ACTA THERIOLOGICA
Vol. 29, 2: 17—33, 1984

Some Aspects of Population Structure and Longevity of Field Roe Deer [1]

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Pielowski Z., 1983: Some aspects of population structure and longevity of field roe deer. Acta theriol., 29, 2: 17—33 [With 3 Tables & 8 Figs.]

Studies were carried out over the period from 1970—1981 in an area 15,000 ha in extent, for the purpose of determining some aspects of spatial organization of a field roe deer population, their survival and longevity, by means of individual marking of members of the population. It was found that the study roe deer population consisted almost entirely of resident individuals, the activity of which was limited to the area of their home ranges. The degree to which they are settled increases with increasing age of the animals, only single individuals exhibiting a tendency to migrate over longer distances (up to 30 km). The annual home ranges of field roe deer are as follows: 151 ha for bucks and 141 ha for does. The extent of long-term ranges (during the animals lifetime) is slightly greater (168 ha for bucks and 219 ha for does). Average survival for these animals is 2.5 years and maximum lifespan is 14—15 years. Only about 10% of the animals survived to the age of 10 years.

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1. INTRODUCTION

A natural phenomenon of outstanding interest is the rapid adaptation of one of the European species of the deer family — the roe deer *Capreolus capreolus* (Linnaeus, 1758) to the changing ecological conditions in an agricultural landscape. Not only do populations of this species fully adapt themselves even to the poorest forest habitat, but these animals exhibit an increasing tendency to permanent settlement of a habitat new to them, fields. There are many indications that the roe deer in agrocenoses will to an increasing extent in the future numerically dominate other species of game animals, the existence of which is threatened (Pielowski, 1981).

Scientific interest in the roe deer is of comparatively recent date (Nečas, 1960, 1968; Kałuziński, 1974; Knorr & Briedermann, 1976, Möller & Léon, 1976; Paustian, 1976; Stubbe, 1976; Tschirch, 1976; Pielowski, 1977; Zejda, 1978; Reichholf, 1980 and others). It is strange for a process interesting from the evolutionary aspect to take place almost before our very eyes — the differentiation of a new ecological form of a species,

[1] Praca wykonana w ramach problemu MR.II.15 koordynowanego przez Instytut Ekologii PAN.

with all its consequences (Pielowski, 1977). In this connection problems of biological significance arise with roe deer as a new component of agrocenoses and their importance to game management, thus necessitating scientific research on this subject.

The Research Station of the Polish Hunting Association at Czempiń undertook early in 1970 an attempt at complex studies of structural and basic functional processes of a roe deer population in agrocenoses, in relation to habitat reactions in the broad sense. The present study is one of several relating to a given population of field roe deer (Bresiński, 1982; Kałuziński, 1982; Pielowski & Bresiński, 1982). The purpose of this study was to examine some elements of population structure, chiefly in connection with spatial organization survival and longevity of individuals.

2. STUDY AREA

The studies were carried out in the research area of the Polish Hunting Association Research Station at Czempiń, which is situated in western Poland within the Poznań voivodship. It covers an area of 15,000 ha of open field with only a small proportion of wooded land (about 7% of the total area). 70% of the area of the open consists of land cultivated by the large-scale field method; the remaining part consists of individual farms with a diversified mosaic of different field crops on relatively small fields. The wooded land consists of six copses varying in size from about 50 to 285 ha. In addition there are strips of wooded land over the whole area in the form of coverts, shelterbelts and drainage ditches, small ponds and field tracks with verges bearing bushes, trees etc, forming a total area of 1.9%. The villages are compactly built. The communications infra-structure is fairly well developed, with a network of hard-surfaced roads, two railway lines etc. Bresiński (1982) and Kałuziński (1982) detail the study area.

Game animals in the research area include the hare, *Lepus europaeus* Pallas, 1778, the partridge *Perdix perdix* (Linnaeus, 1758), the wild boar *Sus scrofa* Linnaeus, 1758, and the roe deer population, the average density of which for the study years was 7 individuals/100 ha, with annual fluctuations from 4 to 12 individuals (Kałuziński, 1982). Among predators constituting a threat to the roe deer are fairly numerous stray dogs and the fox *Vulpes vulpes* (Linnaeus, 1758). The roe deer population has been used for hunting on an average harvest level of 8% of its numbers per year.

3. METHODS

Studies were made over the period 1970—1981, based on individually marked roe deer. The animals were caught during the late autumn and winter period, using nets employed to catch live hares, mainly during their annual captures. This was the only possibility of catching a certain number of roe deer in open fields. For this purpose it is necessary to have several thousand metres of nets, a large number of people and suitable means of field transport (Kałuziński, 1978; Pielowski, 1979). The roe deer caught were marked with leather neck collars to which

enamelled metal plates were attached bearing letters and numbers. This method of marking roe deer was adopted after that of Strandgaard (1972). For purposes of control roe deer were marked with ear-tags of the type used for sheep, with the same symbol stamped on them as on the collar.

The age of the captured animals was estimated on the basis of the wear of mandibular buccal teeth (P and M) (Pielowski, 1970). The animals jaws were opened by means of a specially miniaturized instrument used by the veterinary service for this purpose on large, domestic animals. Over the 10-year period a total of 170 roe deer of varying age were caught, consisting of 82 males and 88 females.

Data on marked roe deer were collected by the whole scientific personal of the Research Station by direct observations, usually when in the study area for the purpose of other research tasks. In this way a total of 1107 return reports were obtained. A map of the study area (scale 1 : 25 000) containing 250×250 m grids was used, and co-ordinates placing of observations with an accuracy of ±6.25 ha. It was difficult to achieve greater accuracy in establishing the place in which a given animal was resident, since observations were usually made at distances of not less than 200—300 m on the very extensive monoculture fields. Dead animals found (n=49) or shot (n=13) were also plotted (Fig. 1).

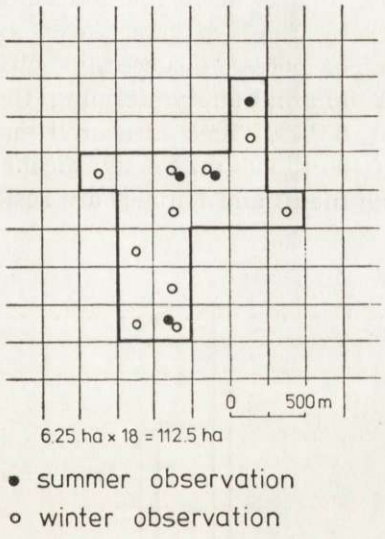

Fig. 1. Map of observation sites and consequent shape of the home range of a given animal — doe no. B-07, for 1972—1976.

Up to 37 return reports were obtained for different marked animals, including 0 observations for 14 animals, from 1—4 for 76 animals, 5—10 for 43 animals, 11—20 for 26 animals, and over 20 for 11 animals.

Technical considerations, i. e. the extreme difficulty in observing roe deer in a field habitat during the summer period, resulted in return reports for this period of the year numbering only 178, thus forming only 16% of the total material.

In defining the size of the home ranges of roe deer only those individuals for which at least 5 return reports were obtained, omitting definition of localizations occurring at short intervals within approximately 15—16 days. When considering the long-term range, which, for part of the roe deer also formed their home range over their lifetime, such observations were distributed over a period of at least 3 successive years. In the case of five or more observations the size of the home range does not significantly alter in relation to the number of observations. The minimum number of five localization observations was also accepted by Fruziński *et al.* (1983) for forest roe deer.

Calculation of the relative size of home ranges consisted in totalling the area of squares (6.25 ha each) in which at least one observation took place, and adding the area of all squares situated in closest vicinity from one observation site to another (Fig. 1). The reasons for this choice of method for calculating the size of home range is to be found in "Discussion".

4. RESULTS

4.1. Movements

Based on 546 return reports of 76 marked animals, the distribution of extent of movements by field roe deer over a year was determined, applying mean distances between successive observation sites (Fig. 2). This forms an index approximately defining the degree to which the population is resident. 83% of such measured movements during a year come within limits of 400 to 900 m. No significant differences were found in the degree to which males and females are resident.

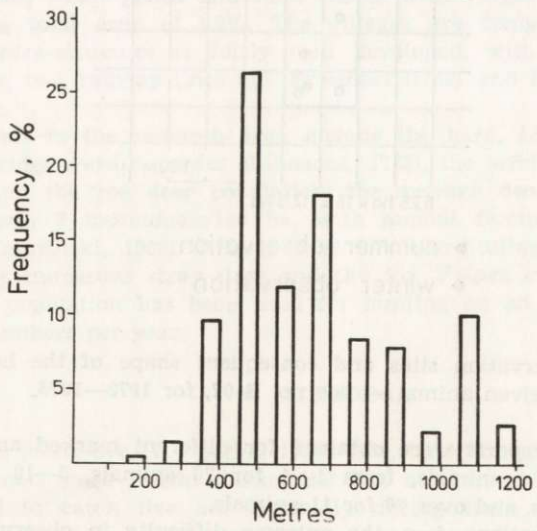

Fig. 2. Distribution in percentage of the average annual movements of field roe deer (mean values from the sum of distances between successive observation sites, n=546).

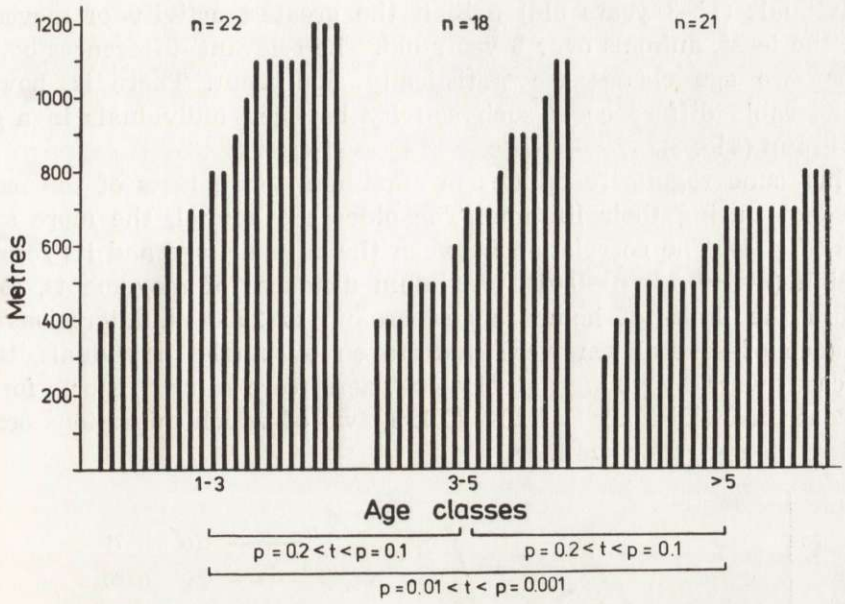

Fig. 3. Differences in the extent of average annual movements of field roe deer deperding on age of individuals (mean values from the sum of distances for 458 localizations determined.

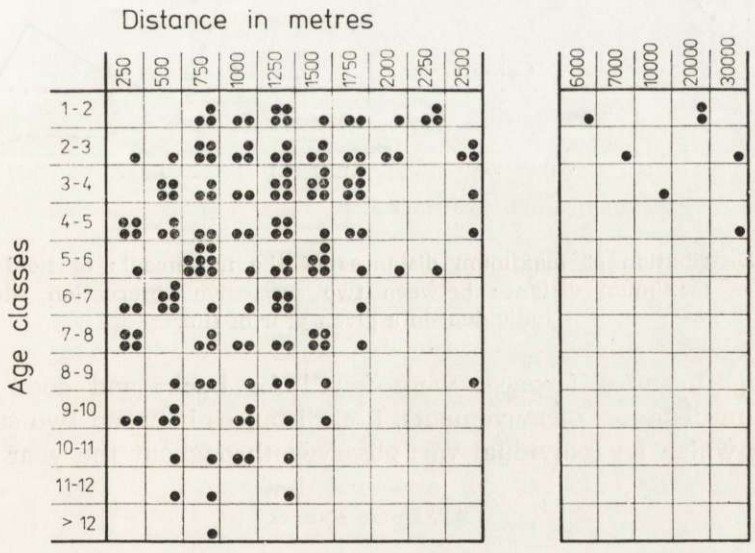

Fig. 4. Relation of maximum movements of field roe deer and age of individuals, n=163.

When considering the age of marked roe deer, it was found that young individuals (1—3 years old) exhibit the greatest activity of movement, and the least, animals over 5 years old. The relevant differences between these two age classes are statistically significant. There is, however, considerable difference is such activity between individuals in a given age group (Fig. 3).

This same regularity applies to maximum movements of the marked roe deer during their lifetime. The older the animal, the more settled it is (Fig. 4). The correlation between the animal's age and its residency is high ($r=-0.73$; $p=0.01$). Maximum distances of movements, coming within the limits of home ranges, are up to 2500 m. Migrations to a distance of several km were undertaken by single individuals, but in all cases were by young age classes. There were return reports for four roe deer from distances of 20—30 km, two of which migrations occured during the spring or summer.

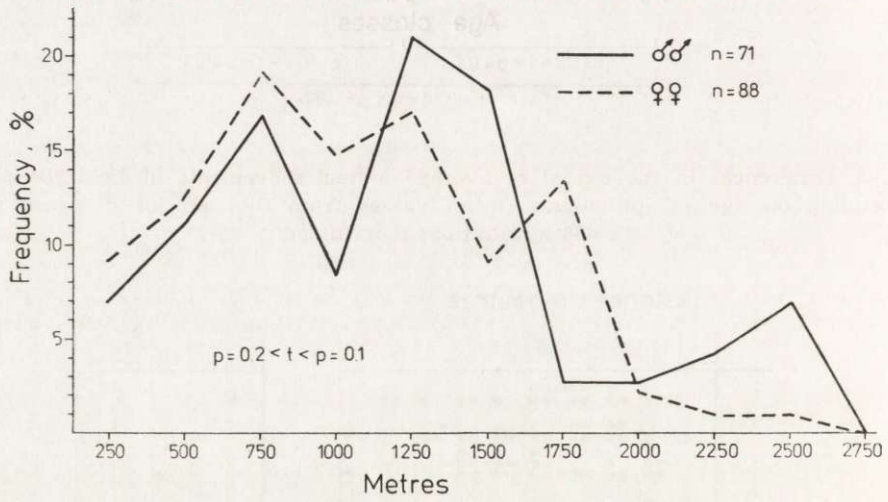

Fig. 5. Distribution of maximum distances of the movements of field roe deer (in %) — maximum distance between two successive observation sites of an individual in a given year of life.

No significant differences were found for bucks and does between maximum distances of movements, i. e. distances between two successive sites on which an individual was observed throughout the year (Fig. 5).

4.2. Home Ranges

Long-term home range size was calculated for 51 roe deer, including 9 individuals living in small forests and the fields adjacent to them. The

average home range of bucks in this group (n=3) was 73 ha, and that of does (n=6) only 46 ha. These are only indicator data, on relatively few individuals with a sufficient number of return reports. The home range of field roe deer, in contrast, is far greater, being 168 ha for bucks (n=18) and 219 ha for does (n=24). Quantitative distribution of home range sizes is illustrated in figure 6.

Examination was also made of the size of home ranges occupied over the course of a year. They are less extensive than the home ranges for the whole lifetime, and the mean size for bucks (n=20) was 151 ha and

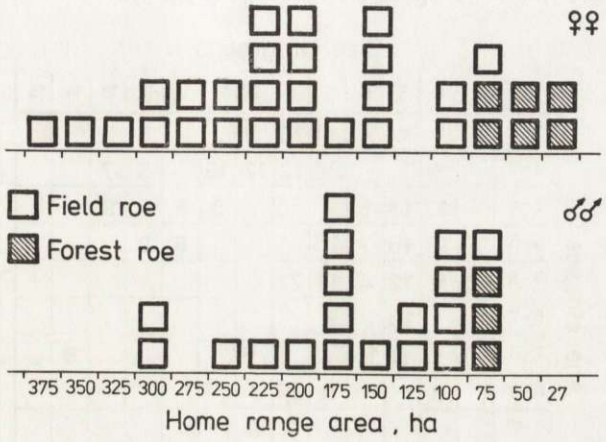

Fig. 6. Extent of long-term home ranges of roe deer from the study population.

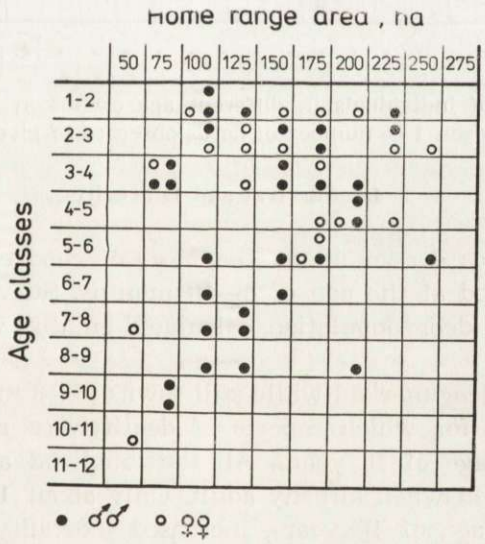

Fig. 7. Relation between extent of annual home ranges of field roe deer and age of individuals.

(n=32) 141 ha for does. As the deer age after 5—6 years of life the size of the annual home range decreases (Fig. 7). Correlation ($r=-0.61$) is significant ($p=0.01$).

4.3. Herd Tendency

The question of herd tendency in field roe deer was examined in detail by Bresiński (1982). His data can be supplemented by the fact that older animals (over 5 years), are members of almost exclusively smaller winter herds of up to 9 members (Fig. 8).

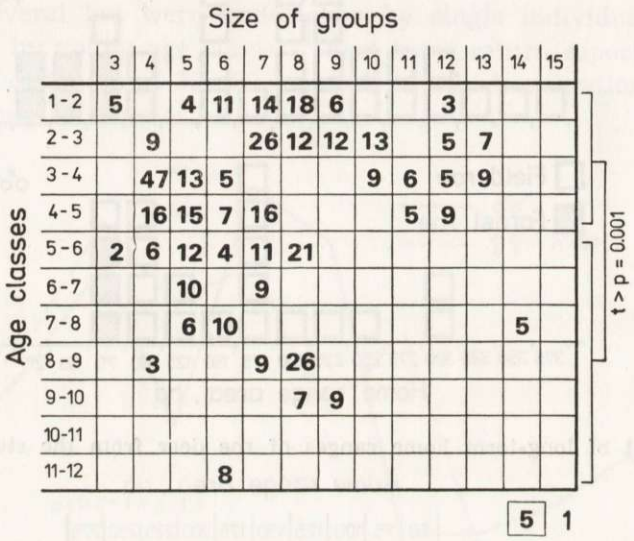

Fig. 8. Proportion of individuals in different age classes in winter herds of field roe deer. 1 — number of herds observed of given size.

4.4. Survival and Longevity

A life table was drawn up on the basis of reports of the deaths of individuals marked at the age of 8—10 months. Survival of individuals in the study roe deer population calculated in this way was 2.5 years (Table 1).

Of the 50 roe deer marked while still fawns (6—8 months) or juveniles (1—3 years old), for which reports of death were received, none had survived to the age of 10 years. All the longlived animals were those caught and marked when already adult. Only about 10% of the animals survived to the age of 10 years, increased mortality being evident at the age of 6 to 9 years (Table 2).

Maximum age of marked roe deer from the study population was

Table 1

Life table for field roe deer
(based on reports of death of marked animals 8—10 months old).

x	dx_p	lx_p	l_x	L_x	T_x	e_x
0— 1	19 [1]	54	1000	824	2498	2.50
1— 2	14	35	648	518	1674	2.58
2— 3	6	21	389	333	1156	2.97
3— 4	4	15	278	241	823	2.96
4— 5	1	11	204	194	582	2.85
5— 6	2	10	185	166	388	2.10
6— 7	4	8	148	111	222	1.50
7— 8	1	4	74	65	111	1.50
8— 9	2	3	56	37	46	0.82
9—10	1	1	19	19	19	1.00

dx_p — number of roe deer dying in the given age class,
lx_p — number alive at start of age class (basic date),
l_x — number alive at start of age class (data relating to 1000 individuals),
L_x, T_x — auxiliary values in calculating e_x,
e_x — life expectation for age class.

[1] Number of dead fawns was calculated from Kałuziński's data (1982) relating to the same roe deer population.

14—15 years, only one individual reaching this age — a doe marked at the age of 5—6 years and one died during the very severe winter of 1978/79. Of the two females surviving to the age of 13—14 years, one most probably died as the result of extreme age, and the second was shot, as it exhibited symptoms of great senile decrepitude. A further 4 individuals from 11—13 years old were also found dead: the death of two of these took place during the severe winter referred to above. Two further marked roe deer were observed up to the age of 10—11 years, after which time they disappeared without trace.

Analysis of the causes of death of marked roe deer showed that the most important eliminating factor — exclusive of shooting — consists in severe winter conditions (Table 3).

5. DISCUSSION

Methods: Visual marking of roe deer an observing them under field conditions to obtain information about spatial distribution on different animals has been used by many researchers (including Kurt, 1968; Strandgaard, 1972; Ellenberg, 1978; Wotschikowsky, 1981; Fruziński *et al.*, 1983). Maps were prepared from these data of definite home ranges, or else statistical methods were used, converting the shape of the home range to a geometrical figure (e. g. Ellenberg, 1977 and Fruziński *et al.*, 1983). Statistical methods were borrowed from studies on small rodents

Table 2

Longevity of roe deer (based on reports of the death of marked individuals).

Age class	No. of marked indiv.	No. of reports of deaths	Number of individuals surviving to given age														
			1—2	2—3	3—4	4—5	5—6	6—7	7—8	8—9	9—10	10—11	11—12	12—13	13—14	14—15	15—16
1	73	35	14	6	4	1	2	4	1	2	1	—	—	—	—	—	—
1— 2	23	10	×	4	1	3	1	—	1	—	—	—	—	—	—	—	—
2— 3	11	5	×	×	1	—	1	—	2	1	—	—	—	—	—	—	—
3— 4	17	13	×	×	×	3	1	1	4	—	3	—	1	—	—	—	—
4— 5	6	1	×	×	×	×	—	1	—	—	—	—	—	—	—	—	—
5— 6	9	7	×	×	×	×	×	1	2	1	1	—	1	—	—	1	—
6— 7	9	6	×	×	×	×	×	×	—	2	—	1	—	1	2	—	—
7— 8	3	2	×	×	×	×	×	×	×	2	—	—	—	—	—	—	—
8— 9	2	1	×	×	×	×	×	×	×	×	—	1	—	—	—	—	—
9—10	0	0	×	×	×	×	×	×	×	×	×	—	—	—	—	—	—
10	1	1	×	×	×	×	×	×	×	×	×	×	1	—	—	—	—
Total	154	81	14	10	6	7	5	7	10	8	5	2	3	1	2	1	—

(Stickel, 1954; Calhoun & Casby, 1958; Mazurkiewicz, 1971 and others). The way in which home ranges of field roe deer were calculated in this paper is open to discussion and requires explanation. It must be emphasized that to date there has been no universal method for defining the size of home ranges for ungulates primarily due to technical difficulties involved in obtaining appropriate initial material. The best and most accurate way would appear to be by radiotelemetry, as used by Tester and Siniff (1973) for the Virginian deer and Bramley (1970) for roe deer in England. Attempts at employing this method in studies of roe deer were also initiated in the Soviet Union (Sokolov *et al.*, 1977), in the German Federal Republic (Berg, 1978) and in France (Janeau *et al.*, 1979). The degree of technical difficulty is, however, exceptionally great and at the present time results of this method are only conditionally suitable for population studies.

Table 3

Causes of death of 81 marked roe deer.

Cause	Number
Winter conditions	15
Predators — stray dogs poaching	8
Death on railway tracks	6
Poaching	5
Complications during delivery	2
Diseases	1
Poisoning	1
Death caused by agricultural machinery	1
Mechanical injury — collision with fence	1
Death due to old age	1
Unknown causes	25
Shooting	15 [1]

[1] Sanitarny shooting for scientific purposes (known age skulls), 37 shooting, 3 shooting beyond the experimental area, 2 unintential hunters' kills.

Ellenberg (1977) compared the method of direct definition of the home range of roe deer and mathematical estimates of home range size (in the shape of an ellipse) and concluded that the statistical method systematically overestimates actual home range sizes. I concur. Overestimation becomes absurd, in a habitat consisting of agricultural landscape, where there is seasonal disappearance of covert and feeding grounds over a large area, with consequent exclusive irregular movement of different roe deer.

For these reasons the home range size estimation method accepted here for roe deer is that also used by Ellenberg (1978), under forest habitat conditions. The fact that return reports of marked roe deer were

not obtained strictly in accordance with a given principle (time, space etc.) and hence were fairly random and irregular, also substantiated use of simplified method. All in all this material does not allow very accurate and certain conclusions to be drown. Individual marking of roe deer in a large area is, for understandable technical reasons, incapable of including all or a large proportion of individuals, as in small areas or enclosures (Bramley, 1970; Strandgaard, 1972; Ellenberg, 1978 and others). There also is no practical way to maintain continuous control over all marked animals. A certain number of them disappear without trace, without any return report (8%) or with relatively trivial observations (about 45%). Wotschikowsky (1981) emphasized this phenomenon. He caught and marked 200 roe deer in a large stretch of wooded land, 32% of which animals disappeared without a single return report. This situation appears to depend chiefly on the degree to which different animals can be observed and also on external conditions (Pielowski, 1970; Strandgaard, 1972; Ellenberg, 1978 and others). Material obtained by this study method is therefore smaller than might been expected, but has the advantage of permitting data collection from extensive areas. In the case of field roe deer this last aspect would appear particularly important, on account of their relatively low population density and specific system of spatial organization (Bresiński, 1982; Kałuziński, 1982).

Movements: The degree to which field roe deer are resident, as examined on the basis of distribution of movements of marked individuals, is difficult to compare with other populations of field roe deer, since there are no data of this kind in the literature. It is, however, interesting that maximum movement activity is exhibited by young individuals 1—3 years old. This phenomenon may be analogious with emigration, in very overcrowded populations of forest roe deer, which search out territories or home ranges of young animals (Bramley, 1970; Strangaard, 1972). Some confirmation of this is provided by the results of studies of roe deer in a small forest amidst fields in the middle of the territory of the population of field roe deer studied here. After total elimination of the local head of roe deer small forest was observed to be taken over by exclusively 1—3 year old roe deer from the neighbouring field areas (Pielowski & Bresiński, 1982).

The distant (30+km) migrations of single roe deer show that this phenomenon is a normal one previously described by numerous authors (Strandgaard, 1972; Myrberget, 1973; Bayern, 1975; Blankenhorn, 1976; Raesfeld *et al.*, 1978; Wotschikowsky, 1981 and others). No movements for distances within the interval from 2500 to 6000 m were found, which may provide evidence that changes of living site for short distances take place within the respective home ranges. On the other hand migrations

in search of a new place of permanent stay are usually over long distances. Although Strandgaard's data (1972) point to gradual regular reduction in the number of individuals which emigrated for distances from 2 to 10 km, this took place under conditions of almost complete absence of roe deer outside the study area and under considerable hunting pressure, which interrupted the migration routes of many roe deer. Home ranges: There are no documented data in the literature on the size of the field roe deer's home range. The home range area of forest roe deer, depending on the habitat conditions in which the given population lives, is estimated to be from less then 20 to 50 or more hectares, not however, always completely defining whether this applies to defended territory, or the seasonal or life home range (Mottl, 1962; Kurt, 1968; Bramley, 1970; Strandgaard, 1972; Cumming, 1974; Ellenberg, 1978; Fruziński *et al.*, 1984 and others).

The average size of the home ranges of does in the Kalö study area in Denmark (Strandgaard, 1972), was 57 ha (data calculated by Ellenberg, 1978, on the basis of the material published by Strangaard). Those are roe deer from a relatively small forest among fields, and the animals' home ranges extend to include adjacent fields. The home ranges of roe deer inhabiting a small forest (285 ha) in the area in which the present studies were carried out, are similar in size (Fig. 6). These home ranges are far more extensive than they appear because of very large fields with abundant supplies of excellent, seasonally available food, but only sparse shelter. Thus the roe deer must undertake frequent seasonal movements, which automatically greatly extends the extent over which they range. In winter there is the additional factor of the specific nature of spatial distribution arising from tendency to gather in herds. Different individuals are then subordinated to the principles governing the herd. This also applies to choice of temporary resting sites. The observation by Bresiński (1982) that large numbers of individuals change their adherence to a given herd in winter, may, among other reasons occur when a group is left as it moves too far from the home range of a given roe deer. The range of a herd is by no means the sum total of the areas of home ranges of the animals forming the herd. It is clear from Bresinski's studies (1982) that the ranges of groups of roe deer are not on average greater than the yearly home range of different individuals. The question of correlation between home range size and the range of a herd, is not therefore yet clear and requires further study.

There are insufficient data for a detailed analysis of the problem as to what extent successive yearly ranges overlap, forming when totalled, the long-term life home range. The scanty material available on this

subject points to a considerable variety of different solutions. In the case of young male and female roe deer 1—2 years old successive annual ranges are either in the same place or very near it. Occasionaly, however, the may be several kilometres distant. With older animals, fidelity to a given place appears far greater. It is only the cultivation activities of man, particularly intensive in an agricultural landscape, which forces roe deer to periodical or permanent range shifts.

The annual home range of a roe deer decreases with the animal's increasing age. This is an obvious consequence of the lesser movement activity of older roe deer discussed above. This phenomenon may also be connected with the established fact that older individuals belong almost exclusively to small winter herds.

Survival and longevity: The average length of life or field roe deer from the study population (2.5 years) is very similar to that determined by Pielowski and Bresiński (1982) by means of total elimination by shooting of the stock from a defined plot within the same study area (2.2 years), after adding to the life table losses of fawns up to 8 months of age. It does not significantly differ from the average length of life of roe deer in large forest areas — 2.4 years in the Niepołomicka Forest near Kraków (Bobek *et al.*, 1974) and 2.9 years in the Zielonka Forest near Poznań (Fruziński & Łabudzki, 1982).

These data on the longevity of field roe deer are more or less in agreement with what has previously been found on this subject (Pielowski, 1970; Raesfeld *et al.*, 1978; Stubbe & Passarge, 1979). That only about 10% of the animals less than 1 year old survive up to 10 years of age, corresponds with Strandgaard's data (1972) from a Danish population which was not used for hunting purposes. Data of Raesfeld *et al.*, (1978) from the German Federal Republic, on the other hand, show that occasional roe deer survive up to the age of 8—10 years. There were no individuals over 8 years old in the roe deer population examined by Bobek *et al.* (1974).

The increased mortality among roe deer in age classes from 7—9 years found in the present studies would thus agree with the above data. The explanation may be that at this age, most animals in the population die. The correctness of this hypothesis is borne out by the fact that among the old marked roe deer it was only those individuals which had been caught when adult, that is, those which had survived after elimination of young animals, which ultimately reached old age.

Acknowledgement: Many thanks are due to Dr. Gilbert L. Dryden for his linguistic correction of the text.

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Accepted, October 12, 1983.

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ASPEKTY STRUKTURY EKOLOGICZNEJ POPULACJI ORAZ DŁUGOŚĆ ŻYCIA SARNY POLNEJ

Streszczenie

W ramach kompleksowych badań nad populacją sarny polnej przeprowadzono w latach 1970—1981 badania na jej organizacją przestrzenną oraz przeżywalnością i długością życia jej osobników. Podstawową metodą badań było indywidualne znakowanie sarn, a następnie zbieranie informacji o ich miejscu pobytu oraz o zejściach śmiertelnych. Oznakowano 170 zwierząt a uzyskano 1107 wiadomości powtórnych (od 0 do 37 na osobnika).

Ustalono rozkład aktywności przemieszczeniowej osobników i stwierdzono, że dla 83% z nich średnia wielkość przemieszczeń w ciągu roku mieści się w granicach od 400 do 900 m. Aktywność przemieszczeniowa odbywa się w obrębie areału osobniczego i maleje wraz z wiekiem osobników (Ryc. 2—4). Nieliczne tylko młode osobniki migrują na odległość 6 do 30 km. Oszacowano wielkość wieloletniego areału osobniczego, wynoszącą średnio dla kozłów 168 ha a dla kóz 219 ha. Poszczególne areały są różnej wielkości (Ryc. 6). Areały roczne są nieco mniejsze — 151 ha dla kozłów i 141 ha dla kóz. Ich wielkość zmniejsza się wraz z postępującym wiekiem osobników (Ryc. 7). Osobniki starsze z reguły są członkami mniejszych stad zimowych (Ryc. 8).

Obliczono przeżywalność sarn z badanej populacji, wynoszącą 2.5 lat (Tabela 1). Do wieku 10 lat dożyło tylko ca 10% osobników (Tabela 2). Maksymalny wiek znakowanych sarn wyniósł 14—15 lat.