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Autumn swarming of the pond bat *Myotis dasycneme* at hibernation sites in Latvia

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Abstract. Capturing of swarming bats was carried out at five hibernation sites in Latvia in 2005–2007. In total 436 pond bats *Myotis dasycneme* were caught and marked with forearm rings. The most prominent swarming was observed in August–September, which corresponds with relevant results from other countries. Most bats caught were adults, with the domination of adult males. Spearman's rank correlation showed statistically significant changes in numbers of different age and sex groups of bats during the swarming season. Behavioural observations of bats and recaptures of males indicate that possibly the main reason for the swarming activity of pond bats is mating.

Key words: pond bat, *Myotis dasycneme*, swarming, hibernation sites, mating.

INTRODUCTION

Late summer and autumn activity or swarming at hibernation sites is supposed to be a characteristic behaviour of bats of the genus *Myotis* (Parsons et al., 2003a). Swarming is described as a social behaviour of bats, when they circle in high numbers before entrances of hibernation sites or inside the roosts (Fenton, 1969), sometimes staying there in smaller numbers the next day. It is most commonly proposed that the purpose of such an energy-consuming activity of bats can be both mating (Parsons et al., 2003a; Rivers et al., 2005) and introduction of the young bats with potential hibernation sites (Humphrey & Cope, 1976). It is also suspected that during swarming bats may check on the condition of the known hibernation sites before winter, or use them as transitional roosts on their way from summer to winter sites (Fenton, 1969; Whitaker, 1998). Several authors have reported about the high site fidelity of bats to their swarming sites (Parsons & Jones, 2003). Although it is a known phenomenon already for several decades, swarming is still one of the least investigated aspects for several bat species or geographical regions. Since pond bat is not evenly distributed throughout the

whole of Europe, and in most areas is regarded as a rare and vulnerable species, information about this species' swarming behaviour is practically nonexistent. There have not been any detailed studies on its swarming seasonality, behaviour, or other aspects of swarming. In Latvia no special studies on autumn swarming of any bat species had been conducted before 2005. However, we had several hints that such phenomenon can be observed at least at the biggest hibernation sites, including those used by pond bats.

A particular research project of swarming bats at three hibernation sites in Latvia was carried out in 2005–2007. Its aim was to find out whether swarming can be observed also in Latvia, which species and when do swarm, and whether there are differences in swarming between different age and sex groups of bats. In order to spread the study area, additional data about bat swarming were collected at two other sites during the inventory of all known hibernation sites of the pond bat in Latvia in 2007. Two of the investigated five roosts were the most important hibernation sites for pond bat in Latvia. In total our study revealed that seven species of bats were swarming in Latvia (Šuba et al., 2008). Particularly careful attention was paid to the investigation of pond bat, due to its special conservation status in Europe as a Council Directive 92/43/EEK Annex II species.

STUDY AREA, MATERIALS, AND METHODS

Study area

In 2005 three caves in Gauja National Park, Central Latvia, were selected for studies of bat swarming (Fig. 1). One of the caves, called Kalējala, was a natural 46 m long sandstone cave, known as a hibernation site mainly for the northern bat *Eptesicus nilssonii*. Another cave was an over 50 m long man-made sandstone gallery in Līgatne village, called Remdēnkalna cave, and the last one was a 60 m long dolomite cave (called 'Sikspārņu' or 'Bat' cave), which probably is a former underground mine. In 2005 studies began in the first half of August, and the first few times of catching were spent mainly on the approbation of methods. In 2006 and 2007 bat catching was continued at Remdēnkalna cave (since June) and at the dolomite 'Bat' cave, but Kalējala cave was not studied, mainly because of the lack of human resources to carry out the study in all three sites. In 2007 two additional pond bat's winter roosts were checked, one in the north (Dauģēnu, another natural sandstone cave) and the other, Fortress of Daugavpils City, in the eastern part of Latvia (Fig. 1). Bat catching at the former was performed two times (in August and September) and at the latter, three times (August, September, October). The dolomite 'Bat' cave in Gauja National Park and Daugavpils' Fortress are the biggest known hibernation sites of pond bat in Latvia.

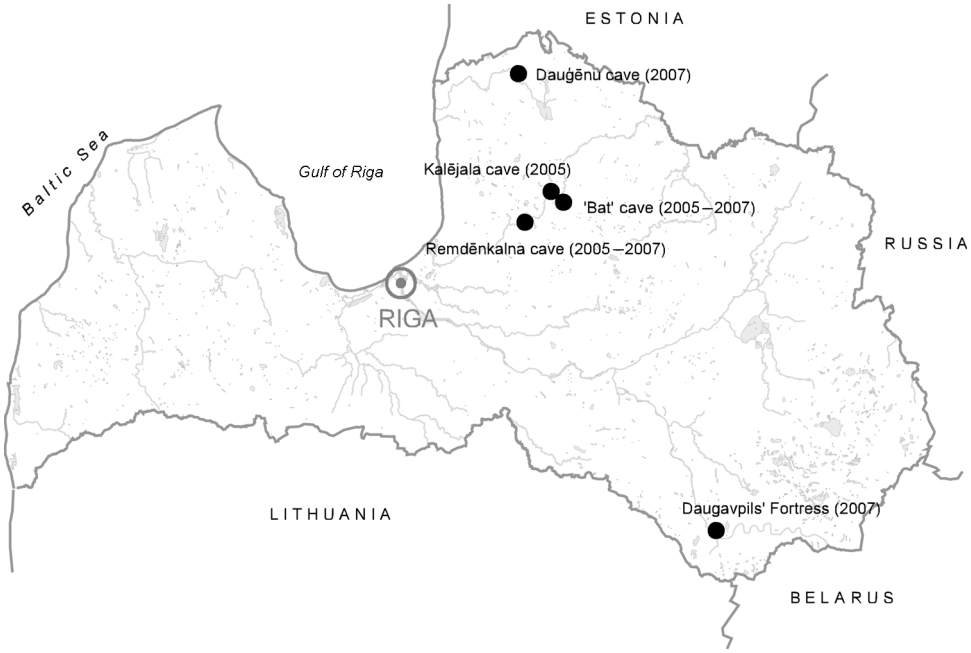

Fig. 1. Location of the studied swarming sites in Latvia and years when bat catching in each site was performed.

Catching methods and data analysis

Bats were caught with nylon mist nets (mesh size 14 mm) at the entrances of hibernation sites once a fortnight to avoid serious disturbance. Mist nets were put across the very entrances of the hibernation sites (Fig. 2); net size was adjusted to each roost's entrance size. Nets were erected at about sunset–one hour after sunset, and catching was carried out until dawn. In one case, in Daugavpils' Fortress, catching was cancelled at midnight because there were no bats swarming and many bats were already torpid inside the roost, so the possibility of disturbance was very high. Captured bats, except a few escapes, were marked with aluminium forearm rings. All animals were sexed, for most of them measurements of forearm length and weight were taken. Some bats were not measured only during nights of very high bat activity (300–500 bats per night). Age of bats (adult or 1st year subadult) was determined according to the degree of ossification of the epiphyseal joints in the finger bones (Anthony, 1988). However, especially towards the end of the season, age determination became more difficult and not always possible due to the further ossification of epiphysis combined with the considerable thickness and low transparency of the pond bats' bones. Bats were handled and released as soon after catching as possible.

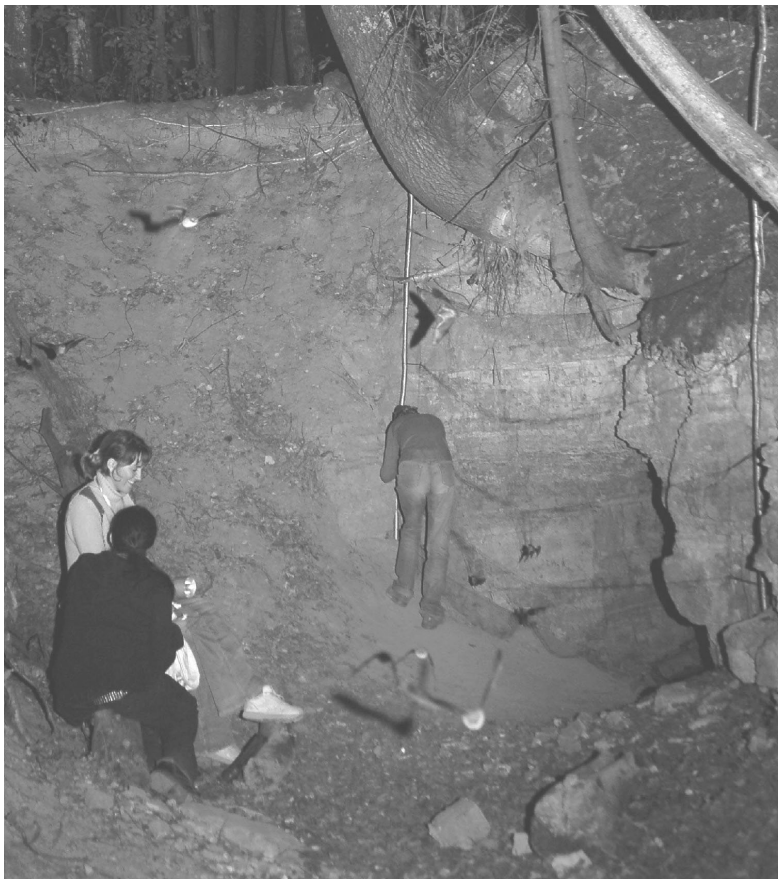

Fig. 2. Catching of bats at the entrance of the dolomite 'Bat' cave in autumn 2006. A mist net with an adjusted length is placed across the very entrance of the roost. The picture was taken in a moment of an intensive swarming of bats.

Catching data were grouped in corresponding half-months (e.g. second half of July, first half of August, etc.). Spearman's rank correlation was used to estimate statistically significant changes during the swarming season in different sex and age groups of bats.

RESULTS

Altogether 436 pond bats were caught at the entrances of four sites (Table 1), adding up to 10% of all swarming bats caught. At one site no pond bats were observed. Since most pond bats were caught at the entrance of the dolomite 'Bat' cave, data from this site from 2006 and 2007 were used for further analysis. Data from the year 2005 were not sufficiently comparable because of the slightly different catching approach during the first times of catching.

Table 1. Intensity of catching and number of pond bats caught at five sites in Latvia during the study period

Site, year	No. of nights of catching	Males			Females		
		Adult	Sub-adult	Indet. age	Adult	Sub-adult	Indet. age
'Bat' cave (2005–2007)	20	152	95	4	86	48	2
Daugavpils' Fortress (2007)	2.5	5	15	0	3	15	0
Dauģēnu cave (2007)	2	4	0	0	0	0	0
Kalējala cave (2005)	7	0	0	0	0	0	0
Remdēnkalna cave (2005–2007)	23	2	1	0	4	0	0
Total		163	111	4	93	63	2

In all three years swarming of pond bats started in the first half of August and continued until the end of October, when most bats caught had a considerably higher body mass and were ready for hibernation (J. Šuba & V. Vintulis, unpubl. data).

The peak activity of swarming appeared to take place in August–September. However, in 2005 and 2006, despite good weather conditions, a drop in the numbers could be observed in the middle of the season (Fig. 3).

Most of the captured bats, as shown in Table 1, were adult males. However, the proportion of different sex and age groups varied in different sites. Seasonal changes in the numbers of different sex and age groups of pond bats could be observed both in 2006 and 2007. The number of adult males was highest at the beginning of the season and dropped towards its end in both years (Spearman's correlation coefficient $R_s = -1.000$, $P < 0.01$, $N = 6$ and $R_s = -0.893$, $P < 0.001$, $N = 7$, respectively). A statistically significant negative correlation could be observed also between the numbers of adult and subadult or 1st year males ($R_s = -0.899$, $P < 0.05$, $N = 6$ in 2006 and $R_s = -0.901$, $P < 0.01$, $N = 7$ in 2007). In 2007 the difference was significant also between adult males and subadult females ($R_s = -0.811$, $P < 0.05$, $N = 7$). The number of 1st year males, on the contrary, increased significantly towards the end of the season ($R_s = 0.899$, $P < 0.05$, $N = 6$ in 2006 and $R_s = 0.901$, $P < 0.01$, $N = 7$ in 2007). A positive correlation could be observed also in the increase of the numbers of the 1st year males and females ($R_s = 0.870$, $P < 0.05$, $N = 6$ in 2006 and $R_s = 0.809$, $P < 0.01$, $N = 7$ in 2007). However, a statistically significant increase in the 1st year females towards the end of the season was observed only in 2007 ($R_s = 0.955$, $P < 0.01$, $N = 7$). In 2006 the numbers of the 1st year females increased as well, but not significantly. In both years there was a very high negative correlation between the total numbers of males and females ($R_s = -1.000$, $P < 0.01$, $N = 6$ or 7, respectively).

Figure 4 compares pond bat swarming in the 'Bat' cave (central Latvia) and Daugavpils' Fortress (eastern Latvia) in 2007, which probably illustrates seasonal

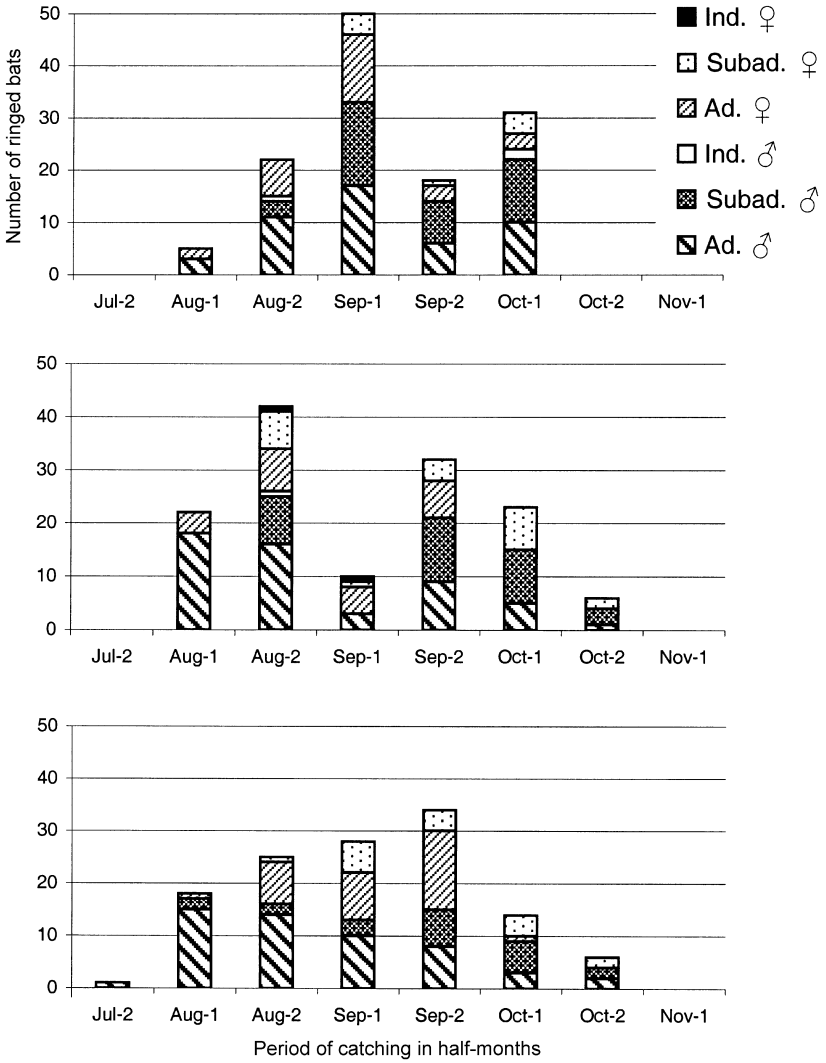

Fig. 3. Seasonal changes in the numbers of different age groups of swarming pond bats *Myotis dasycneme* in the dolomite 'Bat' cave in 2005 (top), 2006 (middle), and 2007 (lower diagram). Ind. – of indeterminate age, Subad. – subadults, Ad. – adults.

differences between these two parts of the country. In October there was practically no more activity of bats in Daugavpils, while in the 'Bat' cave some swarming still occurred.

Altogether 72 recoveries of 60 ringed pond bats were obtained in two of the swarming sites. As many as 27 animals were re-captured one to three times, and 33 were found dead (killed by a cat). Fifty of the recoveries, alive or dead, were of male bats; at the moment of the recapture they all were adult animals.

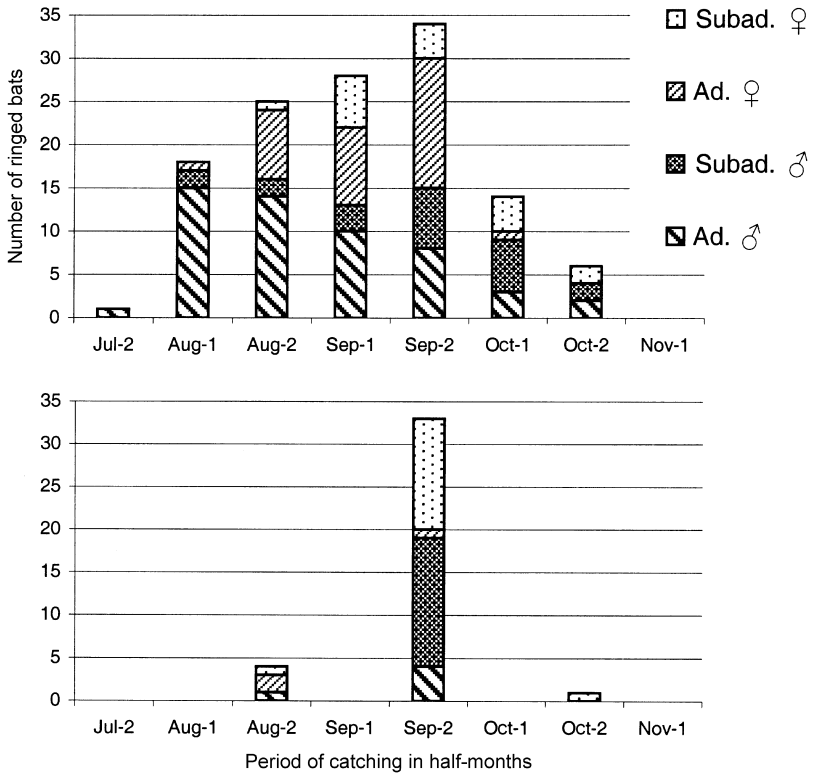

Fig. 4. Activity of swarming pond bats *Myotis dasycneme* in the 'bat' cave, central part of Latvia (top diagram) and Daugavpils' Fortress, eastern part of the country (lower diagram), 2007. See Fig. 3 for abbreviations.

Thirty-three of the male recoveries were obtained by repeatedly catching them during a swarming season. No recoveries of pond bats were made outside the study area. Twenty-two recoveries were of hibernating pond bats inside their swarming sites.

DISCUSSION

Our study gives evidence that autumn swarming of pond bat occurs also in Latvia, at least at the largest hibernation sites of the species. The peak period of swarming is August and September. However, quite high activity can be observed also in October if the autumn is warm. In two of the three seasons a drop in the numbers of swarming pond bats was observed in the 'Bat' cave in September. The reason could be either coincidence as the numbers of swarming bats can change considerably from night to night (Parsons et al., 2003b) or it can be a sign of the functional change of bat activity (end of intensive mating?). At the

beginning of the swarming season the number of adult males was the highest. A strong male bias has been reported in many swarming studies (Furmankiewicz & Górniak, 2002; Parsons et al., 2003; etc.) and concentration of sexually active males is supposed to give evidence of mating taking place during swarming (Parsons et al., 2003a; Rivers et al., 2005). Ringing/recovery data suggest that males most likely are territorial and bound to the swarming roosts. If so, they are bound to arrive at the mating place first and take their individual territories within the site. However, Parsons et al. (2003a) suggested that males can be more nomadic and less bound to their summer home range than females, so they can spend more time in swarming sites. As they are bound to the swarming place, they can also be more easily caught, at least at the beginning of the season. Chances to catch females, who probably visit males and swarming roosts only briefly for mating, can be considerably lower at that time. Later in the season as also the total number of females visiting the site is increasing, the number of captured females is higher while the number of active males decreases (or they learn not to get trapped in mist nets, or both). The mating theory is supported by two field observations of male pond bats chasing females into the roost (and being subsequently caught in a mist net). Also, a swarming pond bat male with distinct erection was caught (Fig. 5). Our observations suggest that mating activity is taking place already in very early stages of swarming. Possibly the negative correlation between adult and 1st year males indirectly shows not only seasonal swarming differences, but also intolerance of sexually active males to potential rivals during the first phase of the swarming season.

Towards the end of the swarming season the number of young bats considerably increases, while the number of adults, especially of males, decreases. Weighing of bats indicated that in October many bats, mostly females, were already fat and ready for hibernation (J. Šuba & V. Vintulis, unpubl. data). Probably the main activity of bats during the second part of the swarming season is finding and exploring unknown potential hibernation sites by young animals. The swarming activity of other bats at the entrance may help them to find such places. Therefore our hypothesis is that for the pond bat swarming is a polyfunctional activity. In the first phase of the swarming period mainly mating takes place, which to a less extent can be carried on also long into the second phase. In the second phase mainly young bats explore the swarming sites as potential hibernation places and towards the end of the swarming season at least part of the bats arrive with an intention of staying in the roost for winter.

The question whether the swarming bats stay to hibernate at the same site or move away after the swarming season is over was discussed by Parsons et al. (2003a). Recoveries of ringed bats in the 'Bat' cave and also Remdēnkalna cave in winter suggest that in Latvia at least a part of the swarming bats hibernate at the place of swarming. Moreover, no pond bats were caught during swarming at Kalējala cave, where this species had never hibernated. No pond bats were found hibernating in any of the known hibernation sites monitored every winter in Gauja National Park (V. Vintulis & G. Pētersons, unpubl. data). Some authors report that

Fig. 5. Adult male pond bat *Myotis dasycneme* caught with distinct erection is one of the proofs of mating during swarming.

the species composition during swarming represents the roost's composition of hibernating bats, only numbers are higher during swarming (Karlsson et al., 2002). In our study sites the number of swarming pond bats also was proportional to although considerably higher than the numbers of hibernating bats of the species (Table 2). This should not be surprising, because *Myotis* species are known to use different shelters such as deep cracks or crevices in walls and ceilings within their hibernation sites (Stebbings, 1988). The best hibernation sites of the pond bat in Latvia are very rich in crevices and other hiding places for bats, so only a small part of hibernating bats are visible and available to count in winter. Therefore we conclude that in Latvia, where suitable hibernation sites are very scarce but until the last few years winters have quite often been severe, pond bats have no other choice and must swarm and hibernate at the same (best) sites.

Data on differences between swarming seasonality in different parts of Latvia are not sufficient for drawing correct conclusions. However, catching data from

Table 2. Numbers of swarming and hibernating pond bats *Myotis dasycneme* in the studied swarming and hibernation sites. For the 'Bat' cave and Remdēnkalna cave only data about the last season are included

Site and year	Number of swarming bats caught (nights of catching)	Number of hibernating bats
'Bat' cave, 2007, 2008	126 (7)	15
Daugavpils' Fortress, 2007, 2008	38 (2.5)	15*
Dauģēnu cave, 2007, 2008	4 (2)	2
Kalējala cave, 2005, 2006	0 (7)	0
Remdēnkalna cave, 2007, 2008	2 (9)	0

* Number of bats hibernating only in the sector of the fortress where swarming studies were carried out.

Daugavpils (eastern Latvia) hint that possibly in the east of the country swarming ends earlier than in the central part and, most likely, also in the western part. In the second part of October many bats could be observed already hibernating in deep torpor in the Fortress of Daugavpils city, while in the 'Bat' cave (central Latvia) some swarming activity still took place and not many bats could be found inside the roost. Also in the second part of September the sex and age composition of swarming bats in Daugavpils was very similar to that in the 'Bat' cave two to three weeks later. Additional data are needed to define the possible geographical differences more precisely.

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Tiigilendlase *Myotis dasycneme* sügisene parvlemine talvituspaikade juures Lätis

Viesturs Vintulis ja Jurģis Šuba

Parvlevaid nahkhiiri püüti Läti viies talvituspaigas aastatel 2005–2007. Kokku püüti ja märgistati küünarvarrerõngaga 436 tiigilendlast (*Myotis dasycneme*). Kõige arvukam oli parvlemine augustis-septembris, mis ühtib teiste riikide andmetega. Enamik püütud nahkhiirtest olid täiskasvanud ja domineerisid täiskasvanud isased. Spearmani korrelatsioonikordaja näitas statistiliselt olulisi muudatusi eri soolis-vanuseliste gruppide arvukuses parvlemise perioodil. Isaste käitumise vaatlused ja nende taaspüügid näitasid, et tiigilendlaste parvlemise peapõhjus on arvatavasti paaritumine.