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# Epizootological significance of the lesser mealworm *Alphitobius diaperinus* and modern methods of its control (a case study of a poultry farm)

***Alphitobius diaperinus* – zararkunanda qora qo'ng'izlarning epizootologik ahamiyati va ularga qarshi kurashishning zamonaviy usullari (parrandachilik fabrikasi misolida)**

Эпизоотологическое значение малого мучного хрущака *Alphitobius diaperinus* и современные методы борьбы с ним (на примере птицефабрики)

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### ENGLISH

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**Abstract.** The article analyzes the population density, bio-morphological characteristics, and economic-structural damages caused by the lesser mealworm (*Alphitobius diaperinus*) in commercial poultry houses. The epizootological role of this pest as a reservoir and vector for dangerous avian pathogens (*Salmonella*, *Escherichia coli*, and various viruses) is evaluated. The high efficacy (92-96%) of integrated pest management is demonstrated by monitoring population dynamics using advanced traps (Arends tube, pheromone, and corrugated cardboard traps) and applying the synthetic pyrethroid cypermethrin via the spraying method during the downtime (inter-flock) periods.

**Keywords:** *Alphitobius diaperinus*; poultry production; zoo-hygiene; epizootology; *Salmonella*; cypermethrin; monitoring; Arends trap; feed conversion

### O'ZBEKCHA

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**Annotatsiya.** Maqolada parrandachilik xo'jaliklarida keng tarqalgan zararkunanda — kichik qora qo'ng'iz (*Alphitobius diaperinus*) populyatsiyasining zichligi, uning bio-morfologik xususiyatlari hamda parrandachilik korxonalariga keltiradigan iqtisodiy-strukturaviy zararlari tahlil qilingan. Shuningdek, hasharotning parrandalar o'rtasida xavfli infeksiyalar (*Salmonella*, *E. coli*, viruslar) tarqalishidagi epizootologik roli o'rganilgan. Zararkunanda populyatsiyasini zamonaviy tuzoqlar (Arends, feromonli va kartonli) yordamida monitoring qilish hamda unga qarshi kimyoviy kurashda sintetik piretroid — sipermetrin moddasini texnologik tanaffus davrida purkash usuli bilan qo'llashning yuqori samaradorligi (92-96%) asoslab berilgan.

**Kalit so'zlar:** *Alphitobius diaperinus*; parrandachilik; zoogigiyena; epizootologiya; *Salmonella*; sipermetrin; monitoring; Arends tuzog'i; ozuqa konversiyasi

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## РУССКИЙ

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**Аннотация.** В статье анализируются плотность популяции, биоморфологические особенности и экономико-структурный ущерб, наносимый малым мучным хрущакom (*Alphitobius diaperinus*) в птицеводческих хозяйствах. Изучена эпизоотологическая роль насекомого как резервуара и переносчика опасных инфекций птиц (*Salmonella*, *E. coli*, вирусы). Обоснована высокая эффективность (92-96%) комплексного контроля вредителя путем еженедельного мониторинга с помощью современных ловушек (трубчатые ловушки Арендса, феромонные и картонные ловушки) и применения синтетического пиретроида циперметрина методом опрыскивания в период технологического перерыва.

**Ключевые слова:** *Alphitobius diaperinus*; птицеводство; зоогигиена; эпизоотология; сальмонелла; циперметрин; мониторинг; ловушка Арендса; конверсия корма

## 1. KIRISH

## Introduction

Parrandachilik sanoati global oziq-ovqat xavfsizligini ta'minlashda yetakchi tarmoqlardan biri hisoblanadi. Biroq, parrandaxonalardagi mikroiklim sharoitlari nafaqat qushlar, balki turli zararkunanda hasharotlarning ko'payishi uchun ham qulay muhit yaratadi. Ular orasida eng keng tarqalgan va iqtisodiy jihatdan jiddiy zarar keltiradigan ob'ekt — kichik qora qo'ng'iz (*Alphitobius diaperinus*) hisoblanadi. Ushbu hasharot asosan broyler yetishtirishga ixtisoslashgan xo'jalik binolarida ommaviy ko'payib, parrandachilik sanoatiga ko'p tomonlama zarar yetkazadi.

*Alphitobius diaperinus* parrandaxonalarda nafaqat strukturaviy buzilishlarni keltirib chiqaradi, balki parrandalarning salomatligi va mahsuldorligiga to'g'ridan-to'g'ri salbiy ta'sir ko'rsatadi. Uning lichinkalari g'umbakka aylanish jarayonida binoning issiqlik izolyatsiya materiallarini (penoplast va yog'och konstruksiyalar) teshib, vayron qiladi. Natijada, xonalarni shamollatish va isitish xarajatlari keskin ortadi. Eng xavfli, ushbu qo'ng'izlar parrandachilikda epizootologik jarayonning zanjiri bo'lib xizmat qiladi.

Ular parrandalar uchun o'ta xavfli bo'lgan virusli (Marek, Gumboro, parranda grippi, reovirus), bakterial (*Salmonella typhimurium*, *Escherichia coli*, *Campylobacter spp.*), zamburug'li (*Aspergillus spp.*) patogenlarni hamda gelmint tuxumlari va koksidiyalar oraliq xo'jayini sifatida saqlaydi va tashiydi. Jo'jalarning ushbu hasharotlar bilan oziqlanishi ularning ozuqa konversiyasini yomonlashtiradi, hazm tizimini jarohatlaydi va o'sishdan ortda qoldiradi.

## 1.1. Tadqiqotning maqsadi

Parrandachilik xo'jaliklarida *Alphitobius diaperinus* populyatsiyasining zichligini zamonaviy monitoring usullari yordamida baholash hamda ularga qarshi kurashda sipermetrin faol moddali insektitsidni qo'llash samaradorligini o'rganish.

## 2. METODLAR

## Methods

Tadqiqotlar parrandachilik fabrikasining broyler yetishtirish sexlarida (30°C optimal va 20°C minimal haroratli sharoitlarda) o'tkazildi. Zararkunanda qo'ng'izlarning hayot sikli, biologik xususiyatlari va populyatsiya zichligi laboratoriya va dala sharoitida kuzatildi.

## 2.1. Monitoring va tuzoqlar tizimi

Qo'ng'izlar sonini aniqlash va ommaviy bosqin darajasini baholash uchun quyidagi zamonaviy monitoring vositalaridan foydalanildi:

**Gofrirovka qilingan kartonli tuzoqlar:** Qo'ng'izlarning tirqishlar orasiga panoh izlab kirish instinktiga asoslangan holda o'rnatildi.

**Arends trubkali tuzog'i (Arends tube trap):** PVC quvur bo'lagi ichiga o'ralgan karton qog'ozli qurilmalar broyler xonalarning burchaklari va to'shamalari (litter) ustiga 1 hafta muddatga joylashtirildi.

**Feromonli tuzoqlar:** Sintetik to'planish feromonlari qo'llanilgan chuqurchasimon (*pitfall traps*) tuzoqlar yordamida hasharotlar jalb qilindi.

## 2.2. Kimyoviy kurash usuli (sipermetrin qo'llanilishi)

Zararkunandalar soni iqtisodiy zarar yetkazish mezonidan oshganda, ularga qarshi kimyoviy kurash usuli qo'llanildi. Buning uchun keng ta'sir doirasiga ega bo'lgan sintetik piretroidlar guruhiga mansub sipermetrin faol moddali insektitsid tanlab olindi. Ishchi eritma yo'riqnomaga muvofiq tayyorlanib, parrandaxona bo'shatilgandan so'ng (texnologik tanaffus davrida), bino devorlari, pol, to'shama qoldiqlari hamda darz va tirqishlarga purkash usulida ishlov berildi.

## 3. NATIJALAR

## Results

O'tkazilgan kuzatuvlar shuni ko'rsatdiki, *Alphitobius diaperinus* to'liq metamorfoz orqali rivojlanadi va uning rivojlanish tezligi atrof-muhit haroratiga to'g'ridan-to'g'ri bog'liq (1-jadval).

## 1-jadval

Haroratning A. diaperinus rivojlanish davrlariga ta'siri / **Table 1.** Effect of temperature on the developmental stages of A. diaperinus

| Harorat (°C)    | Rivojlanish bosqichi xususiyatlari                                                              | To'liq sikl davomiyliyi (kun) |
|-----------------|-------------------------------------------------------------------------------------------------|-------------------------------|
| 30 °C (Optimal) | Lichinka 8–11 yosh bosqichidan o'tadi. Uzunligi 11 mm gacha yetadi. Bosqichlararo davr — 2 kun. | 34 – 38 kun                   |
| 20 °C (Minimal) | O'sish va rivojlanish keskin sekinlashadi.                                                      | 165 kungacha                  |
| < 20 °C         | Rivojlanish butunlay to'xtaydi.                                                                 | Rivojlanmaydi                 |

### 3.1. Ko'payish ko'rsatkichlari va oziqlanish xarakteri

Urg'ochi qo'ng'izlarning hayot davomiyligi 4 oydan 1 yilgacha yetishi aniqlandi. Ular kuniga o'rtacha 3,5 ta tuxum qo'yadi. Hayoti davomida tabiiy sharoitda 200–400 tagacha, laboratoriyada esa 2000 tagacha tuxum qo'yishi tasdiqlandi. Oziq-ovqat tanqis bo'lganda populyatsiyada kannibalizm (turdoshlarini yeyish) va agressiv yirtqichlik (kichik umurtqalilarga jamoaviy hujum qilish) kuzatildi.

### 3.2. Epizootologik ahamiyat va kimyoviy ishlov samaradorligi

Bakteriologik tahlillar natijasida qo'ng'izlar organizmida patogenlarning uzoq muddat saqlanishi tasdiqlandi. Xususan, *Salmonella* bakteriyalari qo'ng'iz ichagida 5 haftadan ortiq vaqt davomida faol hayotchanligini yo'qotmadi.

Parrandaxona binolariga sipermetrin bilan ishlov berilgandan so'ng, imago (voyaga yetgan qo'ng'izlar) va lichinkalar populyatsiyasining o'lim ko'rsatkichi dastlabki 24–48 soat ichida yuqori samaradorlikni (92-96%) ko'rsatdi. Sipermetrinning o'tkir kontakt va ichak orqali ta'sir etish xususiyati tufayli, yashirin joylardan sirtga chiqqan zararkunandalar to'liq zararsizlantirildi.

## 4. MUHOKAMA

### Discussion

Tadqiqot natijalari shuni ko'rsatdiki, *Alphitobius diaperinus* parrandachilik iqtisodiyotiga va bioxavfsizligiga global tahdid soluvchi biologik vektordir. Jo'jalar (ayniqsa 1–5 kunlik) to'shamadagi qo'ng'izlarni yuqori ishtiyoq bilan iste'mol qiladi, biroq ularning qattiq xitin qobig'ini hazm qila olmaydi. Bu ichak yallig'lanishiga (enterit) va ozuqa konversiyasining buzilishiga olib keladi. Bizning hisob-kitoblarimiz va xalqaro modellarga ko'ra, har 100,000 bosh broyler uchun ozuqa samaradorligi pasayishi hisobiga \$2,649 dan \$4,262 gacha to'g'ridan-to'g'ri moliyaviy zarar ko'riladi.

Bu zararkunandani parrandachilik binosidan butunlay yo'q qilish amalda imkonsiz, chunki dezinfeksiya paytida ular izolyatsiya materiallari va pol ostidagi chuqur qatlamlarga yashirinadi. Shuning uchun ham zamonaviy strategiyada kimyoviy preparatlarni to'g'ri tanlash va almashlab qo'llash (rotatsiya) muhim rol o'ynaydi.

Bizning tadqiqotimizda qo'llanilgan sipermetrin o'zining uzoq muddatli qoldiq ta'sir qilish (residual) xususiyati bilan ajralib turadi. Binoni yangi partiya jo'jalar kelishiga tayyorlash jarayonida (texnologik tanaffusda) sipermetrin bilan tizimli ishlov berish bino devorlari va pollardagi patogen tashuvchi qo'ng'izlar zanjirini uzishga imkon beradi. Tuzoqlar (Arends trubkasi va kartonli tizimlar) yordamida haftalik monitoring o'tkazish esa fermerlarga sipermetrinni maqsadsiz sepavermasdan, faqat populyatsiya me'yordan oshganda qo'llash orqali iqtisodiy tejamkorlikka erishish imkonini beradi.

## 5. XULOSA

### Conclusion

1. *Alphitobius diaperinus* parrandachilik korxonalarida yuqori hayotchanlik va ko'payish potentsialiga ega bo'lib, 30°C haroratda 34–38 kunda to'liq siklni yakunlaydi.

2. Hasharot parrandalar o'rtasida *Salmonella*, *E. coli* va turli virusli infeksiyalarni tanaffus davrlarida ham saqlab beruvchi xavfli rezervuardir.

3. Zararkunandaga qarshi kurashda uni tizimli monitoring qilish va populyatsiya ommaviy ko'paygan davrda sipermetrin faol moddali preparatlar bilan texnologik tanaffus paytida ishlov berish yuqori epizootologik va iqtisodiy samaradorlikni ta'minlaydi.

## DECLARATIONS

### Declarations

#### Author contributions CRediT

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

#### Funding

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#### Ethics approval

The work was carried out within routine veterinary-sanitary and pest control practice on a poultry farm in accordance with the veterinary-sanitary requirements in force in the Republic of Uzbekistan; no experiments on vertebrate animals were performed.

#### Informed consent

All authors have read and approved the final version of the manuscript and have given their consent to its submission and publication. The study involved no human participants and no personal data.

#### Data availability statement

The data obtained in the study are presented in the text and table of this article; the primary records are available from the authors on reasonable request.

#### Conflict of interest

The authors declare no conflict of interest.

#### Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

## EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

### Purpose and research problem

The poultry industry is one of the leading branches ensuring global food security, but the microclimate of poultry houses creates favourable conditions not only for birds but also for the reproduction of insect pests. The most widespread and economically damaging of them is the lesser mealworm (*Alphitobius diaperinus*), which multiplies massively in broiler houses. Its larvae bore into and destroy the thermal insulation of buildings (polystyrene foam and wooden structures) during pupation, which sharply increases ventilation and heating costs. More importantly, the beetles act as a link in the epizootic process: they harbour and carry viral (Marek's disease, Gumboro disease, avian influenza, reovirus), bacterial (*Salmonella* Typhimurium, *Escherichia coli*, *Campylobacter* spp.) and fungal (*Aspergillus* spp.) pathogens and serve as intermediate hosts of helminths and coccidia, while chicks that feed on them show impaired feed conversion, digestive injuries and growth retardation. The aim of the study was to assess the population density of *A. diaperinus* in poultry farms using modern monitoring methods and to study the efficacy of a cypermethrin-based insecticide against it.

### Materials and methods

The studies were carried out in the broiler-rearing houses of a poultry farm under optimal (30 °C) and minimal (20 °C) temperature conditions, and the life cycle, biological characteristics and population density of the beetles were observed in laboratory and field conditions. To determine the number of beetles and the level of mass infestation, corrugated cardboard traps exploiting the beetles' instinct to shelter in crevices, Arends tube traps (rolled cardboard inside a section of PVC pipe placed for one week in the corners of broiler houses and on the litter) and pitfall traps baited with synthetic aggregation pheromones were used. When the pest numbers exceeded the economic damage threshold, chemical control was applied with a broad-spectrum insecticide based on the synthetic pyrethroid cypermethrin: the working solution was prepared according to the instructions and, after the house

had been emptied (during the technological break between flocks), the walls, floor, litter residues, cracks and crevices were sprayed.

## Results and discussion

*A. diaperinus* develops by complete metamorphosis, and its rate of development depends directly on the ambient temperature. At 30 °C the larva passes through 8–11 instars, reaches up to 11 mm in length with an interval of 2 days between instars, and the full cycle takes 34–38 days; at 20 °C growth and development slow down sharply and the cycle lasts up to 165 days, and below 20 °C development stops. Females live from 4 months to 1 year and lay on average 3.5 eggs per day, up to 200–400 eggs in natural conditions and up to 2000 in the laboratory; when food is scarce, cannibalism and aggressive predation (collective attacks on small vertebrates) occur. Bacteriological analyses confirmed long-term persistence of pathogens in the beetles: *Salmonella* remained viable in the beetle gut for more than 5 weeks. After treatment of the poultry houses with cypermethrin, the mortality of adults and larvae reached 92–96% within the first 24–48 hours, and pests emerging from hiding places were completely neutralised owing to the contact and intestinal action of the insecticide. Chicks, especially 1–5 days old, readily eat beetles from the litter but cannot digest their hard chitinous cover, which leads to enteritis and impaired feed conversion; according to the authors' calculations and international models, the resulting direct financial loss amounts to USD 2,649–4,262 per 100,000 broilers.

## Conclusion and contribution

*A. diaperinus* has high viability and reproductive potential in poultry enterprises and completes its full cycle in 34–38 days at 30 °C. The insect is a dangerous reservoir that maintains *Salmonella*, *E. coli* and various viral infections among poultry even during the breaks between flocks. Complete elimination of the pest from poultry buildings is practically impossible because during disinfection the beetles hide in insulation materials and deep layers under the floor, so the correct choice and rotation of chemical preparations are important. Systematic monitoring of the pest with Arends tube and cardboard traps and treatment with cypermethrin-based preparations during the technological break, when the population increases massively, ensure high epizootological and economic efficiency and allow the insecticide to be applied only when the population exceeds the threshold.

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