based on data obtained while marking very young fawns, confirmed that fawns are born about two weeks later in West Jutland. At Kalø in East Jutland the majority of fawns are born in the last week of May and the first week of June. At Borris in West Jutland the majority are born in the second and third week of June.

Resumé

En undersøgelse over Corpora lutea, fosterudvikling og fødselstidspunkt hos danske rådyr *(Capreolus capreolus)*.

Med henblik på at konstatere sammenhængen mellem antallet af gule legemer (Corpora lutea) og antallet af fostre hos danske rådyr *(Capreolus capreolus)* blev der i vinteren 1970 på tre forskellige distrikter nedlagt 24 drægtige råer.

I Danmark vil der inden for jagttiden (1. oktober – 31. december) ikke være synlige fostre til stede grundet rådyrets forlængede drægtighed. Da det imidlertid ofte kun er muligt at indsamle større mængder materiale i jagttiden, er man ofte henvist til at basere undersøgelse vedrørende artens formeringskapacitet på indsamling af ovarier. På denne baggrund er det af væsentlig betydning at kende forholdet mellem antallet af gule legemer og antallet af fostre.

De 24 nedlagte råer havde tilsammen 48 gule legemer, og der fandtes 46 fostre. Dette svarer til, at der var udviklet et foster for 96 % af de løsnede ægs vedkommende. Der blev ved materialeindsamlingen holdt rede på højre og venstre ovarium, ligesom der blev taget notat om fostrenes placering i uterus. Undersøgelsen viste, at hos råer med to fostre fandtes til stadighed et foster i hvert børhorn, hvad enten begge æg kom fra samme ovarium, eller de kom fra hver sit. En rå, der havde produceret tre æg i højre ovarium, havde 1 foster i højre børhorn og to i venstre. Uden hensyn til, hvilket ovarie æggene kommer fra, vil fostrene anbringe sig med størst mulig afstand.

Fosterudviklingen viste sig at forløbe parallelt på de tre distrikter. Derimod fandtes en tidsmæssig forskydning på 13 dage mellem fostre hos råer fra Østjylland og råer fra Vestjylland. Først 13 dage senere vil fostre fra Vestjylland have opnået en given vægt i forhold til de østjyske. En undersøgelse af fødselstidspunkterne baseret på oplysning om data for mærkning af små rålam viste i overensstemmelse hermed, at lammene fødes ca. to uger senere i Vestjylland. På Kalø i Østjylland fødes hovedparten af lammene den sidste uge i maj og den første uge i juni. På Borris i Vestjylland fødes hovedparten anden og tredje uge af juni.

РЕЗЮМЕ

Исследование *Corpora lutea* эмбрионального развития и времени родов у косуль *(Capreolus capreolus)* в Дании

В течение зимы 1970 г., в трех разных районах Дании было убито 24 беременных косуль *(Capreolus capreolus)* с целью получения возможности изучения отношения между числом *Corpora lutea* беременности и получающимся в результате их числом зародышей.

Вследствие удлиненной беременности косуль, в убитых в течение сезона охоты в Дании (с 1 октября по 31 декабря) косулях видимых зародышей обнаружить невозможно. Однако, значительное количество материала обычно возможно собрать только в течение сезона охоты, поэтому часто является необходимым основывать исследования воспроизводительной способности этого вида на собранных яичниках. В виду этого, чрезвычайно важно знать соотношение числа *Corpora lutea* и числа зародышей.

Убитые 24 косули содержали общим

числом 48 *Corpora lutea*, и было обнаружено 46 зародышей. Это соответствует образованию зародышей из 96% отделившихся яиц. При сборке материала делались отметки о правых и левых яичниках, а также о расположении зародышей в матке. Выяснилось, что у самок с двумя зародышами всегда было по одному зародышу в каждом рогу матки, невзирая на то, произошли ли оба яйца из одного и того же, или по одному из каждого рога матки. Одна самка, которая в правом яичнике произвела 3 яйца, имела одного зародыша в правом рогу матки, и двух в левом.

Зародыши размещаются на наибольшем возможном расстоянии один от другого, независимо от того, в каком из яичников были произведены яйца.

Было выяснено, что зародыши во всех районах развиваются одинаково. Однако, между развитием зародышей в животных из Восточной и Западной Ютландии была разница в 13 суток; в животных из Западной Ютландии, зародыши достигают взятого веса на 13 суток позднее зародышей в животных из Восточной Ютландии. Исследования времени рождения молодых косуль, основанные на данных, полученных способом пометки очень молодых особей, подтвердили что в Западной Ютландии молодые рождаются прибл. на 2 недели позднее. В Калё, в Восточной Ютландии, большинство молодых косуль рождается в последней неделе мая и первой неделе июня. В Боррис, в Западной Ютландии, большинство их рождается на второй и третьей неделях июня.

Literature

Andersen, Johs., 1953: Analysis of a Danish Roe-Deer population. – Danish Reveiw of Game Biology 2, pp. 127–155.

Asdell, S. A., 1946: Patterns of mammalian reproduction. – Comstock Pub. Co. Ithaca.

Borg, Karl, 1970: On mortality and reproduction of Roe Deer in Sweden during the period 1948–1969. – Swedish Wildlife Vol. 7 No. 2, pp. 121–149.

Cheatum, E. L., 1949: The Use of Corpora Lutea for Determining Ovulation Incidence and Variations in the Fertility of White-Tailed Deer. – The Cornell Veterinarian 39, pp. 282–291.

Haugen, A. O. & Tranger, D. L., 1962: Ovarian Analysis for Data on Corpora Lutea Changes in White-Tailed Deer. – Proc. Iowa Academy of Science 69, pp. 231–238.

Markgren, Gunnar, 1969: Reproduction of Moose in Sweden. – Viltrevy Vol. 6 No. 3, pp. 127–299.

Morrison, John A., 1960: Ovarian Characteristics in Elk of Known Breeding History. – J. Wildl. Mgmt. Vol. 24, No. 3, pp. 297–307.

Myrberget, Svein & Raiby, Milton, 1971: Capreolus capreolus with 5 embryos. – Fauna, Norsk Zoologisk Forenings Tidsskrift, nr. 1, p. 67.

Tranger, D. L. & Haugen, A. O., 1965: Corpora Lutea Variations of White-tailed Deer. – J. Wildl. Mgmt. Vol. 29, No. 3, pp. 487–492.

Valentincic, Stane I., 1958: Beitrag zur Kenntnis der Reproduktionserscheinungen beim Rotwild. – Z. Jagdwissenschaft Bd. 4, 3, pp. 105–130.

Appendix I

EMBRYONIC DEVELOPMENT

Statistical analysis has been performed on the material to investigate the degree to which the difference in the weights of embryos of animals from East and West Jutland is a result of a real separation of the embryo development in time.

A description of the results follows. As mentioned previously (p. 8), the logarithm of the embryo weight will be considered as a function of time. It is reasonable to assume that the logarithm of embryo weight is composed of two components, one which represents variation in embryo development from female to female, and a lesser component representing variation in embryos of the same female. (The variation in the weights of embryos of the same litter is much less than the variation from female to female; this is evident from Figs. 1–3).

The variance in litters of triplets and in the dead pair of embryos proved to be larger than the variance of the rest of the twin-pairs, and it is thus most suitable to consider the 9 + 10 + 4 = 23 average values of the logarithm of embryo weight as the original observations. By taking the average, embryos from females with only one embryo will thus have the same influence as the averages of two or three embryo weights. However, single observations do not differ from double or triple observations, as is evident from Figs. 1–3, and thus require no special consideration.

The data are thus:

Kalø		Løvenholm		Borris	
X_i	Y_i	X_i	Y_i	X_i	Y_i
36	0.4742	43	1.5826	45	0.8677
37	0.6100	44	1.0484	56	0.8680
38	0.5353	44	1.0413	83	1.8751
40	1.5039	48	1.0386	91	2.3292
42	1.5942	48	1.8767		
42	0.4814	63	1.7696		
80	2.4878	66	1.4150		
80	2.2066	77	2.1133		
81	2.4832	78	2.0112		
		78	1.9165		

(X_i = no. of day in year, Y_i = average per litter of logarithm of embryo weight).

(*X_i = dag i året, Y_i = gennemsnit af log af fostervægt*).

Choosing the model that the logarithm of embryo weight is a linear function of time, in each district it is seen that this model describes the lines in Figs. 1–3 quite well, and a test based on 2 roe deer being shot on certain days gave no grounds for revising the model. Thus there are three regression lines: $\alpha_k + \beta_k \cdot t$ where k = 1, 2, 3 represent the three districts, and t is time. Then,

Log. embryo weight at time t and district k is:

$$\alpha_k + \beta_k \cdot t$$

The three estimated lines are drawn as continuous lines in Figs. 1–3. (All estimators and tests are based on the method of maximum likelihood).

Next, the slopes (β_k) of the regression lines are tested, to see if the lines can be considered as being parallel. If this is the case, then embryo development is parallel, i. e. the embryos of animals in the three districts grow at the same rate. Of course development may begin at different times, which is expressed by the values of α_k being different.

The test value obtained is 1.59, which lies between the 70 % and 90 % fractiles of the v^2 distribution with (2,17) degrees of freedom (v^2 is also known as Snedecor's F-distribution and $z = \frac{1}{2} \log v^2$ is Fisher's z-distribution). The slopes can thus be considered to be the same, and the three estimated parallel lines are drawn as broken lines in Figs. 1–3.

It is clear from the diagrams that the lines for Kalø and Løvenholm are very close to each other. However, the line from Borris is somewhat lower, which corresponds to a later development of embryos. It is thus reasonable to test whether $\alpha_1 = \alpha_2$, i. e. whether the results from the two areas of East Jutland are the same. The test value obtained is 0.0089 in the v^2 distribution with (1,19) degrees of freedom, and not at all significant. Thus no difference could be found between the material from Kalø and Løvenholm.

The estimate $\beta = 0.0317$

The estimate α (Kalø and Løvenholm) = 1.483

The estimate α_3 (Borris) = 1.485.

The material from Kalø and Løvenholm is given in Fig. 4, and the material from Borris in Fig. 5.

The regression lines are drawn as continuous lines, and are respectively:

$$y = 1.483 + 0.0317\ (t - 56)$$

and $$y = 1.485 + 0.0317\ (t - 69)$$

Thus there is a difference in time of 13 days between the lines.

Next, a test is performed to see if these two lines are identical. Taking the hypothesis that they are coincident, the test value obtained is 4.097 in the v^2 distribution with (1,20) degrees of freedom.

The value of the 90 % fractile is 2.97, and of the 95 % fractile 4.35; the test value thus approaches significance. However, it hardly justifies drawing the conclusion that the lines are different, when only the information on the logarithm of embryo weight is considered. But if it is related to the fact that the birth of fawns takes place just under two weeks later in West Jutland than in East Jutland (p. 10–12), then the difference of 13 days found between the regression lines can be considered as significant.

It is thus possible to conclude:

1. Embryo development is concurrent at Kalø and Løvenholm.
2. Embryo development proceeds at the same rate in East and West Jutland.
3. Embryo development in West Jutland is 13 days later than in East Jutland. This estimate is based only on the data concerning embryo weight, and not on the time of birth.

Appendix II

THE DISTRIBUTION OF CORPORA LUTEA AND THE LOSS OF EMBRYOS IN RELATION TO THE AGE OF THE MOTHER

The purpose of this Appendix is partly to examine whether the number of Corpora lutea is dependent on the age of an animal, and partly to examine whether the loss of embryos, i. e. the difference between the number of Corpora lutea produced and the number of embryos, increases with increasing age of the parent. Related to the first purpose is the question of whether females giving birth for the first time produce fewer Corpora lutea than older animals. A description of the statistical investigation of these relationships follows. At the same time, a comparison is made between the present material from Denmark and the material published by BORG (1970) on roe deer in Sweden.

The number of Corpora lutea in relation to the age of the mother

The extent to which the number of Corpora lutea is dependent on the age of the mother can be investigated using both the present material and some data from other studies (cf. p. 14). The data are found in Tables 6–10 and Table 12.

The age of 1–2 years means that the deer was shot during the period when it was, or could have been, pregnant for the first time (from about August to the following July). Although the age of an animal at the time of death may lie between 1 and 2 years, all animals will have the same age with regard to the time when fertilisation occurs. Animals of more than two years are placed in a single group, as it was not possible to show any difference between each year-class in this group, either in material from Denmark or Sweden.

An examination of Tables 7, 9 and 10 suggests that 1–2 year old animals produce fewer Corpora lutea. Amongst these animals there are no cases with 3 Corpora lutea, but many with only 1.

The following tests are based on the assumption that if the two rows in a $2 \times k$ table are considered as independent multinomial distributions, then under certain conditions the contents of the table will be described by the $(k - 1)$ dimensional hypergeometric distribution. A test is then performed to determine whether the probability parameters in the multinomial distributions are the same, which would indicate that there is the same average number of Corpora lutea per animal for the animals in the rows considered.

The test used is specifically sensitive for the kind of difference that appears to be present, that is, that young animals have on average fewer Corpora lutea than older ones. The test procedure used is described in detail in ELLEN & HELGE CHRISTENSEN: »Hypergeometriske fordelinger og kontingenstabeller«, Studenterseminar af 23.4.1971, Matematisk Institut, Århus Universitet.

If the three sets of material (Table 7, 9 and 10) in which 1–2 year old animals occur are considered independently, Table 7 has a test probability of about 7 %. This is scarcely significant and is no doubt due to there being only 3 1–2 year old roe deer.

Table 9 gives a test probability of 0.7 %, and Table 10 of 0.07 %. In both these sets of material there is thus a clearly significant difference between 1-2 year old roe deer and those of more than 2 years old.

It is reasonable to combine the data of Tables

6–10 into one table, Table 11. (The test of whether this is permissible was nonsignificant). In the combined Danish material there is a strongly significant difference, the test probality p being about 1/10000 %.

It is thus evident that roe deer females of 1-2 years of age and pregnant for the first time have on average fewer Corpora lutea than older females.

BORG (1970) gives similar material from roe deer from Sweden (Table 12).

When the data from Sweden and Denmark are compared, there appear to be more Corpora lutea per individual, in animals from Sweden.

If the distribution of the number of Corpora lutea amongst individuals of more than 2 years old in Table 12 is examined, it is found that the distribution is the same in the three groups. If the distribution of the number of Corpora lutea of animals 1–2 years old is compared to that of older roe deer, no significant difference can be determined in roe deer from Sweden (p = 18 %, using two-sided probability).

If the 1–2 year old roe deer from Sweden and Denmark are compared, a very strong significance of less than 1/10000 % is found. For the animals of 2 years or more, a significance of the same order is obtained.

If the 1–2 year olds from Sweden are compared with those of more than 2 years from Denmark, 1/100 % is obtained, thus a very significant difference is still present.

To conclude, the following arrangement of the average number of Corpora lutea per individual can be presented:

Denmark		Sweden	
1–2 yrs.	more than 2 yrs.	1–2 yrs.	more than 2 yrs.
1.6	2.1	2.4	2.5
		2.5	

Age *Alder*	No. of Corpora lutea *Antal Corpora lutea* 1	2	3	Total no. of roe deer *Antal råer*
1–2 yrs. *1–2 år*	–	–	–	–
more than 2 yrs. *ældre end 2 år*	–	8	2	10
				10

Table 6. Roe deer shot at Kalø in February and March 1971.

Tabel 6. Råer, nedlagt på Kalø i februar–marts 1971.

Табл. 6. Косули, застреленные в Калё в феврале и марте 1971 г.

Age *Alder*	No. of Corpora lutea *Antal Corpora lutea* 1	2	3	Total no. of roe deer *Antal råer*
1–2 yrs. *1–2 år*	2	1	–	3
more than 2 yrs. *ældre end 2 år*	–	7	–	7
				10

Table 7. Roe deer shot at Løvenholm in February and March 1971.

Tabel 7. Råer, nedlagt på Løvenholm i februar–marts 1971.

Табл. Косули, застреленные в Лёвенхольме в феврале и марте 1971 г.

Age *Alder*	No. of Corpora lutea *Antal Corpora lutea* 1	2	3	Total no. of roe deer *Antal råer*
1–2 yrs. *1–2 år*	–	–	–	–
more than 2 yrs. *ældre end 2 år*	1	4	2	7
				7

Table 8. Roe deer which died at Borris. The material from 1971 (p. 7) has been supplemented with 3 roe deer which died after March 1 1971.

Tabel 8. Råer, omkommet på Borris. Materialet fra 1971 (side 7) er suppleret med 3 råer, omkommet i tiden efter 1. marts 1971.

Табл. 8. Косули, погибшие в Боррис. Материал 1971 г. (стр. 7) дополнен тремя косулями, умершими после 1-го марта 1971 г.

Age *Alder*	No. of Corpora lutea *Antal Corpora lutea* 1	2	3	Total no. of roe deer *Antal råer*
1–2 yrs. *1–2 år*	4	5	–	9
more than 2 yrs. *ældre end 2 år*	–	34	3	37
				46

Table 10. Roe deer shot at Kalø in 1950 (Andersen 1953).

Tabel 10. Råer, nedlagt på Kalø i 1950 (Andersen *1953).*

Табл. 10. Косули, убитые в Калё в 1950 г. (Andersen 1953).

Age *Alder*	No. of Corpora lutea *Antal Corpora lutea* 0	1	2	3	Total no. of roe deer *Antal råer*
1–2 yrs. *1–2 år*	1	1	7	–	9
more than 2 yrs. *ældre end 2 år*	–	1	33	3	37
					46

Table 9. Roe deer shot at Kalø during 1955–1968.

Tabel 9. Råer, nedlagt på Kalø i tiden 1955–1968.

Табл. 9. Косули, убитые в Калё с 1955 по 1968 г.

Age *Alder*	No. of Corpora lutea *Antal Corpora lutea* 0	1	2	3	Total no. of roe deer *Antal råer*
1–2 yrs. *1–2 år*	1	7	13	–	21
more than 2 yrs. *ældre end 2 år*	–	2	86	10	98
					119

Table 11. The distribution of the number of Corpora lutea per individual in 119 roe deer from Denmark.

Tabel 11. Fordelingen af antal Corpora lutea pr. rå blandt 119 danske råer.

Табл. 11. Распределение числа *Corpora lutea* для каждой особи по 119 датским косулям.

Age *Alder*	No. of Corpora lutea *Antal Corpora lutea*				No. of roe deer *Antal råer*
	1	2	3	4	
yrs. *år*					
1–2	1	19	14	–	34
2–5	3	33	45	1	82
5–7	3	14	14	4	35
7	1	12	14	1	28
					179

Table 12. The distribution of the number of Corpora lutea per individual in 179 roe deer from Sweden (BORG 1970).

Tabel 12. Fordelingen af antal Corpora lutea pr. rå blandt 179 svenske råer (BORG 1970).

Табл. 12. Распределение числа *Corpora lutea* для каждой особи по 179 косулям в Швеции (BORG 1970).

Age *Alder* yrs. *år*	No. of Corpora lutea *Antal Corpora lutea*	No. of embryos *Antal fostre*	Loss *Tab*
1–2	81	76	5
2–5	208	196	12
5–7	89	79	10
>7	71	56	15
	449	407	42

Table 13. The number of embryos and Corpora lutea in 179 roe deer from Sweden (BORG 1970).

Tabel 13. Forholdet mellem antal fostre og antal Corpora lutea blandt svenske råer (BORG 1970).

Табл. 13. Соотношение между числом зародышей и числом *Corpora lutea* у 179 косуль в Швеции (BORG 1970).

Loss of embryos

Age *Alder* yrs. *år*	No. of Corpora lutea *Antal Corpora lutea*	No. of embryos *Antal fostre*	Loss *Tab*
1–2	4	4	0
2–3	6	6	0
3–4	14	14	0
4–5	8	7	1
5–6	6	6	0
>6	10	9	1
	48	46	2

Table 14. The number of embryos and the number of Corpora lutea in 24 roe deer from Denmark, shot during February and March 1970.

Tabel 14. Forholdet mellem antal fostre og antal Corpora lutea blandt 24 danske råer, nedlagt februar–marts 1970.

Табл. 14. Соотношение между числом зародышей и числом *Corpora lutea* у 24 косуль в Дании, убитых в феврале–марте 1970 г.

BORG (1970) describes a loss of embryos in relation to Corpora lutea, which is apparently twice the loss determined in the material from Denmark.

In the material from Sweden comprising 449 Corpora lutea from animals found dead, the loss of embryos increases with age (test probability = 1/100 %).

The material from Denmark, consisting of 48 Corpora lutea from shot roe deer, was insufficient to establish whether or not this was also the case in Denmark.

A greater loss in the oldest group from Sweden exists than in the total material from Denmark (p = 1 %), but no difference was found between the same age groups in the material from Sweden and Denmark.

The difference between the loss of 2/48 = 4 % in the material from Denmark and the loss of 42/449 = 9 % in that from Sweden should probably be ascripted to chance. However, it could be due to the fact that the Swedish deer had been found dead.

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