BIOLOGY AND MANAGEMENT OF ROE-DEER
IN DENMARK

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The Danish roe-deer population is quite considerable, and so is the importance of roe-deer as a game species. These simple facts form the background of the research on roe-deer biology which is being carried out at the Game Research Station at Kalø.

The area of Denmark is about 40,000 sq. km; the country is densely populated, and agriculture is the dominant feature of the countryside since about 75 per cent of the country is intensively cultivated arable land; forested areas contribute about 10 per cent, mostly as small woods containing a mixture of conifers and broad-leaved trees; this is especially true of the eastern part of the country.

According to the official bag-record about 25,000 roe-deer are killed each year (1957 : 27,600).

The country has more than 100,000 sportsmen, and the landowner hold the right to shoot all game that may occur on their land irrespective of acreage. The owner can reserve the shooting rights or sell them to others if he so desires. Thus we have no area limits, unlike some countries, nor has a bag limit been enforced upon the sportsmen as e.g. in the U.S.A.

The open season for roe-deer has considerable extent, for bucks from 15 May to 15 July and for bucks and does from 1 Oct. to 31 Dec.

Theoretically it would seem possible to eradicate roe-deer in Denmark without violating regulations but the attitude of sportsmen is such that the Roe-deer is in no danger of becoming extinct.

From the point of view of national economy the Roe-deer is to some extent a liability since it causes no small amount of damage to young forest plantings and since rather costly countermeasures are necessary to keep the
Fig. 1. — No. of roe-deer killed per 100 ha. in Danish provinces in 1957.
damage within bounds. The general attitude towards the Roe-deer is determined by its damage, by its great importance as a game species, and by ethic considerations—after all it is a natural element in our fauna.

There is full justification for shooting this large number of roe-deer each year since the annual production is in excess of the number bagged.

During the last 50-75 years the government has encouraged people to increase the forested acreage; this policy may be partly responsible for the steadily increasing roe-deer population—and bag.

HABITAT OF ROE-DEER

The Roe-deer shows a preference for woods and plantations, and it would seem that the density reaches its maximum in small woods surrounded by arable land.

The possibility for reaching cover is an important factor in determining the habitat preference since roe-deer spend their periods of rest in dense plantings; their first reaction to danger is also to seek cover in wooded areas. On the other hand the size of the wood appears to be little importance, the length of the woodland margin being more decisive. There are good indications that soil fertility enters the picture in as much as woods in fertile districts produce more roe-deer than in less fertile ones. This is brought out clearly by the map: in the fertile southeastern parts of the country the annual bag is three times greater than in sandy W. Jutland.

FOOD

Detailed information on the food of roe-deer is not at hand but they make frequent visits to the arable land just outside their home forest, and agricultural crops occupy a prominent position in roe-deer diet (especially grass, clover, mangold, swede, and corn crops in the sprouting stage); woody plants may be of some importance, young twigs and shoots of ash, oak and beech are often eaten and to some extent also spruce and pine.

It may be worth mentioning here that semi-wild roe-deer kept in a 1 ha deer park consume 600 g of oat or barley + $\frac{1}{2}$-1 kg of swedes daily during the winter, i.e. upward of 1 int. feed unit, rather much compared to the food consumption of cattle.
ENEMIES

There are no natural enemies of adult roe-deer in Denmark but in rare cases they may become attacked by large domestic dogs. Foxes are able to kill the newborn fawn but it seems a rare event that they do so, although on the other hand the large population of foxes (the 1957 bag was 40,000) occurs in the same habitat as the roe-deer.

BEHAVIOUR

It has already been mentioned that, ordinarily, the Roe-deer occurs in woodland but where they occur on large stretches of heathland—now a rarity in Denmark—they spend all the time in the open; great authorities on roe-deer biology have even expressed the opinion that two different behavioural types of roe-deer occur, wood—and field-deer, the latter type spending all the time in the open only seeking the forest when they are being hunted.

The Kalø herd certainly belongs to the former type since the deer are rarely seen in the fields during daytime but a change of behaviour has apparently taken place. In 1950 the entire herd of roe-deer was removed and 24 new animals were introduced from an estate in Funen where deer were commonly seen in the fields during daytime; we were surprised to see that they showed the same behaviour after removal to Kalø. However, after two or three months, their habits had changed, and they had become woodland deer as their predecessors.

POPULATION ESTIMATES

The size of the Kalø roe-deer herd is known with considerable accuracy; during autumn and winter it counts appr. 70 deer per 100 ha of woodland. In 1950 it was decided to remove the entire herd during a number of shoots; highly experienced local forestry and game personnel had estimated the herd to count 70 deer, the estimate being based on direct observation. After endless trouble and the expenditure of immense labour we succeeded in shooting 213 deer, three times more than we had expected to be present. The fact that we had grossly underestimated the herd-size deserves attention, and I shall say more about it later on.

The new herd of 24 deer introduced after the shoot
(presumably supplemented by odd immigrants) expanded so rapidly that in 1955 we estimated the herd to have reached its former size.

Fig. 2. — Map of the Danish Research Farm Kalö. The area is slightly less than 1000 ha. The two woods Hestehaven (176 ha) and Ringelmosen (164 ha) are surrounded by intensively farmed land. (After Johs. Andersen 1953).

In 1956 and in all subsequent winters, except in 1957, we trapped a large number of roe-deer; the trapping took place in January-February, all animals trapped were given a conspicuous mark and released; during this last winter (1960) no less than 95 individuals were trapped in one of the two woods at Kalö. Observation and counts
of marked deer have enabled us to estimate the herd size with great accuracy; all details of this project are given in my paper *Roe-deer census and population analysis by means of modified marking-release technique* published 1960 in *The British Ecological Society Symposium Volume*.

The trapping experiment is conducted in one wood only (Ringelmosen) which in 1950 held 117 deer, and it appears that today it has a herd of about 120 (during autumn-winter) while there is reason to believe that the other wood contributes nearly the same number but were we to give an estimate of herd size on the basis of direct observation and apparent abundance of roe-deer we were bound to arrive at an underestimate once more, the number of roe-deer one notices in the woods bears little relation to the number actually there.

Roe-deer, and several other game species, possess great ability to escape being seen (and shot); during the shoot we were forced to accept this as a fact, and another example can be mentioned here:

In February 1956, 38 roe-deer were trapped in «Ringelmosen»; all adults received a collar studded with red buttons and fawns, now 7-8 months old, one with white buttons; the deer were released immediately after marking.

Afterwards six persons from among the game personnel—including myself—carried through a «shoot» with binoculars and notebook. The wood consists partly of open beechwood and partly of spruce thickets. The deer hide in these thickets, two men combed the thickets with trained dogs while the remaining four took up posts outside. In the course of some hours all thickets had been searched and a total of 11 deer, among which were 4 marked, had been seen. The less experienced helpers were inclined to think that the remaining 34 deer had left the wood but this was not the case, as was confirmed by later observations and by the fact that most of the missing deer were later shot or trapped in the very same wood.

Although it remains somewhat puzzling that so few roe-deer are seen it is important to realize this situation. All population estimates based on direct observation, line counts, track counts etc., cannot be accepted at face value, they are bound to be underestimates and must be replaced by more efficient techniques.

It is worth mentioning here that a few other Danish estates have attempted to remove the local herds and introduce others from outside; invariably this apparently simple process of shooting all roe-deer proved extremely
laborious. In 1953 a Zealand landowner decided to remove his roe-deer herd from a 200 ha wood on a small peninsula. He kindly offered us all material resulting from the herd. During our talks I asked how the shoot was going to take place and how many deer the herd counted. The answer was that about 60 roe-deer were present and that it had been planned to kill them during one or two battues. I tried to make it clear that the herd could not be killed off unless 5-6 men worked hard throughout the autumn—but without avail. Some months later I received a letter from the landowner who now regretted that he had not taken our advice, 120 deer had already been killed but a large herd was still left.

Similar cases are known for hare and red deer, one example may suffice.

A large but relatively young herd of red deer lives in the dune areas in SW Jutland where it inhabits the young pine plantations. The area in question covers 10,000 ha, it consists of 10 plantations with heathland or arable land in between. The plantations and all shooting is supervised by a forest director and 10 rangers. The Red deer cause considerable damage in the surrounding fields (but not much in the plantations since the trees are of little value); in spite of economical compensation the farmers have complained of the damage, and they have claimed that altered regulations be made enabling the eradication of red deer in this district; the Ministry of Agriculture with whom the complaint was lodged asked us to carry through a detailed investigation while at the same time a heavier shooting pressure was used in the plantations.

The herd was estimated to count 150 deer but the director was aware of the fact that the estimate might be too low. With assistance from the Game Research Station 140 deer were shot during autumn and winter 1954-55 and another 40 deer were killed outside the plantations, i.e. a total of 180; the game keeper of the plantations and our hunter independently made estimates of the number of deer still present, they both arrived at a figure of about 250 red deer which would imply that the autumn population must have been of the order of 400.

During the subsequent three years about the same number was killed annually, and not until then was a decline noticeable. The last estimate received from the forest director dates from January 1960, and it mentions about 300 (although with the usual reservations).

I am a firm believer that the explanation why animal populations show such pronounced tendencies to survive
must be sought for in the fact that the human eye is a less reliable guide than usually assumed and that, consequently, the shooting policy is based on false assumptions. Without detriment a much heavier toll could be taken but, of course, the surrounding land would suffer—and game owners profit from the leniency since the surplus emigrates into surrounding areas—a fact, which has also been confirmed through our marking experiments at Kalö.

It should be pointed out, however, that although we know that underestimates are likely to result from direct observation it is not possible to state e.g. that the population is three times its apparent size. Objective methods are required although they are often cumbersome and expensive. This is all the more important when game biologists are asked for advice in connection with game and conservation legislation.

REPRODUCTION

Like most other large mammals the number of offspring is fairly stable in the Roe-deer. In a previous publication it was shown that during the autumn the reproducing does of the Kalö herd had an average of 1.8 fawns each, or almost the theoretical maximum. It can be concluded that unlike most small mammals mortality is almost nil from birth (in June) to the autumn. Owing to an excess of does in the Kalö herd the percentage of young individuals (fawns) is high, about 40, which means that the herd increases by 70% annually; this is more than currently assumed although the Swedish authority on roe-deer, Lambert von Essen, arrives at exactly the same figure (Svenska Hortdjur, 1958) but in Middle and North Sweden the winter mortality among fawns is much higher. It should be stressed, of course, that the percentage of fawns need not necessarily be the same everywhere.

MANAGEMENT

The principles of roe-deer management in Denmark are probably little different from those followed in other countries: not to shoot too many, to shoot those of «poor quality» preferably, to give supplementary food during winter etc.

Management practices have two general aspects:
1. Improvement of antler quality,
2. Increase of herd size through prevention of emigration and/or not shooting does.
1. Improvement of antler quality.

This practice has often been recommended when it is desired to obtain more pleasing heads, and in actual practice bucks with poor heads are killed selectively.

As far as I know this selective shooting has never led to the desired result although it seems logic to apply the principles which have met with so great success in modern breeding practices. It is important, however, to realize that undesired individuals of Roe-deer in a forest cannot be removed with the same efficiency as in cattle breeding where less than 1% of the males is used for propagation while the remaining 99% are slaughtered. Other important differences are that selection of female individuals is just as important in cattle breeding, and that we know next to nothing about the genetics of Roe-deer.

The hollowness of the recommended practice is also brought out by Voormann's results (Uber die Gehörnentwicklung bei gezeichneten Böcken in Deutsche Jagd n. 24, 1939 - here quoted from the latest edition of F. von Raesfeld: Das Rehwild). He concludes that the development of antlers does not follow a definite bell-shaped curve but that shape and size vary quite irregularly between years. If this is so, improvement of quality cannot be achieved through selective shooting since there is no rational basis for selecting desirable types.

An example from Denmark may suffice (details not yet published but report by Kai Ulfkjær, Game Biology Station, Kalø, in preparation). Selective shooting was practised during the thirties on the Funen estate belonging to Count Ahlefeldt-Bille, our highest authority on roe-deer, alongside with the use of concentrates and stock improvement through the introduction of odd animals from outside. The estate covers 1500 ha including 500 ha of woodland and the roe-deer herd counts about 300 individuals.

Only two or three of the largest bucks were shot each year partly by prominent visitors and partly by the Count as his personal reward. All large heads from the twenties, where this shooting practice was not used, are kept, and by comparing these heads with those from the thirties (when rational game management was practised) it has been demonstrated that size of the antlers has not changed in spite of management but still shows an average of only 80 marks (according to the C.I.C. grading).

In 1939 the Count's patience came to an end, the
The entire herd was killed off during a period of two years, and 40 deer were introduced from a district where much better heads were grown.

The new herd grew rapidly during the forties under continued trimming through selective shooting, and the small number of large bucks killed under this policy were considerably better since now the average reached 100 marks. It must be added here that 100 marks is well up the Danish range, Danish antlers are smaller than East European ones, the record being 158 marks.

Thus we have indications that genetic factors are at play but on the other hand this may not be the entire explanation since the best heads occurred during the first years when the herd was expanding; the improved result may, therefore, be partly explained through the fact that roe-deer density was lower during these years while with increasing density a deterioration has set in.

As far as I can make it out the only certain result of selective shooting is that the holder of the shooting rights will build up a collection of poor trophies; but I am not at present able to suggest a procedure to obtain good trophies.

2. Increase of herd size through prevention of emigration and/or not shooting does. Fencing is often used to prevent emigration; however, it is my experience that a fence is rarely efficient, e.g. roe-deer are eminent at finding weak points in a fence such as roads and tracks that have not been hermetically closed.

On the other hand, efficient fences have been put to use, and we have had the opportunity to study roe-deer in an efficiently fenced district in Jutland (Rye-Nörskov) with an area of 600 ha of rather poor soil planted to conifers. Although the area would seem less suited for roe-deer the herd was fairly large.

In several respects the deer showed poor quality, in particular were the heads poor, so poor that they could not be graded according to the C.I.C. scale.

Being interested in game research the forest supervisor kindly offered us the material of weights, jaws, ovaries, etc. that would result from the extermination of the herd which had been decided in 1954. On the basis of direct observation he estimated the herd to count 125 deer but after much trouble 161 deer were killed, and some were still left.

The average weight of the deer proved to be 2 kg lower than in the Kalø herd, the antlers were incredibly poor, and the reproducing does had an average of
0.9 fawns against 1.8 at Kalø. Bucks and does were present in the ratio 1:1 but what particularly aroused my interest was the low ratio of fawns.

I interpret these undesirable features as an effect of crowding, undoubtedly present in Rye-Nörskov. In the Kalø material we found 2 corpora lutea per doe while the corresponding figure for Rye-Nörskov was 1.6 which indicates that the reduced reproduction shows up already during pregnancy. The poor soil of the area could also be used as an explanation of differences between the Rey and Kalø herds; it is, however, more reasonable to ascribe them to crowding since we have seen no similar situation in roe-deer herds in W. Jutland where the soil is even poorer; furthermore the local game and forestry personnel expressed their disbelief in fencing since the roe-deer living outside the fence, but otherwise in the same type of habitat were of better quality.

Also the age distribution in the Rye-Nörskov herd was greatly different from the one found at Kalø; in the latter place the mean age was 2 years while the Rye herd held a larger proportion of older animals; exact age distribution cannot be given since the tooth wear gives a very unreliable estimate of age in the oldest animals.

Old, infertile does were not present in the Kalø herd; among the ovaries obtained from the Rye herd three were found which had no corpora lutea, but it should be added that the respective does were not particularly old.

On the whole there is thus reason to be somewhat suspicious as regards the value of efficient fencing.

While on the subject of fencing it is worth while to consider in some detail the question of roe-deer migration.

At Kalø we have earmarked fawns during the summer as well as adults during winter. Although new-born fawns are difficult to find we have succeeded in marking a total of 155 during recent years. From among this number we have had 39 reported less than 10 months old (winter trapping or shot during the spring) and all were reported from within the district, more than half of them from within 300 metres from the point of marking and only a few from up to 1 km distance. The average distance between the points of marking and recapture was 370 m; the detailed distribution is apparent from the accompanying diagram.
Among the fawns marked as new-born 20 were recaptured at an age of more than 10 months, 16 within the district, 0-600 m from the point of marking and 4 from outside Kalō; a single female was shot at an age of 1 ½ years, 17.5 km from the point of marking. Also these results are shown diagrammatically; those reported from a distance of more than 2 km, i.e. four deer, are emigrants.

![Diagram showing distances travelled by fawns recovered less than 10 month old.](image)

The conclusion must be that roe-deer are extremely sedentary, although a few are likely to leave the area where they were born.

Among the adults trapped during the winters most remain within the district but a few are recovered outside Kalō (particularly since we have introduced cash payment for returning marks plus jaws to the Station).

Our largest trapping campaigns date from January-February 1958, 1959 and 1960 (this last year we have trapped 95 deer). Among the deer trapped in the two previous years were 64 fawns and 74 of higher age; from among them 18 have been reported shot outside Kalō, usually at 2-3 km distance; only 3 were shot 5-10 km from Kalō.

Among the emigrants were 8 young animals marked during the first winter and shot during the following open season, and 10 older animals. Although the figures are small they are of some value since they seem to
show that the deer emigrate in the ratio in which the various age groups are present in the herd; thus it is not a question of young individuals being driven out. Among the older animals the exact age is known of two males since they were first marked as fawns at Kalö, two

Fig. 4. — Distances travelled by fawns recovered more than 10 months old.

years later recaptured at Kalö and finally shot, three years old, outside the district, one of them 10 km away. As regards sexes there seems to be a preponderance of males among the emigrants: among the 8 young individuals were 6 males, and among the 10 older ones also 6 males. This excess of males is all the more striking since more females than males were marked but it fits in well with the fact that the Kalö herd has an excess of females in the later age groups.

From what I have presented here it will be understood that we are right in the middle of investigations on roe-deer biology and that our chief interest has been directed towards the population dynamics. In order to pursue our studies it has been necessary to develop some technique for estimating herd size, a problem which we have found much more difficult than we had expected.

Our results concerning the validity of current assumptions in game management may appear somewhat disheartening to the sportsman since we have reached the conclusion that certain currently accepted important rules do not lead to the desired result. Unfortunately, we are not able to suggest any better procedures but, on the other hand, we have hope that future studies, not just based on simple and direct observation, will enable us to reach sounder principles in roe-deer management.