

SCATOLOGY IN DOMICILIARY COCKROACHES

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Shape and characteristics in five domiciliary cockroach-feces

Feces of domiciliary cockroaches often contaminate food or medicine packages. The presence of feces in foraging places is evidence of a cockroach infestation. The shape and other characteristics of feces differ among species. When they feed on mouse chow and have adequate water, *Blattella germanica* deposits feces which are about 0.70 mm long in the male and about 0.95 mm in the female. *Periplaneta fuliginosa* feces are 1.79 mm in male and 2.05 mm in female, *P. japonica* feces are 1.59 mm in male and 1.86 mm in female, *P. americana* feces are 3.93 mm in male and 4.35 mm in female, and *P. brunnea* feces are 2.13 mm in male and 2.24 mm in female. When they feed on mouse chow and limited water in an agar-gelatin cake, the size of feces decreased in all species. The feces of *P. fuliginosa* showed strong viscosity and have a tendency to stick on the surface of packages; *P. americana* and *B. germanica* produced considerable viscosity, and the feces of *P. japonica* and *P. brunnea* were always solid and do not stick to packages when they feed on mouse chow and water.

Food color and color of feces in the smoky-brown cockroaches

We encountered colored-feces contamination by the smoky-brown cockroaches on the surface of medicine packages. When cockroach food (rice flour) were dyed with various pigments, the color of feces was assimilated with each of dyed foods, with a few exceptions (e.g. soybean sauce and ketchup). This suggests that feces of various colors would contaminate packages of foods or medicines.

Insecticide repellency observed by feces distribution

When German cockroaches feed on mouse chow and water, males produces 14 drops of feces per day and females produced 12 per day. The male smoky-brown cockroach produces 11 feces per day and the female 10 on the same food condition. They deposit their feces where they rest. After an arena (radius 15 cm, height 17 cm, and arena 705.5 cm²) keeping 10 male German cockroaches was divided into four-fan type sections a harborage was put in one of the sections, water and food were put in each of two other sections, and nothing in the rest section. Then, 90% or more of feces were scattered at the harborage section in 48 hours.

In the harborage test, 10 adult German cockroaches were maintained in the same plastic arena with water and mouse chow. When two harborages (insecticide treated and non-treated) were set in diagonal position in the arena, permethrin (0.05%) or propoxur (0.05%) showed dramatically decreased the number of feces in the treated section, and no cockroaches were killed within 48 hrs due to the repellency. However, with microencapsulated fenitrothion (0.05%) or diazinon (0.05%), the number of feces in the treated harborage section did not decrease markedly, and a majority of the cockroaches were killed with them. These methods is applicable to nymphs of the German cockroach and the smoky-brown cockroach.

Adaptation of the German cockroach to the harborages made of various Japanese woods

Harborages made of 30 species of Japanese wood were evaluated for acceptance to the German cockroach as a resting place. Two pieces of wood panels (25 mm x 60 mm, 5 mm thickness) were fastened at the edges to make a triangular-shaped harborage; control harborages were made from panels of lauan (*Pantacme contorta*) plywood. One test harborage and 1 control harborage were placed in the diagonal position in an arena at the same time and exposed to 10 male German cockroaches. Harborage acceptability or repellent index was determined by measuring the number of cockroach feces scattered in each of the two-harborage corners in 48 hrs. Few cockroaches selected the harborages made of Japanese oak (*Quercus mongolia*), beech (*Fagus crenata*), zelkova wood (*Zelkova serrata*), Sawara cypress (*Chamaecyparis pisifera*), Japanese yew (*Taxus cuspidate*)

and paulownia (*Taxus cuspidate*), compared with lauan plywood panels. The repellent index for these 4 species was 94.2, 88.0, 81.9 and 77.5, respectively. Cockroaches preferred the harborage made of the northern cypress, (*Picea jezoensis*) to the harborage of lauan plywood.

Repellency of herbs against the German cockroach

Ethanol extracts of several species of herbs showed strong repellency against the German cockroach and the smoky-brown cockroach. The extract of 33 species of herbs was treated on the surface of cockroach harborages made of plywood panels (5 cm x 5cm, 5mm single void, for the German cockroach, 10 mm single void for the smoky-brown cockroach). More than 90% of cockroach feces were deposited in the non-treated harborage (control) corner when the extract of dill (*Anethum graveolens*), celery (*Apium graveolens*), caraway (*Carum carvi*), cumin (*Cuminum cyminum*), coriander (*Coriandrum sativum*), cinnamon (*Cinamomom zeylanicum*), mace (*Myristica fragrans*), and chili pepper (*Capsicum annum*) was treated in the other side harborage in the same arena. Their efficacy was obtained even after 80 times dilution with water. When the two most effective extract samples were compared each other in the same arena (round tests), caraway or Deet showed superior efficacy to other, followed by chili pepper, mace, cumin, celery or dill. The repellent efficacy remained one month or more. Some herbs like anis (*Pimpinella anisum*), onion (*Allium cepa*), Sansyo (*Zanthoxylum piperitum*) or mustard (*Armoracia rusticana*), showed attractant efficacy to the German cockroaches.

Coprophagy and delayed efficacy of hydramethylnon bait to the domestic cockroaches

The longevity of German cockroaches and the smoky-brown cockroaches which fed on their own feces or carcasses was remarkably short compared to those fed on mouse foods. The cockroaches were reluctant to feed on their feces or carcasses. When two kinds of food materials were placed separately in a plastic arena, the cockroaches preferred mouse foods to feces or carcasses. Comparing food preference among four kinds of insect's feces: the smoky-brown cockroach, the silkworm, *Bombyx mori*, the common cutworm, *Spodoptera litura* and the drug-store beetle, *Stegobium paniceum*, the cockroaches selected silkworm feces most, then the drug-store beetle's feces; they did not consume their own feces or the feces of the common cutworm. In the case of ideal food absence, the cockroaches showed cannibalism. The results demonstrate that feces or dried carcasses may not be suitable foods for the cockroaches.

Small amounts of hydramethylnon were dispersed in a test arena or inside of harborages by the German cockroaches, following their feeding on gel bait with this active ingredient. Water, cockroach carcasses and their feces were also contaminated with hydramethylnon. When fresh colonies of the German cockroaches were exposed to the contaminated arena or harborages, most died within 20 days; mortality from exposure to water, carcasses, and feces was less than in the contaminated arena or harborages. The amount of feces produced by cockroaches feeding on hydramethylnon was remarkably less than what cockroaches normally produce. Delayed action of hydramethylnon bait against the German cockroaches might be the result of exposure to contaminated harborages or the surface of the foraging area.