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"Single-capture" rodents: vagrants or just newly weaned young?

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The reliability of the estimation of residency time of the bank vole *Clethrionomys glareolus* (Schreber, 1780) and the yellow-necked mouse *Apodemus flavicollis* (Melchior, 1834) in open populations was assessed by halving the 6-week intervals between trapping sessions. The status of "single-capture" individuals was identified to estimate the probability that they are native young rather than adult invaders. We found that the majority of "single-session" individuals constituted true transients that were present in the study plot for a short time only. They were young, immature rodents with a small body mass and a small number of captures. The probability that the "single-session" individuals stay on the plot for a longer time was 0.35 and 0.37 for voles and mice, respectively. These ostensible transients were trap-prone, fully-grown, mature adults, that revealed their presence on the plot already at the beginning of each trapping session. We found that "single-capture" individuals were mainly young, immature rodents that were not retrapped. The probability that the single-capture rodents are mature individuals, with a longer residency time, was 0.10 and 0.18 for voles and mice, respectively.

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Introduction

The common occurrence of individuals of small rodents that are caught only once, or only during one trapping session, in extended live trapping programs has been noticed fairly often. With relatively short trapping sessions interspersed at long intervals, this phenomenon is understandable but introduce severe bias into examination of demography and dispersal behavior in open population of rodents. The "transients" may be neighbours, "trap-shy" residents or dispersers moving through the study site (Watts 1970, Flowerdew 1978, Mazurkiewicz and Rajska-Jurgiel 1987, Jones 1990, Tew *et al.* 1994). As the status of "single-capture" individuals remains unclear, they are usually not included in estimation of population parameters.

Dispersal in rodents is a subject of profound interest (Stenseth and Lidicker 1992). Seasonal and long-term changes in site tenacity can affect population dynamics of woodland rodents in continuous forests (Mazurkiewicz and Rajska-

-Jurgiel 1998). However, the problem on the status of "single-capture" rodents has been rather neglected, as solving it is difficult due to insufficient information about individuals that arise from insufficient plot size or frequency of trapping.

The effect of plot size on the estimation of residency times of rodents was analyzed elsewhere (Rajska-Jurgiel, in press) but the problem on the status of short-stayers did not disappear with a study grid extension. Trapping programs are compromises between two criteria that are incompatible: (1) we must avoid sampling of "trap-living" populations, (2) we must obtain sufficient numbers of captures of particular individuals. In the study cited above, the interval between trapping sessions was 6 weeks. As this is the time span from conception to weaning of a litter, it allows for recording and marking successive cohorts of young. With this interval, one can also distinguish between (native) juveniles and adult immigrant (Rajska-Jurgiel 1992, 2000).

This paper describes an experiment that explored the consequences of different intervals between censuses on estimation of residency time of the same individuals of the bank vole *Clethrionomys glareolus* (Schreber, 1780) and the yellow-necked mouse *Apodemus flavicollis* (Melchior, 1834). This is also an attempt to answer the question: who are the individuals appearing for a short time in the trapping grids? The data come from the main breeding season of moderate density years when disappearance rates of rodents are higher than expected from mortality alone (Mazurkiewicz and Rajska-Jurgiel 1998).

Material and methods

The study was conducted in the Kampinos National Park, a large forest complex situated near Warsaw (52°20'N, 20°51'E), in 1988–1989. A 6-ha study plot was located in a mosaic of mixed coniferous forest and oak-hornbeam forest (Mazurkiewicz and Rajska-Jurgiel 1998). Live-traps were arranged in a 15 × 15 m grid. All data were collected by the capture-recapture method. Trapping was performed five times a year, the midpoints of the trapping sessions being 12 May, 7 June, 2 July, 18 August, and 8 October. A trapping session lasted 7 days. Usually about 95% of residents are captured in the first 3 days of trapping in island populations (Bujalska and Grüm 1989) or in 4–5 days in open populations (Mazurkiewicz and Rajska-Jurgiel 1987). Traps were checked twice daily. At each capture we noted the rodent number, trap location, sex, reproductive status, body mass and age (based on the body size and pelage color; see Mazurkiewicz and Rajska-Jurgiel 1987, Rajska-Jurgiel 1992).

The interval between trapping sessions in May, June, and July was 3 weeks, thus it was shorter by half than in the study cited above. These data were used to analyze the effect of between-session intervals on estimation of residency time of rodents marked in May and July. The residency time of the same individuals was estimated (1) based on their captures in May and July only, and (2) taking into account information about their captures also in June. All individuals were categorized into those present on the plot over May–July or July–August (residents), and those captured in only one trapping session, either in May or in July ("single-session" individuals or "transients"). In the next step, the transients were grouped into individuals present also in June (ostensible transients or OT) and individuals not captured in June (true transients or TT).

Results

The material consists of 1255 captures of 232 bank voles and of 530 captures of 149 yellow-necked mice marked in May and July. "Single-session" individuals,

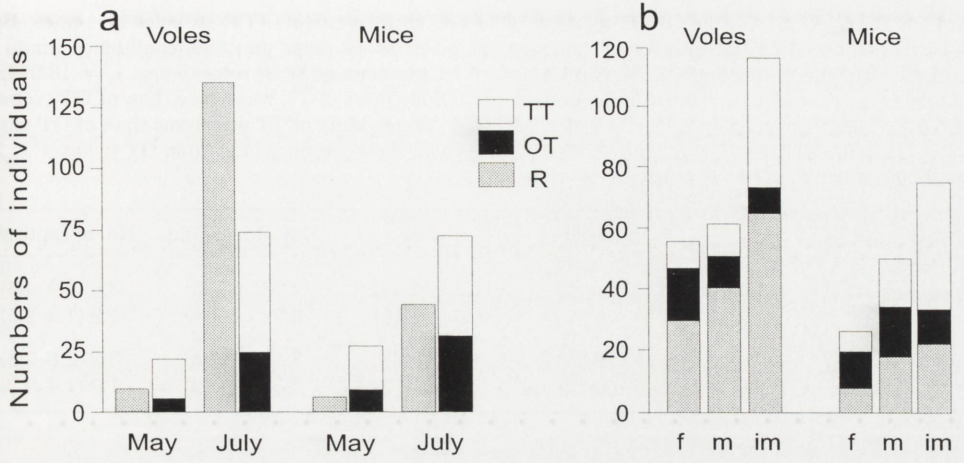

Fig. 1. (a) Numbers of residents (R), ostensible transients (OT) and true transients (TT) among May and July marked rodents. There were proportionally more true transients in mice than in voles (Chi-square test: $\chi^2 = 13.43$, $p < 0.001$). (b) Numbers of residents, ostensible transients and true transients among newly marked mature females (f), mature males (m) and immatures (im). There were more true transients among immature recruits than among mature recruits (voles: $\chi^2 = 12.9$, $p = 0.0003$; mice: $\chi^2 = 11.4$, $p = 0.0007$) and more true transients among immature than among mature "single-session" individuals (voles: $\chi^2 = 17.4$, $p < 0.0001$; mice: $\chi^2 = 14.4$, $p = 0.0001$).

trapped in only one trapping sessions, accounted for 41% of the voles and for 66% of the mice. We found, however, that 35% of the "single-session" voles and 37% of the "single-session" mice were in fact present on the plot also in June (Fig. 1a).

Total numbers of residents, ostensible transients and true transients among mature and immature May–July recruits are shown in Fig. 1b. Halving the 6-week interval between trapping sessions, we found that 59% of mature "single-session" voles and 57% mature "single-session" mice but only 15% of immature voles and 20% of immature mice were the ostensible transients. Thus, 38% of all immature vole recruits and 55% of all immature mouse recruits marked in May and July were truly present there only for one trapping session. The respective values for mature recruits were 15% and 27%.

Ostensible transients (OT) and true transients (TT) differed in many traits (Table 1). TT rodents were predominately immature individuals. The body mass of TT was lower than that of OT. TT individuals revealed their presence on the plot later than did OT. In the first two days, 63% of OT voles and 60% of OT mice were captured, but only 26% of TT voles and 29% of TT mice. Also the number of captures of TT was lower than that of OT (Table 1).

We found that 48% of the "single-session" voles and 45% of the "single session" mice were "single-capture" individuals. It means that they constituted 20% of all vole recruits and 30% of all mouse recruits. In total, as many as 76% of the "single-capture" voles and 71% of the "single-capture" mice were never retrapped true transients. Among them, 89% of the voles and 72% of the mice were immature

Table 1. Description of ostensible transients (OT) and true transients (TT) in voles and mice. Body mass, day of marking and number of captures are given as averages and 95% confidence limits (in parentheses). There were more immatures among TT than among OT in voles (voles: $\chi^2 = 13.97, p < 0.0001$; mice: $\chi^2 = 15.3, p < 0.0001$, Chi-square test). Body mass of TT was lower than of OT (voles: $F = 13.9, p < 0.001$; mice: $F = 17.4, p = 0.001$, ANOVA). Trappability of TT was lower than of OT (voles: $F = 5.7, p = 0.004$; mice: $F = 5.3, p = 0.006$). TT revealed their presence later than OT (voles: $F = 5.8$, $p = 0.003$; mice: $F = 4.5, p = 0.001$).

Species	Class	*n*	% immatures	Body mass (g)	Day of marking	No. of captures
Voles	OT	34	24	22 (20–24)	2.0 (1.6–2.5)	3.6 (2.9–4.5)
	TT	62	71	17 (16–18)	3.7 (3.1–4.1)	1.9 (1.2–2.5)
Mice	OT	38	26	26 (24–28)	2.4 (2.1–2.8)	3.2 (2.8–3.8)
	TT	61	66	20 (18–22)	3.8 (3.2–4.2)	1.9 (1.4–2.3)

young. The body mass of the single-capture individuals that were the true transients and the ostensible transients was 15 ± 4 g and 20.5 ± 6 g, respectively, in voles (ANOVA: $F = 8.14, p < 0.006$), and 19.5 ± 5 g and 27 ± 6 g in mice ($F = 9.2$, $p = 0.004$). Only 9% of all "single-capture" voles and 18% of all "single-capture" mice were mature individuals, with a longer residency time.

Discussion

We found that seed-eating mice being hunters rather than croppers were less site-tenacious than folivorous voles (see also Mazurkiewicz and Rajska-Jurgiel 1987, 1998, Rajska-Jurgiel 1992, in press). However, home range shift distances were found to decrease with increasing density in the voles, but not in the mice. At low density, under poor habitat conditions, dispersal distances and emigration/immigration rates significantly increase (Mazurkiewicz and Rajska-Jurgiel 1998). In both species, observed range lengths increase with time. The lifetime ranges, needed to satisfy all requirements over the life cycle, can be quite large even in such small creatures (Mazurkiewicz and Rajska-Jurgiel 1998, Rajska-Jurgiel 2000, in press).

Halving the time between censuses, we found that most of the "single-session" rodents actually stayed on the study plot for a short time only. The probability that so-called transients stay longer on the plot was higher for mature than immature individuals, and increased with their body mass and number of captures. The majority of "single-session" rodents were, however, true transients. These were young, immature individuals, with a small body mass. Some of them might have died but most of them probably dispersed. Dispersers commonly are maturing young (Watts 1970, Mazurkiewicz and Rajska-Jurgiel 1975, Bujalska and Grüm 1989, 1995, Gliwicz 1989, 1992, Rajska-Jurgiel 1992, Stenseth and Lidicker 1992, Viitala *et al.* 1994, Plesner Jensen 1996). According to Viitala *et al.* (1994), ca 50% of losses from a bank vole population was due to immature dispersal. Disappearance rates of newly marked rodents are usually higher than expected from mortality alone (Mazurkiewicz and Rajska-Jurgiel 1998).

Some individuals identified as transients in fact stayed in the study area a little longer. They were trap-prone, fully-grown, mature adults, that revealed their presence on the plot at the very beginning of each trapping session. The adult immigrants often appear on trapping plots, especially at low density (Gliwicz 1989, 1992, Brandt 1992, Mazurkiewicz and Rajska-Jurgiel 1998, Rajska-Jurgiel 2000). Also the immigrants disappeared soon from the plot as rodent populations include some vagrants/dispersers that move across the study plots (Rajska-Jurgiel 2000, in press) and little is known about them.

The practical guidelines to distinguish between the two categories of transients were as follow. Mature rodents that were captured at least three times and revealed their presence on days 1–3 of the trapping session, with a body mass of more than 19 g in voles and more than 23 g in mice, were found to be ostensible transients. Immature individuals that were captured 1–2 times and revealed their presence on the plot on days 4–7 of the trapping session, with body mass below 19 g in voles and below 23 g in mice, were true transients. Both, the true transients and the ostensible transients were dispersers rather than neighbors or visitors.

What was the true status of "single-capture" individuals as found in this paper? A great majority of them were not adult vagrants but immature young. The probability that "single-capture" rodents were mature adults, with a longer residency time was only 0.09 for the voles and 0.18 for the mice. Young, immature rodents as well as all strangers are usually "trap-shy" individuals (Gliwicz 1970, Watts 1970, Andrzejewski and Rajska 1972, Jensen 1975, Rajska-Jurgiel 1976, Smal and Fairley 1982, Brandt 1992), although their body mass does not significantly affect the trappability (Andrzejewski and Rajska 1972). The "trap-shyness" and the later captures of juveniles may be an effect of gradual changes in home ranges and the dependence on mothers and external food resources. Yet, we know that only few of them mature near the natal site (Watts 1970, Mazurkiewicz and Rajska-Jurgiel 1975, Gliwicz 1989, Stenseth and Lidicker 1992, Rajska-Jurgiel 2000).

The same was found with a method of study grid extension (Rajska-Jurgiel, in press). Neighbors or visitors from the surrounding area accounted for a small percentage of single-capture individuals recorded in the trapping grid. Only 12% of the voles and 14% of the mice were immigrants/emigrants that moved between the grid and the surrounding at a distance up to 450 m. Even looking from "beyond" the grid, the probability that "single-capture" rodents were immature young, with short time in the grid and the surrounding area, was 0.88 for voles and 0.86 for mice. However, 12% of the voles and 17% of the mice were trapped in the same trapping session off the grid, at a distance up to 350 m, when dispersing across the surrounding area (Rajska-Jurgiel, in press). These two papers show that both "single-capture" and "single-sessions" individuals are true transients/dispersers rather than neighbors or invaders. What are the effects of immature dispersal remains to be studied. However, high immigration rates of woodland rodents (Mazurkiewicz and Rajska-Jurgiel 1998) may suggest that the survival cost of dispersal may be less than some other costs of philopatry.

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