

## SURVIVAL LENGTH AND STRATEGIES OF THE LIGHT ATTRACTED CARABIDS IN THE CENTER OF A LARGE CITY

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**Abstract.** The excessive illumination of some places in the interior of large cities, especially of advertisements and some historical buildings, causes massive immigration of insects into such places. In Carabids, the most intensive migrations take place approximately from mid-July to mid-September, reaching the peak by the end of July – the beginning of August. In 1998 and 1999, marking and recapturing of medium sized and autumn-breeding species (*Pseudoophonus rufipes*, *P. calceatus* and *Dolichus halensis*) representing the major part of the light attracted Carabids was carried out in one such place in the centre of Bratislava. It was showed that the major part of the attracted individuals live the illuminated place within several hours. Only a small part of them remain there and form temporal aggregations, in which some individuals are able to survive for about 4-6 weeks. The proportion of the remaining individuals is very variable and independent on the number of the attracted individuals. There is only a weak tendency that the proportion of the remaining individuals is larger in the days with low intensity of migration. Beetles occupy different covers (ant galleries, armature of rain water pipes, ventilation openings) and use supplementary food resources (human food wastes, other light attracted insects, dead congeneric Carabids, dog excrements). The species show different movement and “hunting” strategies according to their life form – the stratohortobionts mostly walk slowly along the building bases and sometimes undertake trips into the centre of the pavement, with irregular trajectories and many pauses. They are often trampled by pedestrians. In contrast, the stratobionts hide in galleries in the bases of buildings and undertake quick attacks into the pavement in direct loop-like paths and rapidly return to the initial place.

**Keywords:** light pollution, migration, Carabids, survival strategies, large cities.

**Rezumat. Durata și strategiile de supraviețuire ale Carabidelor atrase de lumină în centrul unui oraș mare.** Iluminarea exagerată a unor locuri din centrele orașelor mari, în primul rând a reclamelor și a dominantelor istorice, provoacă imigrarea masivă a insectelor în astfel de locuri. La carabide, aceste migrații au loc aproximativ de la jumătatea lunii iulie până la jumătatea lunii septembrie, cu vârful la sfârșitul lunii iulie și la începutul lunii august. În anii 1998 și 1999, în centrul orașului Bratislava a fost efectuată marcarea și recapturarea speciilor cu talie mijlocie și cu reproducere de toamnă (*Pseudoophonus rufipes*, *P. calceatus* și *Dolichus halensis*), care reprezintă cele mai abundente specii dintre carabidele atrase de lumină în aceste locuri. S-a arătat că cea mai mare parte a indivizilor atrași părăsesc aceste locuri în cursul câtorva ore. Numai o mică parte din ele rămâne pe loc și formează agregatii temporare în care unii indivizii sunt capabili să supraviețuiască chiar 4-6 săptămâni. Proporția indivizilor care rămân pe loc este extrem de variabilă și independentă de numărul indivizilor atrași. Există însă o tendință slabă, ca proporția indivizilor stabiliți să fie mai mare în zile cu migrație puțin intensă. Gândacii ocupă diferite ascunzișuri (galerii de furnici, armatură de conducte de apă de ploaie, deschideri de aerisire) și se hrănesc cu diferitele surse suplimentare (resturi de mâncare aruncate, celelalte insecte atrase de lumină, carabide congenere moarte, excrementele câinilor). Speciile folosesc diferite „strategii de vânat” după forma lor de viață. Stratohortobiontele se târâsc cel mai mult pe lângă baza clădirilor și uneori fac „excursii” în centrul trotuarului pe o cale neregulată, cu multe pauze. Adesea sunt călcate de pietoni. Spre deosebire, stratobiontele se ascund în diferite galerii la baza clădirilor și fac atacuri rapide în centrul trotuarului, pe o cale directă, în forma unei bucle. După atac, se întorc la locul inițial.

**Cuvintele cheie:** poluarea cu lumină, migrație, carabide, strategie de supraviețuire, orașe mari.

### INTRODUCTION

The excessive illumination of the cities, advertisements and the roadways considerably change life conditions of animals in the landscape and modifies their migration paths, in particular of insects, which are strongly attracted to light and even contribute to the spreading of their geographical distribution (HALLQUIST et al., 2011). Light pollution has become a serious problem of nature and environment protection and is taken into consideration in landscape management (FRANCIS & CHADWICK, 2013; LONGCORN & RICH, 2008; NOWINSZKY, 2006; PATRIARCA & DEBERNARDI, 2010; POVOLNÝ, 2004).

Although insect attraction to light is known from the remote past and the collection of insects on light is recommended in different entomological manuals since the turn of the 19<sup>th</sup> and the 20<sup>th</sup> century, this phenomenon got a completely new dimension in the late 1920-s, when the electric illumination of streets and houses became a standard. Just at that time, *Agonum gracilipes* (Duftschmidt 1812), an eurytopic, but usually rare species, was surprisingly recorded in cities centres (DELAHON, 1931). The special affinity of this species to light was also shown by HONĚK & PULPÁN (1983). However, the classical bulbs used to illuminate public places did not act as a stronger attractant at night migrations of carabids. The intensity of illumination of public places considerably increased in early 1960-s, when mercury discharge lamps began to be used, being gradually replaced by the high-pressure sodium lamps. In such conditions, in the late 1970-s, it was observed that night migrations of Carabids in city centre depends on the intensity of local illumination and direction of streets in relationship to an area of urban greenery (ŠUSTEK, 1981; ŠUSTEK & VAŠÁTKO, 1982). A radical change came in the 1990-s, when strong halogen discharge lamps with high light temperature around 5000°K (OSRAM, 1994) and producing an enormously bright white light were introduced to increase attractiveness of advertisement or to illuminate significant historical dominants. Unlike the mercury discharge

lamps, they almost do not have the UV component in their spectre, but their intensive white light strongly attracts attention of the human kind and, obviously, also of the insects.

Due to it, insects are attracted into city centres in enormous amounts, penetrating even in the interior of supermarkets with permanently open entries or into flats. The local aggregations of huge amounts of “unknown” insects disturb pedestrians, draw attention of the public, provoke fear from an unusual phenomenon and cause hygienic problems. Such cases are commented even in the press (Fig. 16) or discussed in other mass-media.

The species diversity of Carabids and other beetles attracted to light in intensively illuminated places in the centre of big cities in warm evenings, especially from mid-July till mid-August can be very high (ŠUSTEK, 1999, 2002). Their temporal aggregations consist mostly in the species living in arable land in city surroundings, but also include many ripicolous or aquatic beetle species.

There arise questions – how the Carabids are able to survive in the city, how long they stay in places which essentially differ from their natural habitat and do not offer them corresponding food basis, and what strategies the Carabids use to survive in such unsuitable habitats. An attempt at answering this question is the objective of this study.

## MATERIAL AND METHODS

The study was carried out since mid-July to late October 1998 and from mid-July to early November 1999. It focused just on three medium sized Carabids – *Pseudoophonus rufipes* (De Geer 1774), *Pseudophonus calceatus* (Duftschmid 1812) and *Dolichus halensis* (Schaller 1783). They occurred sufficiently abundantly (Table 1) and their body size allowed marking them by complex pictorial codes allowing recording the date the individuals were captured for the first time. At the same time, activity of other medium sized species, represented in this site by few individuals, but constantly occurring, like *Chlaenius spoliatus* (P. Rossi 1792) was also observed. However, they were not marked to prevent their stressing or wounding. This allowed observing the behaviour of relatively rare species in conditions completely different from their natural habitats.

Table 1. Number of marked individuals of three Carabid species attracted to light in the centre of Bratislava.

Species	Year		Total
	1998	1999	
<i>Pseudoophonus rufipes</i> (De Geer 1774),	1,114	2,739	3,853
<i>Pseudophonus calceatus</i> (Duftschmid 1812)	17	446	463
<i>Dolichus halensis</i> (Schaller 1783)	20	108	128
Total	1,151	3,293	4,444

The study site was situated in the western part of the Hodžovo námestie square in Bratislava, where a perfumery shop had extremely illuminated windows (11 halogen lamps of 50 W) and the shop sign above them (six halogen lamps of 70 W). In addition, on the shield of the close house between the Panenská ulica and Palisády streets, a huge billboard illuminated by three 440 W halogen reflectors was placed (Fig. 1). The close vicinity of this place was illuminated by sodium discharge lamps of 400 W. In this way, a strongly illuminated place arose there. Isolines of illumination intensity are given in Figures 1 and 2. Immediately in the front of the shop, there was an about 15 meters wide asphalted footpath separated from the road by a grassy bad with several low pines. On left of the shop, as a continuation of the Panenská ulica street, an asphalted area serving as a bus stop was situated. This area was extremely busy, even in the late evening hours.

The study site was situated at the foothill of Little Carpathians at the altitude of 156.5 m a. s. l. Thus, it lied approximately at a level almost identical with the level of roofs of the houses in the southeastern part of Bratislava with the altitudes of 135-136 m a. s. l. Owing to it, the illuminated place was visible from a large distance and attracted the flying beetles from a large area. Due to it, their concentration in this place was much higher than in other strongly illuminated plates in the city centre (ŠUSTEK, 1999). The described form of this locality did not last long because the construction of an administrative building started in 2000.

The illumination was measured by the luxmeter Metra LUX PU 150. The beetles were marked by means of commercially available acetone-dissoluble colours used in apiculture for marking of bee mothers. In each day, other combination of dots on elytra was used. The colours were changed when the possibility to create a new code of dots combination was exhausted. The codes and colours used in those respective dates were recorded on carton cards, which made possible to identify the date, in which the recaptured beetles were marked and released. At each visit, the number of marked beetles was recorded. This mode of marking allowed to rapidly distinguishing the individuals, but it has a disadvantage that some individuals removed the dots from their back part of their elytra by cleaning it with the row of thorns on the inner side of the hinder tibia. This mode of cleaning was even observed *in situ*. Owing to it, some individuals might be marked repeatedly considered as new incomers and the recorded values of survival length can be lower than the real ones. This can be especially the case of *Dolichus halensis* and *Pseudoophonus calceatus* with smooth surface of elytra. In contrast, on the pubescent elytra of *P. rufipes* the marks held better.

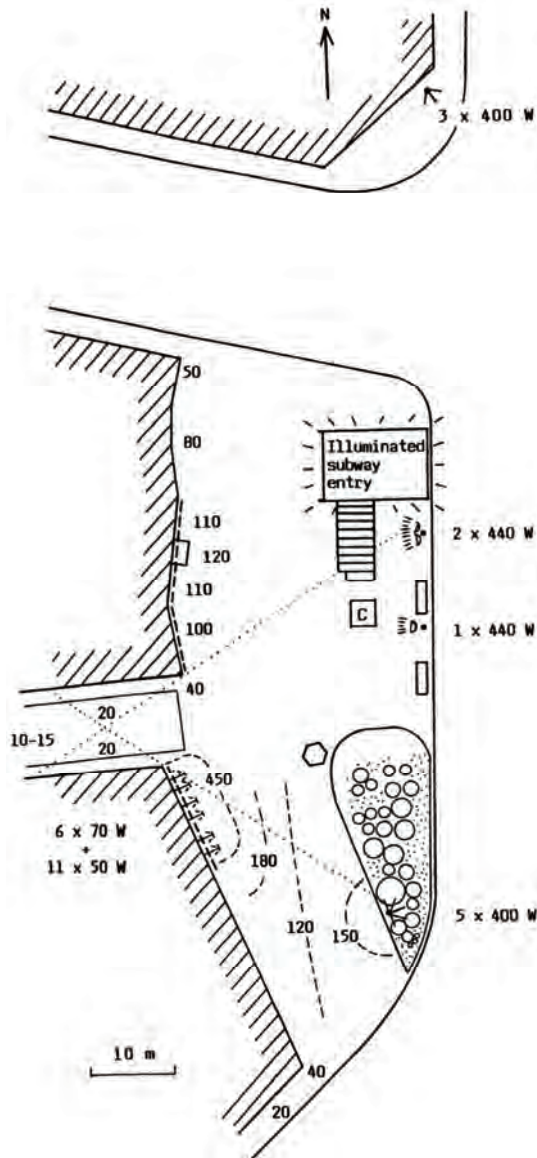


Figure 1. Situation of study site in the western side of the Hodžovo námestie square in Bratislava and isolines of illumination intensity in its individual parts, the 440 W lamps were halogen discharging lamps with the light temperature of about 5000 °K, while the 400 W lamps were sodium discharging lamps with typical yellow light.



Figure 2. Illumination intensity in lux in the vicinity of the shop windows, on which the beetles were attracted and along which they were marked and recaptured.



Figure 3. Illumination intensity in streets and squares in the centre of Bratislava.



The sites were visited at least every second-third day, after nightfall, from the second half of July till the beginning of November, when the last individuals of the three studied species were found. The length of visit and marking new individuals varied from 1 to 6 hours, according to the momentary temperature and the flight activity of beetles. The flight activity was especially high in the nights preventing passing a frontal system, when the number of marked individuals reached even several hundred.

By night, the illumination intensity in the darkest places of the city centre reaches only 4-6 lux, while in the most places illuminated by sodium lamps it varies between 30-60 lux, only rarely reaches to about 100 lux. In the places near shop windows or entries, illumination varies around 300-700 lux. In the particularly strongly illuminated places close to the light sources it reaches about 2,500 lux (Fig. 3), but at the immediate vicinity of the lamps on shop banners the light intensity can reach even 5000 lux (Fig. 2), which represents about half the intensity of the sun light in sunny summer days. The gradient of illumination intensity is however very steep, as shown on the illuminated wall around the perfumery windows (Figs. 1; 2). For the concentration of attracted beetles, the contrast of illumination intensity was important.

## RESULTS AND DISCUSSIONS

### Survival strategies of beetles attracted to light

The attracted beetles concentrated at the foot of walls, but in the especially warm days they also occurred on the whole surface of the footpath, at a larger distance from the strongest sources of light. In general, the attracted beetles, especially in the days of intensive nocturnal migrations, divided into two parts. The larger part stayed in this place only for one or three hours and then flew away. A smaller part colonized this place and searched there for covers.

As covers, the beetles mostly used the existing fissures in the pavement and between the pavement and the wall foot, in ventilation windows of cellars, around or between rain-water pipe armatures (Fig. 4), especially if some plants grew around them. They also hid in the sand filling spaces between stone tiles and often used the galleries built by ants (*Lasius* sp.).

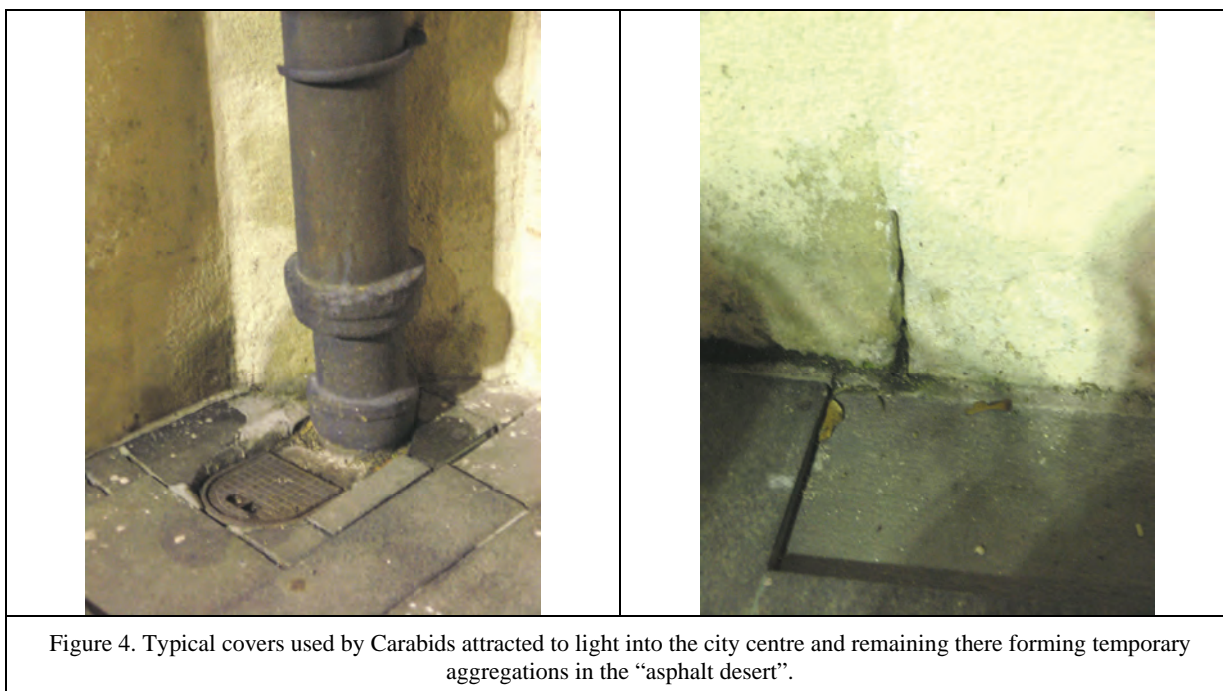


Figure 4. Typical covers used by Carabids attracted to light into the city centre and remaining there forming temporary aggregations in the “asphalt desert”.

There can be distinguished two movement and behaviour strategies of the Carabids forming temporary aggregations in the city centre. They are correlated with the life forms defined by SHAROVA (1981). One is used by the stratochortobionts including mostly the representatives of the genera *Ophonus*, *Pseudoophonus* and *Harpalus*. They mostly walked along the walls in a 2-3 cm wide strip of sandy substrate filling the fissure between the wall and asphalt. In warm days, they also tended to ascend on the walls toward the light sources up to the height of 2-3 m, only rarely higher. Some individuals running along the walls left this “secure” zone and slowly walked toward the centre of the adjacent pavement, in an irregular trajectory (Fig. 5), searching there for pray or food. They often broke the walking and stayed on a place for several minutes. During such walks, they often become victims of trampling by pedestrians. However, after such “trip” a part of them succeeded to return to the “secure” zone at the wall and continued to run along it. This movement was not continuous. They often rested in a place or hid for some minutes in ant galleries or other covers. After a time, they appeared again. There were no conflicts between beetles.

The second strategy was used by the “stratobionts inhabiting crutches” (SHAROVA, 1981). In this study they were represented by *Dolichus halensis* and three individuals of *Chlaenius spoliatus* (P. Rossi 1792). They usually stayed in the mouth of a gallery dug in sandy material at the wall foot and sometimes undertook short, but quick attacks toward the centre of the pavement. The trajectory had the shape of a smooth curve and rapidly returned to their starting point at the gallery entrance (Fig. 6). Only rarely they rested in the centre of pavement. They manifested an outstanding space memory and ability to orientate in this microhabitat. Due to such strategy, they only rarely become victims of pedestrians. In this way, one *Chlaenius spoliatus* was able to survive in one of the busiest places in Bratislava for almost three weeks.

The similar movement strategy of *Dolichus halensis* and *Chlaenius spoliatus* is remarkable from the point of view of their different habitat preference in western Palaearctic. *D. halensis* is here a typical mesohydrophilous species of arable land, while *Chlaenius spoliatus* is a ripicolous and polyhydrophilous species. However, the east palaeartic populations of *Dolichus halensis* inhabit vegetation on the loamy banks of brooks (personal observations in North Korea) and co-occur there with several eastern palaeartic species of the genus *Chlaenius*. Thus, the similar behaviour of *Dolichus halensis* with *Chlaenius* spp. may indicate that *Dolichus halensis* in west Palaearctic also originally inhabited dry shore terraces and preserved some behaviour features of the ripicolous species.

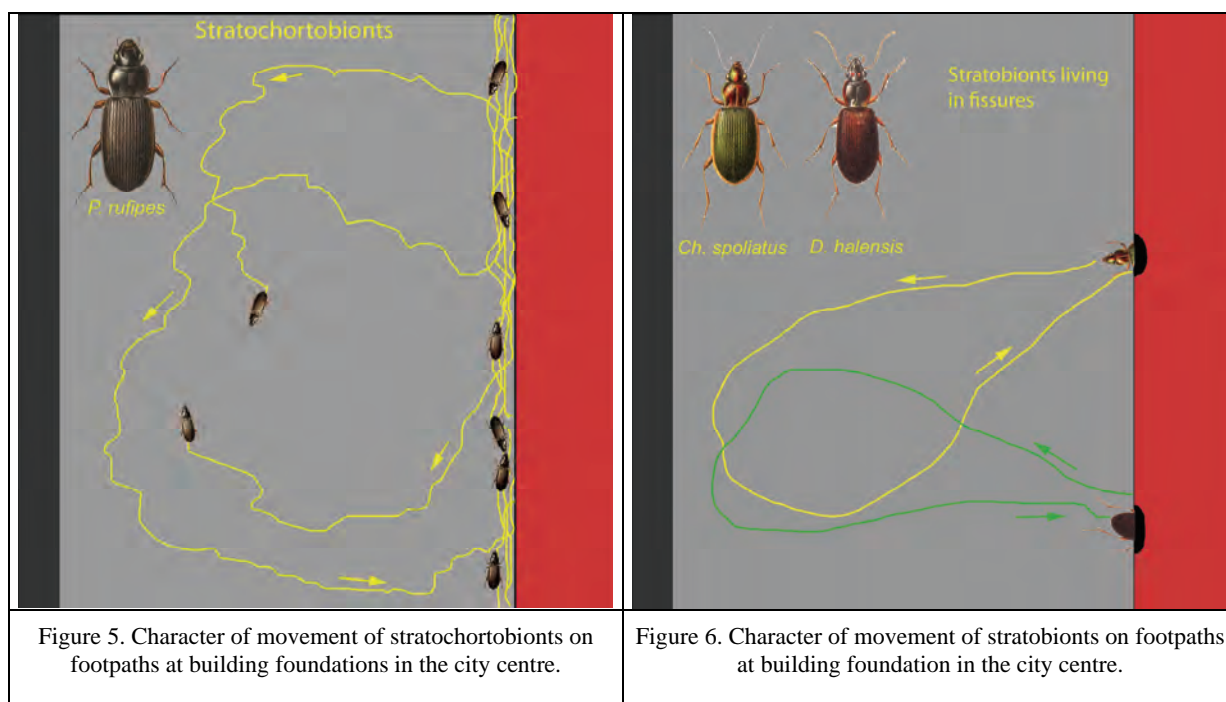


Figure 5. Character of movement of stratochortobionts on footpaths at building foundations in the city centre.

Figure 6. Character of movement of stratobionts on footpaths at building foundation in the city centre.

The beetles colonizing such unsuitable and unnatural places found there a relatively rich food offer. It permanently consisted of ants (*Lasius* sp.) cohabiting in the same place; in warm days, it also consisted of other insects (mainly Diptera, Homoptera and Neuroptera) attracted to light and falling down to the ground. However, the Carabids often ate pieces of fallen apricots or peaches, ice-cream drops or even dog excrements. They also ate the bodies of dead or trampled carabids, often conspecific individuals. This very wide food spectrum was made possible by panthophagy that is characteristic to the species of the genera *Pseudoophonus* and *Harpalus*.

#### Survival length of three Carabid species in the asphalt desert in the city centre

The number of beetles marked in individual evenings varied strongly ranging from 0 to 350 individuals (Figs. 7-14). The flight activity was quite independent on the momentary temperature, but in accordance with the observations of KÁDÁR & LÓVEI (1992) and KÁDÁR & SZÉL (1995), the extreme activity peaks occurred in the nights before passing a frontal system. The strong migrations occurred especially from mid-July to the first decade of August. Later, the activity declined considerably. Since mid-September, the three studied beetles flew to light only sporadically. However, strong night migrations of *Trechus quadristriatus* (Schrank 1781) were observed in early September, with culmination on the 8<sup>th</sup> of September 1998 (Fig. 15). This migration corresponds with the late autumnal peaks of occurrence of this species in different field ecosystems and to certain degree also in the damaged floodplain forests (ŠUSTEK, 1999).

The length of the flying activity of the three studied species was much longer in 1999 than in 1998. In 1999, the last individuals of *Pseudoophonus rufipes* were marked on October 15, whereas in 1998 on September 25. In general, in the days of high flight activity, the portion of beetles colonizing the study sites was much lower than in the days of moderate or low flying activity. On August 8-9, 1999, when 250-300 individuals of *Pseudoophonus rufipes* were marked each day, the marked individuals flew away within 2-3 hours after marking, being replaced by invasion of further individuals. Their departure was directly observed while marking other individuals.

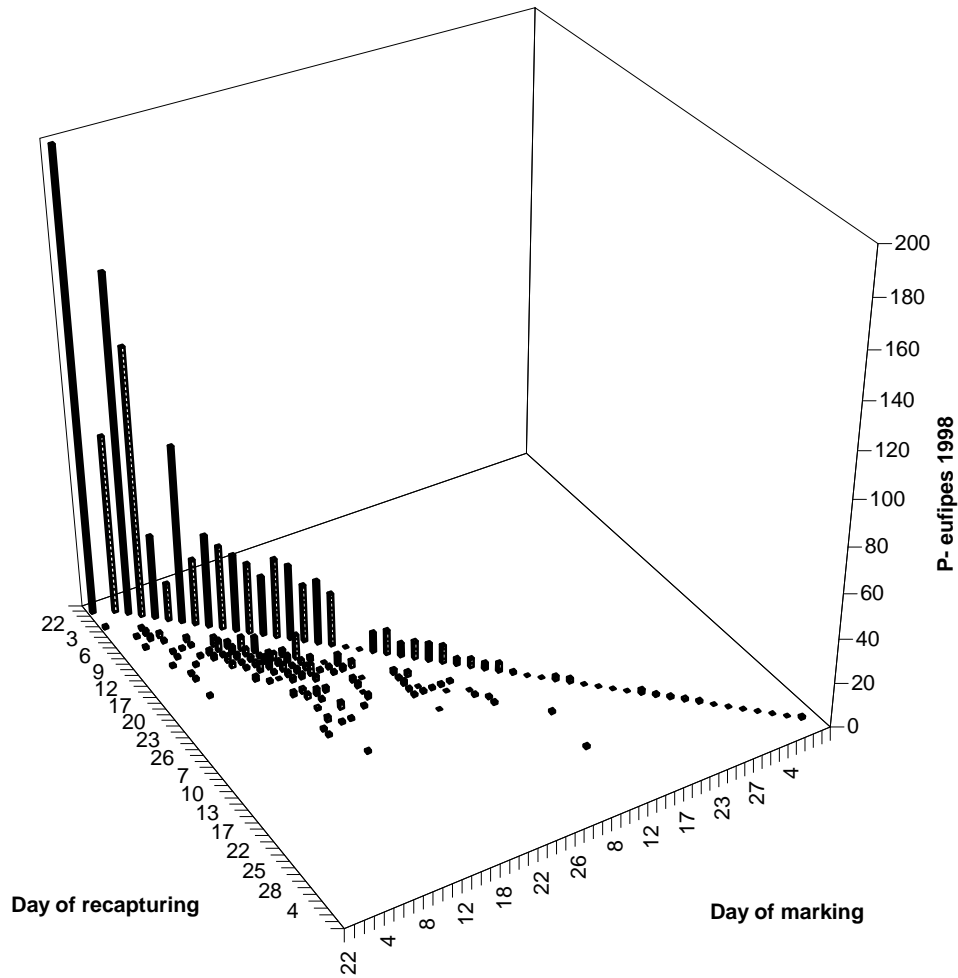


Figure 7. Number of marked and recaptured individuals of *Pseudopohonus rufipes* attracted by light in Hodžovo námestie square in Bratislava in the period July 22 - October 7, 1998.

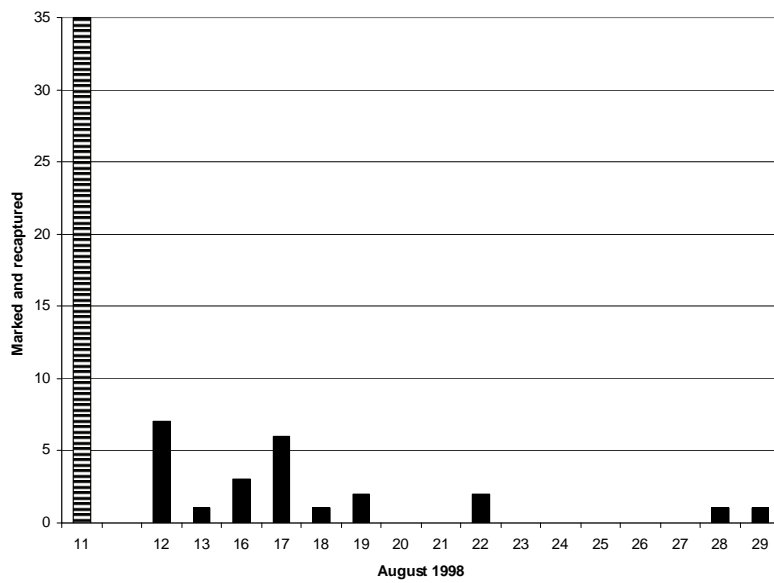


Figure 8. The longest period of survival (18 days) of *Pseudoophonus rufipes* in 1998 (35 marked individuals on August 11).

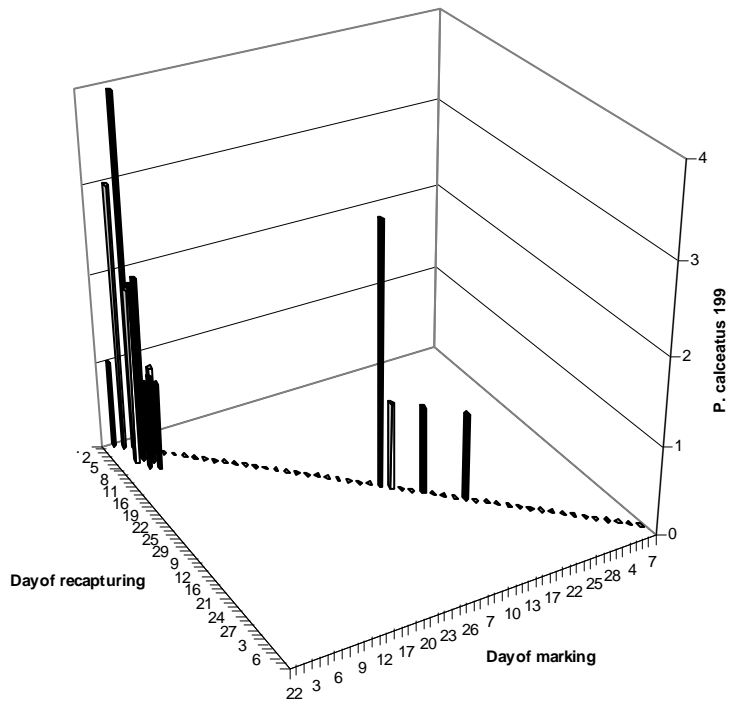


Figure 9. Number of marked and recaptured individuals of *Pseudoophonus calceatus* attracted by light in Hodžovo námestie square in Bratislava in the period July 22 - October 7, 1998.

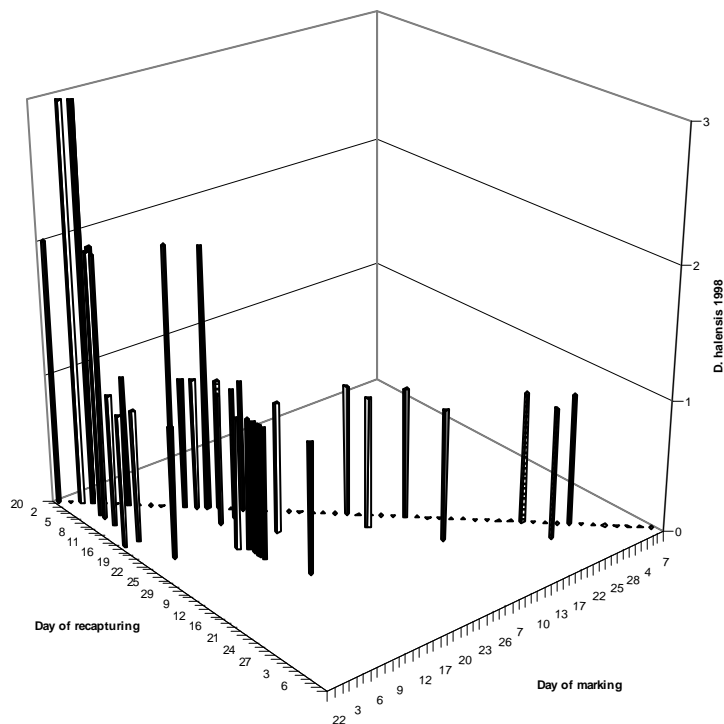


Figure 10. Number of marked and recaptured individuals of *Dolichus halensis* attracted by light in Hodžovo námestie square in Bratislava in the period July 22 - October 7, 1998.



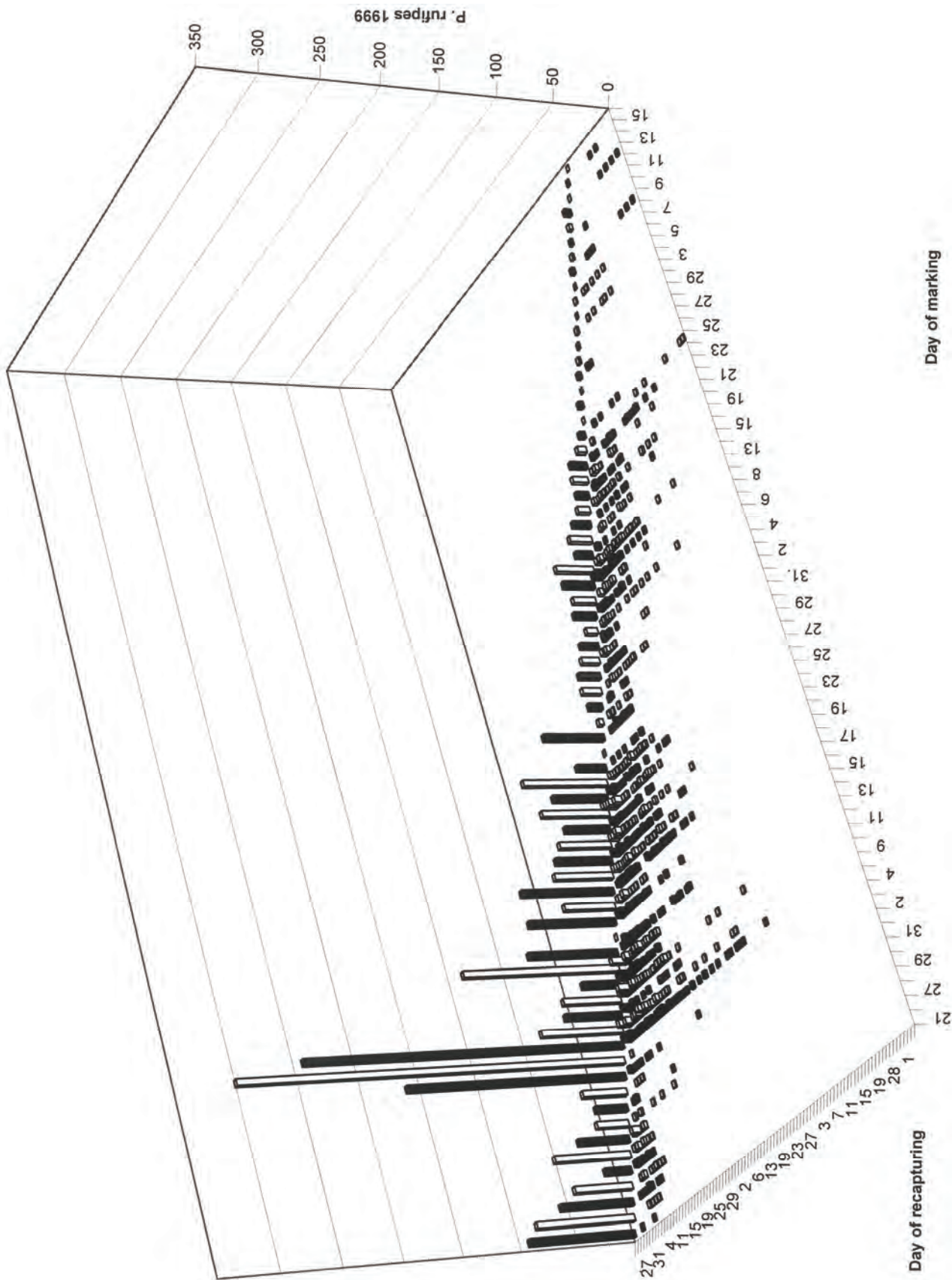


Figure 11. Number of marked and recaptured individuals of *Pseudoophonus rufipes* attracted by light in Hodžovo námestie square in Bratislava in the period July 21 - October 20, 1999.

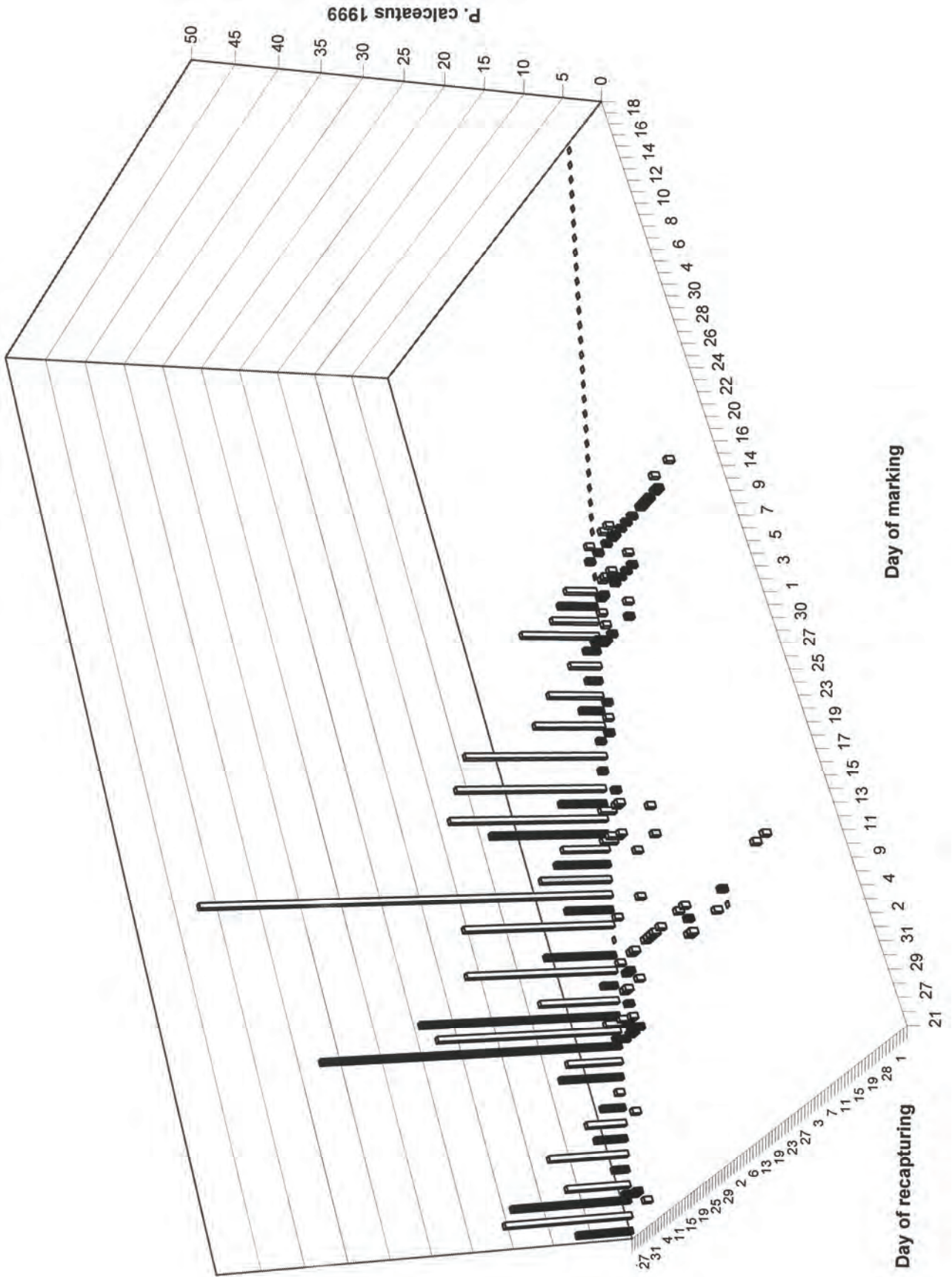


Figure 12. Number of marked and recaptured individuals of *Pseudoophonus calceatus* attracted by light in Hodžovo námestie square in Bratislava in the period July 21 - October 20, 1999.

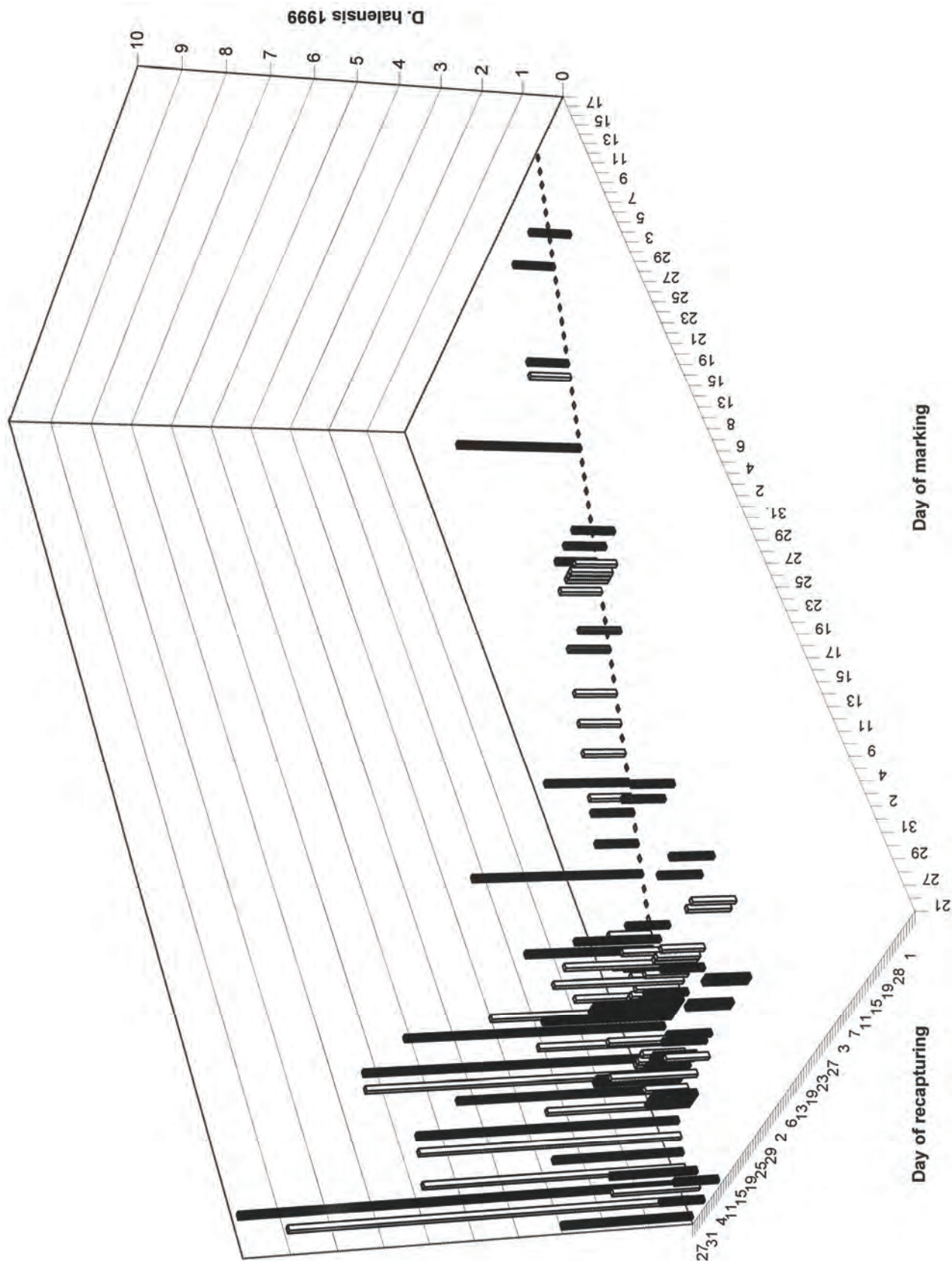


Figure 13. Number of marked and recaptured individuals of *Dolichus halensis* attracted by light in Hodžovo námestie square in Bratislava in the period July 21 - October 20, 1999.

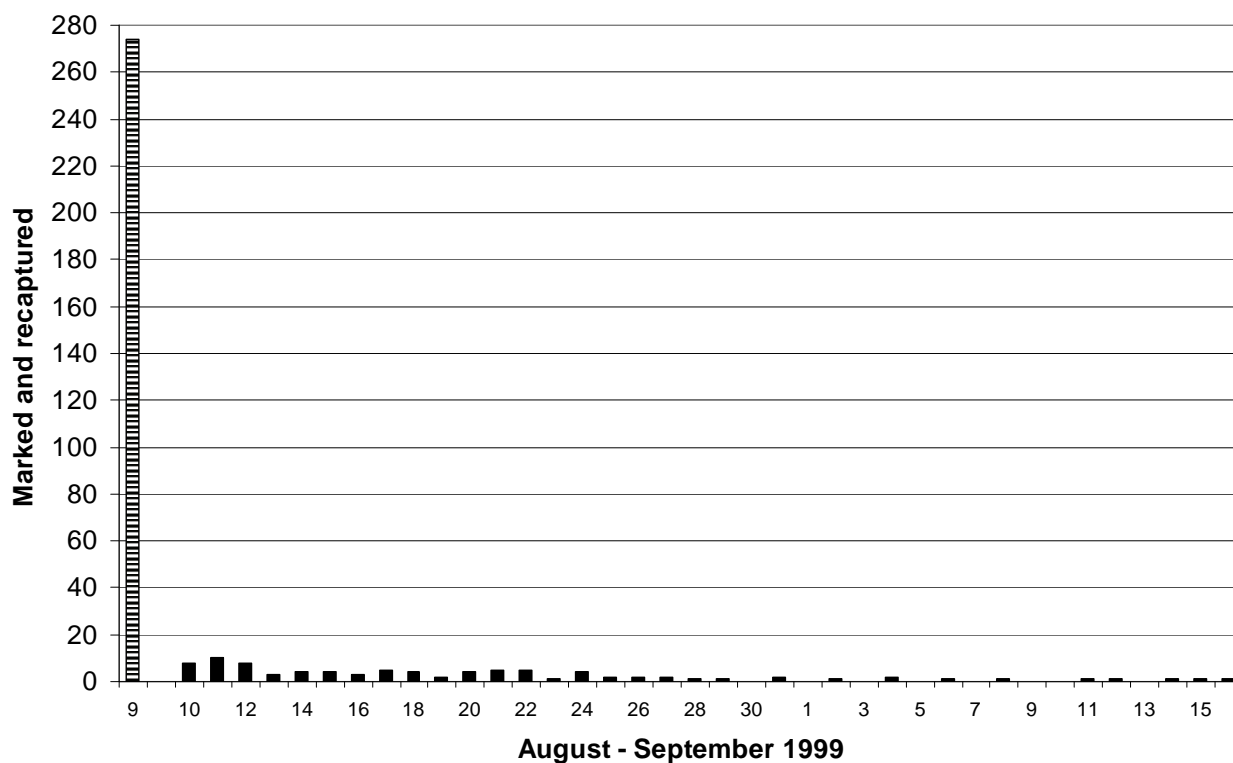


Figure 14. The longest period of survival (18 days) of *Pseudoophonus rufipes* in 1998 (35 individuals of marked on August 11).

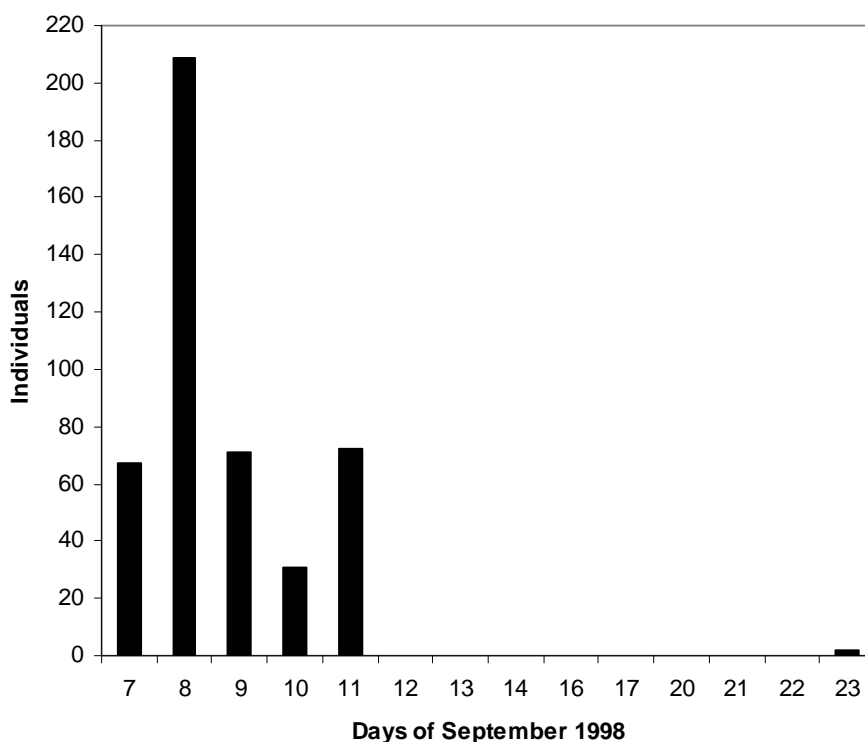


Figure 15. Flight activity of *Trechus quadristriatus* in September 1998 with a strong peak on September 8.

The relation between the number of marked and recaptured individuals of *Pseudoophonus rufipes* was very variable. This variability is best documented by the situation from early August 1999. Among 328 individuals marked on August 8, 1999 only one individual (!!!) was recaptured on the next evening and any other individual marked in



evening of August 8 was not found in the next period (Fig. 11). In contrast, among 190 individuals marked on August 4, 4 individuals were recaptured and one individual was recaptured during next 12 evenings, with several pauses.

Similarly, among the 274 individuals marked on August 9, even 10 individuals were found in the second next evening, while in the subsequent 16 days the number of recaptured colonists stabilized on 4-6 and in the period of further 24 days the number of recaptured individuals declined to 1. In this way, the longest survival time of 42 days was obtained (Fig. 14). In the movement activity of the beetles colonizing the study area differently long pauses are visible. These pauses occurred usually at the end of the life of marked beetles and their length was probably connected with the decline of vitality of individual beetles.

Less conspicuously, the same situation also occurred in August 1998 (Fig. 7). The high numbers of *Pseudoophonus rufipes* marked on August 2-4 are associated with the small numbers of individuals colonizing the study site and with a shorter period of their survival. On the contrary, relatively lower numbers of individual marked later, until mid-September, are associated with larger numbers of colonizing individuals and their longer survival. The longest period of survival (18 days) was recorded in the beetles marked on August 11 (Fig. 8).

The numbers of marked and recaptured *Pseudoophonus calceatus* and *Dolichus halensis* were always much lower (Table 1, Figs. 9, 10, 12, 13). In both years, most individuals of these species were marked in the first decade of August. Their flight activity lasted shorter than in *Pseudoophonus rufipes* and the survival of recaptured individuals also was shorter. Only among 5 individuals of *Dolichus halensis* marked on August 2, 1999 one individual survived 28 days. Similarly, in *Pseudoophonus calceatus*, the longest survival was observed in 10 individuals marked on August 14, 1999. Among them, only one individual was recaptured after 24 days. The pattern of survival of *Pseudoophonus calceatus* and *Dolichus halensis* differed from that of *Pseudoophonus rufipes* by a higher proportion (about 10 %) of individuals colonizing the study site. Similarly as in *Pseudoophonus rufipes*, there were observed pauses in the occurrence of the recaptured colonists at the second half of their survival period. The observed maximum survival of both species was shorter than that of *Pseudoophonus rufipes*. However, the observed values could be influenced by the worse adhesion of colours on smooth elytra of both species, from which the marks could be easier removed. However, the potential survival of *Pseudoophonus calceatus* can be similar as in *P. rufipes* and in *Dolichus halensis* it can be still longer, because of other movement strategy (see above).

Among other Carabids, a mass flight activity and attraction to light was observed only in *Trechus quadristriatus* (Fig. 15). That occurred only during five days in early September 1998, with an expressive peak on September 8. Later, only one individual was observed on September 23. Obviously, all attracted individuals left the study site quickly.

## Kvapníci jdou za chladem. Nový domov našli v nemocnici

**Brouk plní prostory bohunické nemocnice. Neškodí, ale personál neví, jak se hmyzu zbavit.**

NELA MATÁSEJE

Mrtvá hmyzí těla tak musí personál nemocnice neustále odklízet. Je to bláznovce. Jsme domluveni s úklidovou službou, která potluče každou hodinu chodby nemocnice. Nevypodí dobře, když se ve zdravotnickém zařízení považují mrtví brouci, přispěl Bába.

Pacienti i návštěvníci bohunické nemocnice si totiž často myslí, že jde o rasy nebo invazy, které jsou symbolem špatné hygieny. Kvapník je ale podle odborníků neškodlivý. „Na člověka ti to brouci nepřemáje. Ji žádnou nikara, spíše jej pouze obtěžují svou přítomností. Je

oddělení environmentální epidemiologie Zdravotního ústavu Brno Milan Tejček, který doporučuje proti broukovi nasadit síť do oken. Podle Jaroslava Bába to ale nemá smysl. „Musely by se zabarikádovat všechny vchody, a to zkrátka v nemocnici nejde,“ uvedl deratizátor.

Většina lid karšského personálu a broudem navíc

Kromě nemocnice se ale kvapník objevuje i v dalších zařízeních. „Obstředíme ho z nádrží, hypermarketů i třeba z budovy pošty. Za posledních pět let je to problém nejen Brna, ale i celé republiky,“ tvrdí Bába.

S tím souhlasí také deratizátor Stanislav Kopr. Brouci hledají klimatizaci a místa, kde nebude ledadla stupit. Není možné se divit, když nalézají do hypermarketů a velkých obchodních středisek. Je rozšířen i v centru v Dolních Hrástcích,“ uvedl Kopr.

Klimatizované obchodní prostory tu podle něj vznikly prakticky v polí, kde předtím brouci mnoho let žili. „V jejich přirozeném prostředí se tak objevila chladná místa, ona je pozna využívají,“ myslí si Kopr.

**Přemnožený není**

Kvapník plstnatý, který ve svém přirozeném prostředí žije až tři set dnů, pry ale v Brně přemnožený není. „Jeho počty jsou v normálu. Spíše se jen snadí ukryt před příliš teplým počasím, proto na něj člověk může častěji narazit. Není problém ho potkat třeba v bytě nebo rodinném domě,“ dodal brněnský entomolog Václav Pižl.



Figure 16. An article from the newspaper Rovnost from July 2000 about the occurrence of *Pseudoophonus rufipes* in the hospital in Brno – Bohunice (Moravia). The title translation: “The beetles search for cold. They have found a new home in the hospital. The beetle fills the interior of Bohunice Hospital. It does not cause any damage, but the personnel does not know, how to get rid of the insect” The text contains an interview with Václav Pižl, an entomologist, about the problem. The interviewed man is not a specialist in carabids. Therefore some information is not accurate.



## CONCLUSIONS

The attraction to extremely illuminated sites in centres of cities results in formation of temporary aggregations of Carabids, but most of the attracted beetles leave the illuminated sites within a few hours. Thus, such sites do not represent a fatal trap for most of them. The individuals, which colonize such places, show a remarkable adaptability to a highly unfavourable habitat. They have a survival chance of 2-3 weeks, but in extreme cases even of six weeks. However, the presence of the extremely illuminated places in urban or free landscape (advertisement billboards along highways) can considerably influence the migration paths of Carabid beetles and can reduce their chance to find new suitable habitats. In this way, the diversity and structure of the ecosystem can be reduced or unnaturally modified. At the same time the light attraction of Carabids can support the metapopulations inhabiting the plots of urban greenery, parks and gardens in residential quarters.

The most negative aspect of the attraction of Carabids (and other insects) to the extremely illuminated places in the cities is the producing of conflicts with the public (Fig. 16) and hygienic problems in shops or some public institutions. In the private sphere, the most affected social group are the owners of flats situated near to the huge illuminated advertisement tables placed on walls of living houses. The beetles fly in considerable numbers into the opened windows and disturb the inhabitants, who turn with claims and questions to the radio or TV. This experience should be used for formulation of hygienic criteria for the regulation of the placement of illuminated advertisements in the cities, as well as to regulate the excessive energy consuming illumination as such.

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