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THE SOC4IAL ORGANIZATION, HOME RANGE AND MOVEMENT OF THE GARDEN DORMOUSE *Eliomys quercinus*

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In order to provide information on the ecology of the garden dormouse in the alpine habitat, a field study was started in 1995 using the capture-recapture method. The research was carried out in the Val Troncea Natural Park, situated in the Western Alps (Piedmont region, Turin district). During the two year study, 30 adults and 23 juveniles were caught: 14 adults and 9 juveniles in 1995, 20 adults (four of them were also caught in 1995) and 14 juveniles in 1996. The mean movement of adults during one night was about 50 m, with a peak of 209 m. Differences through the months were not significant, for neither males nor females. Males appeared to be more mobile then females, especially in August. Movements during the trapping period showed the same pattern for males: they were little in June and increased in August. Home ranges were greater for males (mean 0.8 ha, N = 2) than females (mean 0.62 ha, N = 5); a female not reproductive exhibited a bigger range (1.04 ha). Adults resident in the study area frequented the same part of the grid in 1995 and 1996.

Key Words: *Eliomys quercinus*, social organization, space-use

Bertolino, S., Currado, I., Azzollini, R. & Viano, C.: Druževna organizacija, životni prostor i kretanje vrtnog puha *Eliomys quercinus*, Nat. Croat., Vol. 6, No 3., 303–312, 1997, Zagreb

U svrhu dobijanja podataka o ekologiji vrtnog puha u planinskom boravištu 1995. su započeta terenska proučavanja uz uporabu capture-recapture metode. Istraživanje je obavljeno u parku prirode Val Troncea, zapadne Alpe, pokrajina Pijemont, torinski kotar. Tijekom dvije godine proučavanja uhvaćena su 30 odrasla i 23 mladenačka oblika: 14 odraslih i 9 mladenačkih 1995, 20 odraslih (4 od njih bila su ulovljena i 1995) te 14 mladenačkih 1996. Srednja pokretnost odraslih tijekom jedne noći bila je 50 m, s najvećom vrijednošću od 209 m. Gledano prema mjesecima, nije bilo znatnijih razlika između mužjaka i ženki. Čini se da su mužjaci pokretljiviji od ženki, osobito u kolovozu. Za vrijeme razdoblja hvatanja kretanje mužjaka pokazuje jednu te istu sliku: bilo je maleno u lipnju a povećano u kolovozu. Ploha kretanja veća je u mužjaka (prosječno 0.8 ha, N = 2) negoli u ženki (0.62, N = 5); neproduktivna ženka ima veću plohu (1.04 ha). Sjedilačke odrasle jedinke u ovom istraživanju posjećivale su 1995. i 1996. uvijek iste dijelove mreže.

Ključne riječi: *Eliomys quercinus*, druževna organizacija, uporaba prostora

INTRODUCTION

The Garden Dormouse (*Eliomys quercinus*) has been the object of numerous studies on hibernation physiology and genetics, but less is known about its biology and ecology in the field. Few studies have investigated its ecological distribution (e.g. LOUARN & SPITZ, 1974; MANN, 1976; BAUDOIN *et al.*, 1986; FOPPEN *et al.*, 1989), space-use and social system (MANN, 1976; BAUDOIN *et al.*, 1986).

The movements of small mammals may be a part of the regular daily activity pattern or due to the migration and dispersal that generally occur during certain periods of their life cycle. BURT (1943) defined home range as the area that is crossed by the individual in its normal activities of food gathering, mating, and caring for young; occasional long-range movements, important in small mammal behaviour, are excluded. Movements and home range of small mammals can be investigated with different techniques. One of the most commonly used is the capture-recapture method. In order to provide information on the ecology of the garden dormouse in natural conditions, a field study was started in 1995 using the capture-recapture method. Here we report the first results in respect of home range, movements and social organization.

METHODS

1. Study area

The research was carried out in Val Troncea Natural Park, situated in the Western Alps (Piedmont region, Turin the district). The study area is a fragmented woodland of *Larix decidua* grown on detritic conoids; the arboreal cover is not homogeneous for the presence of parts with stone mounds; it is located on the left mountain, with in eastern exposure. Annual rainfall ranges from 800–1000 mm, with a peak in spring and autumn and a minimun in summer and winter; snow cover is present for 4–6 months (I.P.L.A., 1982); mean temperatures are 7.1 °C in summer and –2.7 °C in winter.

Other rodents present in the study area were: *Sciurus vulgaris*, *Clethrionomys glareolus*, *Chionomys nivalis*, and *Apodemus* sp.

2. Live-trap method

Garden dormice were caught using 144 Sherman live traps, placed at 20 m intervals in a grid comprising 8 lines with 16–20 traps, covering an area of 4.68 ha. The traps were baited with hazelnuts, cheese and carrots. Animals were trapped over two years, in 1995 and 1996, from May to September; every month, traps were set up for 5–6 days. Many tourists visited the park from June to August, and for this reason we could not leave traps in the field during the day, so traps were set up every evening and removed in the morning. In the same area we trapped also

in a smaller grid, with 100 traps place at 10 m intervals, to study the ecology of other small mammals; supplementary data concerning garden dormice were also collected.

All animals captured were weighed, sexed, measured, and marked with passive integrated transponder (PIT) tags; more information on this tagging method and animal manipulations are reported in BERTOLINO & CURRADO (1997).

3. Home range and movement

The average home range was calculated using the minimum area method (FLOWERDEW, 1976), joining all the external capture points with straight lines and then measuring the enclosed area. The apparent home range size increases with the number of captures, but may reach an asymptote after which variations in the range are minimal for additional captures (STICKEL, 1954; SOUTHWOOD, 1987). To verify this assumption we considered the effect of sample size on increase of home range; Fig. 1. shows the results obtained for 4 animals (3 females and 1 male) caught several times; the increases of mean home range are calculated from 3 to 17 capture events. The graph shows how the range dimension is strongly correlated with the capture number ($r_s = 0.98$, $p < 0.0001$), with the area seeming to become stable (little increased between last three points) only after 16–18 captures. Mean range after 14 captures is 90 % of the maximum. We consider this capture number as the mini-

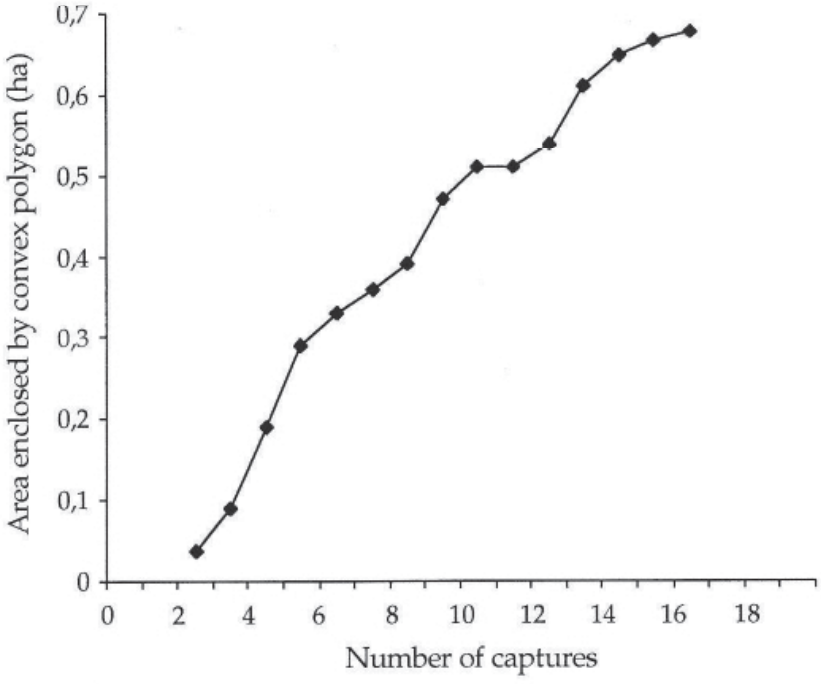

Fig. 1. The effect of sample size on garden dormouse mean home range, obtained with the minimum convex polygon method (N = 4 animals, 3 females and 1 male).

mum necessary for calculating the home range of garden dormice in our study grid. The area frequented by the animals, but calculated with fewer capture-points, is considered a Minimum Vital Area (MVA). According to BURT's (1943) definition of home range, we did not consider occasional movements outside the area normally frequented by the animals. In fact we excluded one of the eighteen points of a female, because if that movement were considered the home range would increase to 76 % of the total.

Movement of animals were measured per night and per trapping session. Night movements were measured using the distance between one capture and the next one; we considered these data only if the second capture occurred the night after the first one. Garden dormice are active only during the night. This fact was verified in September 1996, when we left the traps in the field the whole day long, checking them in the morning and in the evening. VATERLAUS (1997), using radio-tracking confirmed that the onset of activity is related to sundown and the end with sunrise. We think that animals released in the morning stayed at the same place until the evening, when they started their activity and were caught again, so the movement measured between consecutive day trappings are referred to one night's activity. The distance between the most widely separated capture points was used as an index of movement during trapping periods (FLOWERDEW, 1976). These ways to estimate animal movements are limited by the fact that captures stop an individual's activity. Moreover we considered the minimum distance between two traps, but the animals did not travel in straight lines. Notwithstanding these comments, the measure is an average index for animal movements at that particular location.

Seasonal variations and differences between sex and age for movement measures and home range dimension were assessed through the Kruskall-Wallis and Mann-Whitney U-test (SIEGEL, 1956).

RESULTS

During this study 30 adults and 23 juveniles were caught: 14 adults and 9 juveniles in 1995, 20 adults (four of them were also caught in 1995) and 14 juveniles in 1996. During 1995 the study was stopped at the end of August because very low temperatures were dangerous for the welfare of animals caught; for this reason we think that the number of juveniles was underestimated that year.

Table 1 shows night movements; in September few adults were caught and so their data about item are not calculated. For juveniles, August and September samples were pooled. Mean movement of adults during one night was about 50 m, only 5 % of the measures being over 100 m, with a peak of 209 m due to a male that in July had its range in the left part of the grid, but was caught in August on the first night of trapping in the right part and on the second night returned to its original range area. Differences in mean night movement through the months were not significant, for both males and females. Males appeared to be more mobile than

Table 1. Distance covered by garden dormice between consecutive day trappings; 1995–1996 data pooled

Month	recapture no.	Distance (m) min.	max.	Median	Mean (± S.E.)
		MALES			
May	8	10	90	42.50	45.25 (11.25)
June	5	20	80	50.00	47.40 (9.91)
July	8	28	72	52.50	52.50 (5.82)
August	20	14	209	58.50	64.90 (9.58)
Total	41	10	209	51.00	56.51 (5.46)
		FEMALES			
May	13	20	78	40.00	41.46 (5.31)
June	12	20	114	53.50	55.42 (8.43)
July	13	20	102	40.00	44.46 (7.11)
August	30	20	102	40.00	40.33 (3.91)
Total	68	20	114	40.00	44.00 (2.85)
		JUVENILES			
Total	9	20	114	60.00	60.22 (11.53)

the females if we consider all the periods ($z = 2.158$, $p < 0.05$). Comparing month values only August differences were significant ($z = 2.553$, $p < 0.05$). Differences in mean movements by juveniles and adults were not significant, but taking August and September together, the data may hide an increase in juvenile movement in September as against August, when they were at the begining of their activity. In fact, dividing the two months' data the mean increases (August: N = 7, mean = 52.4 m; September: N = 2, mean = 87.5m), but the sample size was too small. Movement during the trapping period (Tab. 2) was measured from June to August, only for adults; other months and juvenile sample sizes were too small. Movements of males

Table 2. Distance between the most widely separated capture points.

Month	no. of animals	Distance (m) min.	max.	Mean (± S.E.)
		MALES		
June	6	22.36	100.00	54.51 (12.87)
July	6	28.28	144.20	60.32 (17.28)
August	8	63.24	145.60	100.15 (12.11)
		FEMALES		
June	5	20.00	114.00	75.46 (16.16)
July	5	40.00	102.00	72.76 (12.52)
August	7	20.00	104.40	69.04 (13,30)

were small in June and increased in August ($H = 6.26$, $p < 0.05$); differences through the months for females and by sex for each month were not significant.

Home range measured with 14 or more captures are available for 7 animals, 5 females and two males (Table 3). Male ranges were greater than those of females and increased if we consider only 1996 data (females mean range = 0.53 ± 0.11 ha). The range of the second female caught in 1995 was greater than that of other females. Differences remained also if we compare the home range dimension with the same capture numbers; considering weight and external aspect we think that this female was not reproductive that year.

Four animals, three females and one male, were caught in both 1995 and 1996; for two of them, one female and one male, we can measure an MVA in the two years (Table 4). Both animals frequented a larger area in 1996 than in 1995: the male showed an increase of MVA even if the area is calculated with few capture-points, while the female showed an increase of about three times, due to the increase of the capture-points. These animals were present in the area during the whole of the study period and did not change their frequented zone (MVA'96 coincided with MVA'95 for 53 % and 84 % respectively); when we started to trap in 1996 they showed the highest weight for their sex.

Mapping month by month all the capture points, it was possible to describe the pattern of animal space-use. In June animals concentrated their activity in two parts

Table 3. Garden dormice home range, measured for animals with 14 or more captures.

Code	Year	No. of captures	Home range (ha)	Mean ± S.E.
FEMALES				
00013C3E07	1995	14	0.45	
00014530C9	1995	18	1.04	
00013A8F41	1996	17	0.43	0.62 ± 0.12
00013B91F2	1996	18	0.42	
00013AB251	1996	15	0.74	
MALES				
00013C2E67	1996	17	0.94	0.80 ± 0.14
000142DDCD	1996	14	0.66	
FEMALES + MALES				0.67 ± 0.10

Table 4. Minimum Vital Area (MVA) for two animals caught in 1995 and 1996.

Code	Sex	No. of captures 95	96	MVA 1995	MVA 1996	MVA 96/ MVA 95	% of MVA 95 present in MVA 96
00013BA5F7	F	9	13	0.17 ha	0.64 ha	3.76	84 %
000142CA4F	M	12	9	0.30 ha	0.38 ha	1.27	53 %

of the grid: movements of males overlapped with the female range area, no sign of territoriality defence being noted. In July, animals were uniformly distributed in the grid, females' ranges were separated from each other and overlapped again in August, males' remained separated both months, with little overlapping of the areas frequented. Juveniles were caught from 20 August, they were homogeneously distributed in the grid area and their movements overlapped.

DISCUSSION

The space-use of small mammals may be investigated with trap-grids, but it is necessary to consider the limit imposed on the animals by the traps, meaning that we can obtain only a partial vision of their real movements. Evaluating home range size using the minimum area method, researchers may find the minimum points needed. STICKEL (1954) proposed a number of ten, KIKKAWA (1964) found that *Apodemus sylvaticus* did not increase their ranges at successive captures and that ten points were enough, *Clethrionomys glareolus* also showing an increase over that limit; DON (1983) reported that in *Sciurus carolinensis* the polygonal domain estimates may not reach an asymptote. However, the augmenting captures may show that the increase in range is real or the frequented area has shifted to another site. In our study, the garden dormice range is correlated with the number of captures and 10 points cover only 69 % of the area measured with 17 points, while with 14 points 90 % was covered. This difficulty in evaluating the effective home range size with trap-grids may be overcome if the aim of the work is to compare space use between sex, age, and periods in the same area. There are more problems when attempts are made to compare results of different areas or using different techniques. VATERLAUS (1997), for example, using radio-tracking on garden dormice found a mean home range size of 1.42 ha for females and 4.19 ha for males (Convex Polygon Method). The differences from our data are probably due to the method used, but it is remarkable that in both cases males were shown to have a greater range.

Space-use and movements of animals must be related to social organization and life cycle. MANN (1976), proposed for the garden dormouse an organization in small sedentary groups during the summer, with variable composition but distinct from each other. They were apparently disorganized, due to the high mobility of males, during the reproductive period in June. Our results were only in partial agreement with this. Data collected for two animals that were caught enough times over two years showed, in accordance with MANN (1976), that after hibernation adults like to frequent the same area as in the preceding year. We can assume that adults hibernate in a place found in their normal range area and when they became active again they try to occupy the zones they know, with the possibility of increasing it. The concentration in June, during the mating season, was probably due to males frequenting points where there were females, and not going out of those areas; their small movements in the trapping period support this observation. In July, female ranges were separated; we believe that every female finds a gestation area and be-

comes intolerant to other individuals; after the birth and nursing periods, this intolerance stopped. Females which were not reproductive remained more mobile and showed a greater range. Males increased their movements in August, and we can relate this greater activity to the necessity to accumulate an energy reserve for hibernation. Females occupied in nursing their young delayed accumulating this reserve and needed to be active longer; after 15 September, all the adults caught were females. Juveniles need to increase their weight fast because in mountain environments the temperature may drop suddenly in September. Our partial data are confirmed by MANN (1976), who reported an increase in mean movements of 71 % in September as compared to August, and PATRIARCA (pers. com.) who caught some juveniles during the day as well in September.

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SUMMARY

The social organization, home range and movement of the garden dormouse *Eliomys quercinus*

S. Bertolino, I. Currado, R. Azzollini & C. Viano

In order to provide information on the ecology of the garden dormouse in the alpine habitat, a field study was started in 1995 using the capture-recapture method. The research was carried out in the Val Troncea Natural Park, situated in the Western Alps (Piedmont region, Turin district). The study area is a fragmented woodland of *Larix decidua* grown on detritic conoids, the arboreal cover is not homogeneus because there are some parts with stone mounds. Animals were caught using 144 Sherman live traps, placed at 20 m intervals in a grid comprising 8 lines with 16–20 traps, covering an area of 4.68 ha. Animals were trapped over two years, in 1995 and 1996, from May to September; every month traps were set up for 5–6 days.

During the two year study 30 adults and 23 juveniles were caught: 14 adults and 9 juveniles in 1995, 20 adults (four of them were also caught in 1995) and 14 juveniles in 1996. Mean movement of adults during one night was about 50 m, with a peak of 209 m. Difference through the months were not significant, neither for males nor females. Males appeared to be more mobile then the females, expecially in August. Movements during the trapping period showed the same pattern for males: they were small in June and increased in August. Home ranges were greater for males (mean 0.8 ha, N = 2) than females (mean 0.62 ha, N = 5); a female not reproductive exhibited a bigger range (1.04 ha). Adults resident in the study area frequented the same part of the grid in 1995 and 1996.

In June animals concentrated their activity on two parts of the grid, and movements of males overlapped with the female range area. No sign of territorial defence was noted during the mating season. In July females found a gestation area and their range remained apart during birth and nursing. Males increased their movements in August, probably to accumulate an energy reserve for hibernation. Females occupied in nursing the young delayed accumulating this reserve and needed to be active for longer, as did the juveniles; both were caught after 15 September as well.

SAŽETAK

Druževna organizacija, životni prostor i kretanje vrtnog puha *Eliomys quercinus*

S. Bertolino, I. Currado, R. Azzollini & C. Viano

Da bi se pribavilo što više informacija o ekologiji vrtnog puha u planinskom staništu, započeto je 1995. godine terensko istraživanje uz korištenje capture-recapture metode. Istraživanje je obavljeno u parku prirode Val Troncea, smještenom u zapadnim Alpama (pokrajina Pijemont, torinski kotar). Istraživano područje je fragmentirana šuma ariša *Larix decidua* na kamenitom tlu, šumski pokrivač nije homogen zbog nekih dijelova pokrivenih kamenjem. Životinje su lovljene pomoću 144 živolovke tipa Sherman, postavljenih na 20 m udaljenosti u mreži od 8 redova sa po 16–20 klopki, koje su pokrivale površinu od 4.68 ha. Životinje su lovljene tijekom više od dvije godine, 1995. i 1996, od svibnja do rujna; svaki mjesec klopke su postavljane na 5–6 dana.

Tijekom dvogodišnje studije ulovljeno je 30 odraslih i 23 mlade životinje: 14 odraslih i 9 mladih 1995. godine, 20 odraslih (4 od njih su bili ulovljeni i 1995) i 14 mladih 1996. godine. Srednja vrijednost kretanja odraslih tijekom jedne noći bila je oko 50 m, s najvećom vrijednosti od 209 m. Razlika među mjesecima nije bila značajna, niti za mužjake niti za ženke. Čini se da su mužjaci bili pokretljiviji od ženki, posebno u kolovozu. Kretanja tijekom lovljenja životinja pokazivala su isti uzorak za mužjake: bila su manja u lipnju a povećala su se u kolovozu. Životni prostor mužjaka bio je veći kod mužjaka (srednja vrijednost 0.8 ha, N = 2) nego kod ženki (srednja vrijednost 0.62 ha, N = 5); ženka u neproduktivnoj fazi kretala se i na većem prostoru (1.04 ha). Odrasle životinje koje su prebivale u istraživanom području posjećivale su iste dijelove mreže 1995. i 1996. godine.

U lipnju su životinje usredotočile svoju aktivnost na dva dijela mreže, a kretanja mužjaka preklapala su se s područjem kretanja ženki. U doba parenja nije zabilježen nikakav znak obrane teritorija. U srpnju su se gravidne ženke odvojile i tako je ostalo i za vrijeme okota i podizanja mladih. Mužjaci su se više kretali u kolovozu, vjerojatno radi stvaranja energetskih rezervi za hibernaciju. Ženke zaokupljene podizanjem mladih stvarale su tu rezervu kasnije i zato su bile aktivne dulje, kao i mladi; oni su bili uhvaćeni i poslije 15. rujna.