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**METHODS OF CONTROL
OF SYNANTHROPIC GERMAN COCKROACH
(*Blattella germanica* L.) IN VARIOUS URBAN ECOSYSTEMS**

**METODY KONTROLI I ZWALCZANIA
SYNANTROPIJNYCH KARACZANÓW (*Blattella germanica* L.)
W RÓŻNYCH EKOSYSTEMACH MIEJSKICH**

Abstract: The German cockroach (*Blattella germanica* L.) is an omnivorous species. It feeds on leftovers, animal food and also on book hardcover. The presence of cockroaches around municipal structures allows these pest for reproducing and increasing the population numbers in various synanthropic ecosystems. Intensive development of cockroach populations is one of the main reasons of allergies, bronchial asthma and other human diseases. Moreover, cockroaches may transport bacteria and disease vectors on their body and in faeces. For these reasons the control of cockroach invasion is not only an aesthetic problem but also an important issue of health care.

In this paper an attempt was made to estimate the composition and numbers of insects living in various synanthropic ecosystems with the use of pheromone traps. Than appropriate insecticides were applied to control the pest.

Changes in the species structure of cockroaches were traced using pheromone based glue traps placed in selected sites like Warsaw hospital, private apartment, shop and bakery. Larvae and males prevailed on traps; females were caught in lower numbers. Females had cocoons which affected the number of caught larvae. Besides, other animals were caught in the glue trap such as the Oriental cockroach, flies, ants and house mice attracted by an easy access to food.

Keywords: synanthropic organisms, the Oriental cockroach (*Blatta orientalis*), the German cockroach (*Blattella germanica*), control methods

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The occurrence of synanthropic insects is largely affected by city infrastructure. In cities we observe clusters of residential houses accompanied by public buildings like hospitals, crèches, schools, shops and supermarkets. Waste bins are often situated nearby. Depending on location, they are emptied daily or once a week. This makes favourable conditions for invasion and spreading of cockroaches but also of rodents, birds and mammals looking for an easy access to food in the city agglomeration.

Isolation from other buildings is an important factor for public buildings which often form separate complexes. Hospitals or large shops (supermarkets) in Warsaw are routinely surveyed for the presence of synanthropic insects and rodents attracted by easily accessible food. This may decrease the population growth of synanthropic insects and their further invasion to apartments.

Residential blocks, where one staircase contains from 5 to 100 flats depending on the construction period, present a bigger problem. An excellent location for the population of the German cockroach, other insects and synanthropic rodents is residential blocks built up in the 1960s and 1970s in the centre of Warsaw. Studies were performed in a flat there. An occupant complained about the invasion of cockroaches. In the centre of Warsaw flats are often rented by students and foreigners working in fast food bars situated in Warsaw and neighbouring communes. Therefore, in such flats, half-finished food products are often prepared and stored. This offers an excellent base for the development of synanthropic insect populations. Another threat is posed by open rubbish chutes on each floor with remaining food leftovers. One may often find there large junk which does not fit into dustbins. This makes a good base for the German cockroaches to occupy and stay outside their feeding period. Cockroaches were seen walking late evening in the corridor near the flat where pheromone traps had been laid. In large communities of people like those living in residential blocks, repairs in flats or in common grounds may leave numerous cracks which facilitate movement of insects and even of rodents.

The next problem is with the costs of disinfection of large residential objects. Many residents do not attempt to control pests thus facilitating their development. This is a result of ignorance about the harmfulness of synanthropic animals on one hand and of the aspiration to live “ecological” life on the other. Means used in the insect and rodent extermination are often toxic or cause an allergic reaction in residents. The problem is also with their improper application. A frequent error made by disinfection firms is an excessive dilution of insecticides, not obeying the methods of their application and a lack of preliminary analyses as to what pest they are dealing with in a given area.

The German cockroach (*Blattella germanica* L.) is a synanthropic species whose life cycle is bound with humans, especially with their building infrastructure. It occurs worldwide, its presence is limited only by temperature [1–3]. The presence of cockroaches around municipal structures allows them to reproduce and increase the number of their populations in various synanthropic ecosystems. They easily migrate through electric and hydraulic connections, dry hydraulic siphons, through cracks in the wall and draughty window frames. They may also get to houses with purchased food, in books, shoe bags etc. Cockroaches search for food more with olfactory than with visual

receptors [1, 4]. Rivault [5] found that single cockroaches are able to migrate at a distance of 3 to 85 m a day. This affects colonization of new spaces by these insects where they actively search for food. Jeanson et al [6] found under laboratory conditions that cockroaches, unlike other animals, are not territorial. They only attempt to keep 3–12 mm distance from each other. Therefore, their population may rapidly develop and exist in a given area.

Omnivory enables their survival under variable local conditions [7, 9]. The whole life cycle of the German cockroach lasts 100 days. It is assumed that the active population of cockroaches is composed of 80 % nymphs and 20 % of adults [1, 9, 10]. Intensive development of cockroach population is one of the reasons of allergy, bronchial asthma and other human diseases. Moreover, cockroaches may transmit bacteria and diseases on their bodies and in faeces [11, 12]. In hospitals cockroaches may transmit pathogens responsible for infections [7, 13, 14]. For these reasons the control of cockroach invasion is not only an aesthetic problem but also an important issue of health care. The German cockroach is a subject of studies carried out by many scientists worldwide who search for new chemical and other control methods [15–17].

Material and methods

Pheromone-glue traps were the study material. These traps do not contain any chemical means; therefore they may be safely used in any space. Attracting substance is contained in the tablet made of a herbal mixture of patented composition which gives an effect of natural insect pheromone.

The studies were carried out in selected Warsaw hospitals, private apartments and bakeries. Insect detectors were placed in various rooms (bathrooms, kitchens, stores, water distributors). Traps were displaced in places with potentially available water or moisture (such places are preferred and searched for by cockroaches) and in places where food may possibly be found. Such places included hosepipes delivering water, the rears of refrigerators near water condensers, surroundings of bathtubs, shower bases, microwave cookers, places of food distribution, dish washers and the rears of bookshelves and cupboards used to keep food in original wrapping.

Insect detectors were exposed in particular rooms for one month with the description on each trap of the date and place of exposition. At the same time a protocol was prepared with detailed description of places of trap exposition. Persons who could have a contact with traps were informed on the necessity of leaving them in place. After the study period all traps were collected in a bag with the description of the object of origin.

The numbers and species of attracted insects were analysed in the Chair of Biology of Animal Environment of Warsaw University of Life Sciences SGGW (WULS-SGGW).

Based on the numbers and types of growth forms of insects one may select appropriate control means and apply proper concentrations of chemicals to achieve efficient and safe insect elimination whether by spraying with low or high pressure facilities or by using insecticide paste (in places where aerosols could not be used).

Results and discussion

Pheromone-glue trap is used to estimate insect intestation in a given area. Nymphs of cockroaches were most frequently caught in glue traps (Fig. 1). Many larvae hatched from cocoons carried by females were also found there. Most such newly hatched larvae were found in the apartment and the least – in bakery. This resulted from the fact that the young hatched from the cocoon carried by female even after its death. The young are a potential source of reconstruction and development of the German cockroach population in a given area.

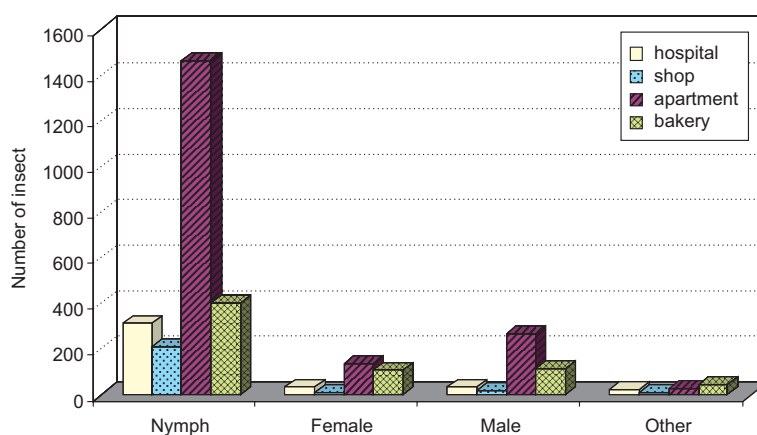


Fig. 1. Mean number of German cockroaches (*Blattella germanica*) caught in pheromone-glue traps

In this experiment only the population of cockroach from bakery was less active. Most active cockroaches were found in the apartment (1899 individuals including 1469 nymphs) compared with the bakery, where only 408 nymphs were noted. The least nymphs (214) were recorded in the shop (Fig. 1).

The catching in a given trap depended also on the place of its exposition (Photo 1). The greatest number of cockroaches in various growth stages was noted in traps placed near refrigerators, food stores, taps and microwave cookers.

This was a results of their physiology and tendency to hide from people's sight. Apart from the German cockroach the traps caught also other synanthropic insects like the oriental cockroach, silverfish, moths or house mice (Photo 2). The latter are attracted to such trap by easy access to highly protein food such as immobilised insects.

Performed experiments showed that glue traps attracted more males than females (Fig. 1) which was especially visible when the insects had been starved before [18, 19]. It is important due to a high reproducibility of cockroaches (Fig. 1). Up to 40 young may hatch from one cocoon.

A big problem presented by cockroaches is their ability to colonise new areas and a lack of territoriality [20]. *B. germanica* unlike other invertebrates and vertebrates is not a territorial animal and most often occupies places with easy access to food and water.

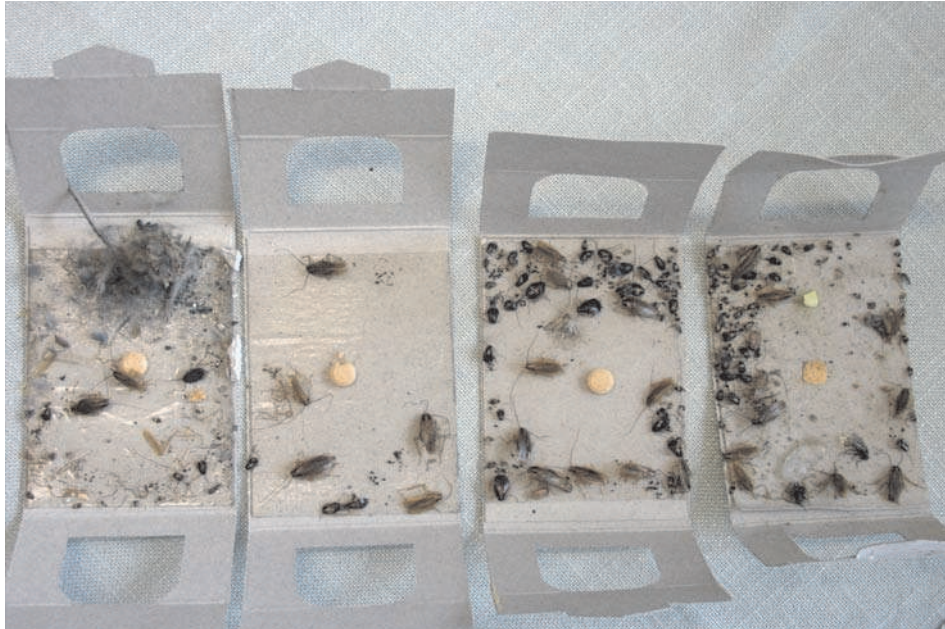


Photo 1. The German cockroach (*Blattella germanica*) in pheromone-glue traps from an apartment



Photo 2. Glue trap from a shop with caught house mice (visible traces of feeding by other individuals can be seen at the bottom)

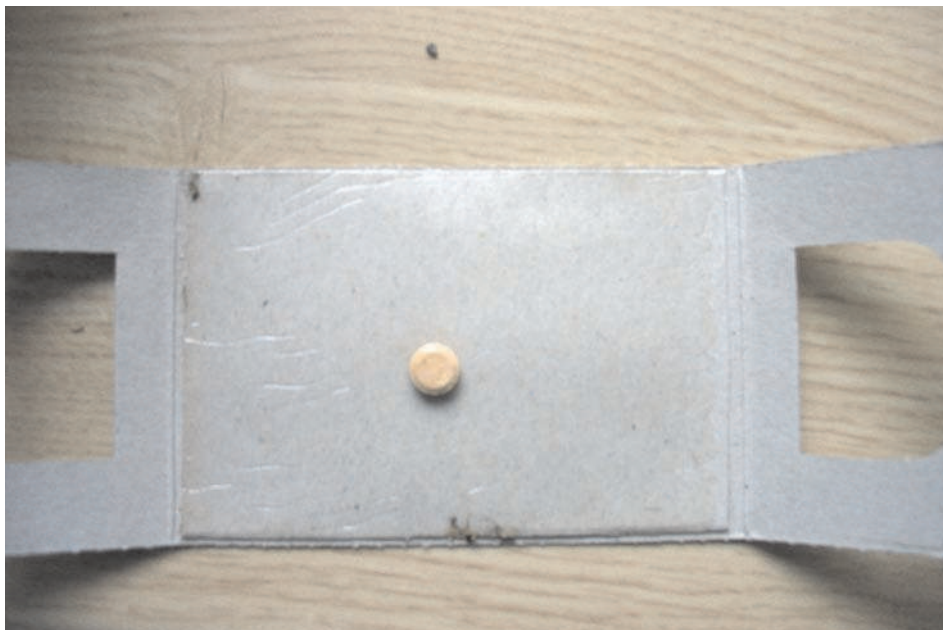


Photo 3. Pheromone-glue traps from hospital kitchen after application insecticides

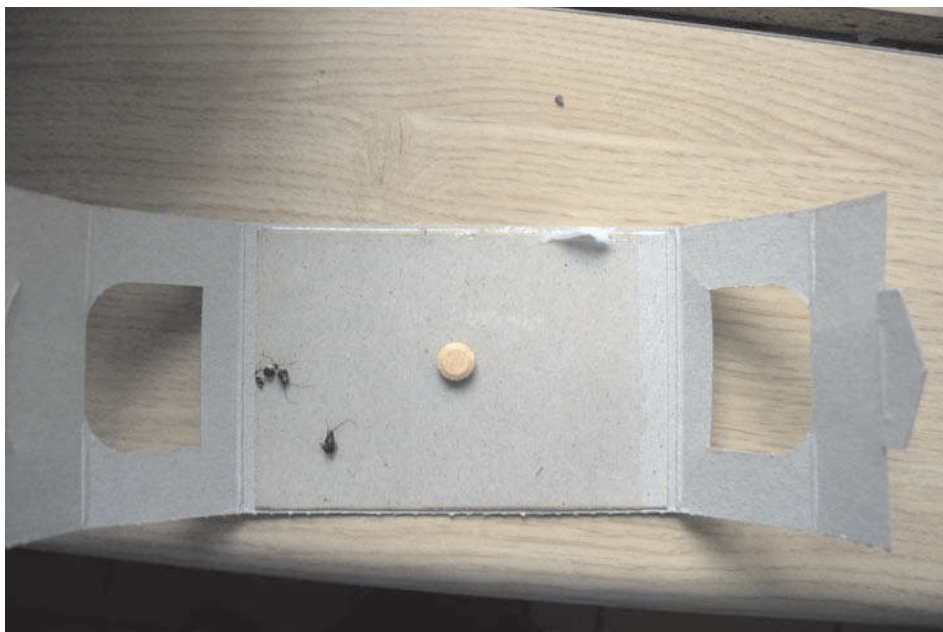


Photo 4. Pheromone-glue traps from an apartment after application insecticides

The factor that determines its occurrence is also a possibility of finding a hiding place to wait for the end of human activity. Cockroaches often hide near generators, in thick curtains and in the casing of household goods.

In contrast with laboratory studies, more larvae and nymphs were found in samples obtained in the field (Fig. 1). This finding confirmed the observations made by Stejskal et al [21] who used artificial barriers on the way to traps. Studies carried out in Warsaw hospitals showed also a higher efficiency of pheromone-glue traps in catching cockroaches as compared with chemical means containing permethrin, deltamethrin or other active substances [7, 13, 14, 24]. Pheromone-glue traps showed primarily where to expose chemical means. On analysed grounds pest extermination was done after sampling due to finding many cockroaches and rodents (Fig. 1). After chemical treatment glue traps were exposed again. The traps caught no or a few insects, mainly nymphs (Photos 3 and 4).

Application of insecticides against cockroaches results in health effects in the users of rooms where chemical control means are used [9, 25]. In such case food stored or prepared in a given place becomes also contaminated [15, 16, 26]. Moreover, the insects are good food for rodents (Photo 2) which apart from insects are a serious problem for the service and food processing industries [26].

Summary

Performed studies showed that using pheromone-glue traps allowed for estimating the structure of caught insects. The nymphs of the German cockroach and larvae newly hatched from cocoons dominated there. The density of insects in a trap enabled application of appropriate killing agents in a given area. Consequently, this decreases the contamination of a given area by insecticides and decreases a chance of appearance of other synanthropic organisms.

References

- [1] Durier V, Rivault C. *J Econ Entomol.* 2003;96:1254-1258. DOI:10.1006/anbe.2001.1807
- [2] Baldwin RW, Koehler PG. *Florida Entomol.* 2007;90(4):703-709.
- [3] Hulden L, Hulden L. *Entomol Tidsdrift.* 2003;124:201-207.
- [4] Durier V, Rivault C. *Anim Behav.* 2001;62:681-688. DOI:10.1006/anbe.2001.1807.
- [5] Rivault C. *Exper Appl.* 1990;57:85-91.
- [6] Jeanson R, Rivault C, Deneubourg JL, Blanco St, Fournier R, Jost Ch, Theraulaz G. *Anim Behav.* 2005;69:169-180. DOI:10.1016/j.anbehav.2004.02.009.
- [7] Gliniewicz A, Sawicka B, Czajka E. *Przeg Epidemiol.* 2003;57:329- 334.
- [8] Scirocchi A, Liberali M, Damis P, Molonia G, Bianchi R, Khoury C, Maroli M. *Tech. Molitoria.* 2004;55:520-531.
- [9] Nardoto T, Justi Junior J, Potenza MR. *Arquivos do Instituto Biologico (Sao Paulo).* 2003;70, supl 3:6, ref 7.
- [10] Eliyahu D, Nojima S, Mori K, Shal C. *Anim Behav.* 2009;78:1097-1105. DOI:10.1016/j.anbehav.06.035
- [11] Wang CL, Bennett GW. *J Econ Entomol.* 2009;102:1614-1623. DOI: 10.1603/029.102.0428
- [12] Holakeui NK, Ladonni H, Asle SH, Afhami S, Shayeghi M. *Sci J School Pub Health & Instit Pub Health Res.* 2004;2:43-45.

- [13] Czajka E, Pancera KW, Kochman M, Gliniewicz A, Sawicka B, Rabczenko D, Stypulkowska-Misiurewicz H. *Przeg Epidemiol.* 2003;57:655-662.
- [14] Stypulkowska-Misiurewicz H, Pancera KW, Gliniewicz A, Mikulak E, Laudy A, Podsiadło B, Rabczenko D. *Przeg Epidemiol.* 2006;60:609-616.
- [15] Matsumara F. *Pest Biochem Physiol.* 2010;97:133-139. DOI:10.1016/j.pestbp.2009.10.001.
- [16] Porcar M, Navarro L, Jimenez-Peydro RJ. *Invertebr Pathol.* 2006;93:63-66. DOI:10.1016/j.jip.2006.05.001.
- [17] Ignatowicz S. *Hig.* 2001;2:44-46.
- [18] Wang CL, Bennet GW. *Environ Entomol.* 2006;35:765-770.
- [19] Smith LM, Appel A.G. *J Econ Entomol.* 2008;101:151-158. DOI: org/10.1603/0022-0493(2008)101[151:COSTFC]2.0.CO;2.
- [20] Stejskal V. *Entomol Exper Appl.* 1997;84:201-205.
- [21] Stejskal V, Aulicky R. *Bull. OILB/SROP.* 2007;30:65-69.
- [22] Gliniewicz A, Sawicka B, Mikulak E, Indoor B. *Environ.* 2006;15:57-61. DOI: 10.1177/1420326X06062235.
- [23] Sevillano M, Cordon AJ, Gomez CM, Lopez AMA. *Alimentaria.* 2000;37:39-42.
- [24] Parreira RS, Ferreira M da C, Martinelli NM, Silva IC, Fernandes AP, Romani G da NJ. *Biosci J.* 2010;26:40-51.
- [25] Miller DM, Meek FJ. *Econ Entomol.* 2004;97:559-569. DOI.org/10.1603/0022-0493-97.2.559.
- [26] Ignatowicz S. *Bezp Hig Żyw.* 2009;3:42-43.

METODY KONTROLI I ZWALCZANIA SYNANTROPIJNYCH KARACZANÓW (*Blattella germanica* L.) W RÓŻNYCH EKOSYSTEMACH MIEJSKICH

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Abstrakt: Karaczan niemiecki (*Blattella germanica* L.) jest gatunkiem wszystkożernym, żywi się resztkami ze stołu, karmą dla zwierząt, nie gardzi także oprawami książek. Obecność populacji prusaków wokół struktur miejskich pozwala tym szkodnikom rozmnażać się i doprowadzać do wzrostu ich populacji w różnych ekosystemach synantropijnych.

Intensywny rozwój populacji prusaków jest jedną z głównych przyczyn alergii, astmy oskrzelowej i innych chorób u ludzi. Dodatkowo prusaki należą do organizmów przenoszących choroby i bakterie na swoich ciele oraz w swoich odchodach. Z tego względu kontrola inwazji karaczanów nie jest tylko kwestią estetyki, ale także ochroną zdrowia.

W niniejszej pracy podjęto się oszacować skład i liczebność owadów występujących w różnych ekosystemach synantropijnych. W tym celu wykorzystano pułapki feromonowo-klejowe. Następnie na ich podstawie zastosowano środki owadobójcze zwalczające je. Wykorzystując pułapki lepowe na bazie feromonów rozłożonych w wybranych punktach, takich jak szpital warszawski, prywatne mieszkanie oraz piekarnia, spróbowano prześledzić zmianę strukturę karaczanów. Na łapanych pułapkach przeważały larwy, następnie samce, w mniejszym stopniu łapały się samice. U samic stwierdzano wystąpienie kokonu, dlatego miało to wpływ na liczbę larw. Oprócz tego na pułapkę lepową łapały się inne zwierzęta, takie jak: karaczan wschodni, muchy, mrówki oraz myszy domowe zwabione łatwym dostępem do pokarmu.

Słowa kluczowe: synantropy, karaczan wschodni (*Blatta orientalis*) i karaczan niemiecki (*Blattella germanica*), metody zwalczania