Pesquisa Agropecuária Tropical
ISSN: 1517-6398
ISSN: 1983-4063
evnovaes@gmail.com
Universidade Federal de Goiás
Brasil

Fidelis Alves da Silva, Izabela Thaís; de Oliveira, Robério; de Queiroz Oliveira, Luana Vitória; do Nascimento Júnior, José Luiz; de Luna Batista, Jacinto

Biological development of *Euborellia annulipes* reared with artificial diets and *Ephestia kuehniella* eggs 1

Pesquisa Agropecuária Tropical, vol. 48, núm. 3, 2018, pp. 295-298
Universidade Federal de Goiás
Goiânia, Brasil

e-ISSN 1983-4063 - *www.agro.ufg.br/pat* - Pesq. Agropec. Trop., Goiânia, v. 48, n. 3, p. 295-298, Jul./Sep. 2018

Biological development of *Euborellia annulipes* reared with artificial diets and *Ephestia kuehniella* eggs[1]

Izabela Thaís Fidelis Alves da Silva[2], Robério de Oliveira[2],
Luana Vitória de Queiroz Oliveira[2], José Luiz do Nascimento Júnior[2], Jacinto de Luna Batista[2]

ABSTRACT

One of the forms of integrated pest management is the rearing of insects using artificial diets. The *Euborellia annulipes* species has gained prominence for being voracious with its preys, demonstrating a potential for use in biological control programs. This study aimed to evaluate the biological development of the *E. annulipes* predator fed with artificial diets and *E. kuehniella* eggs. Newly hatched predator nymphs were separated into an experimental unit consisting of 5 insects, 10 replicates and 7 treatments. The instars duration, nymphal period and viability, postures, number of eggs per posture, period of pre-oviposition and egg incubation and egg viability were evaluated. There was no difference for the periods nymphal, pre-oviposition and incubation of *E. annulipes* eggs. Oviposition ranged from 23.8 to 73.0 eggs/posture, as a function of diet. Artificial diets based on *E. kuehniella* eggs can be used for rearing *E. annulipes*. However, reared eggs fed with rice flour should be avoided, because they reduce oviposition and influence the *E. annulipes* development.

KEYWORDS: Artificial diet; integrated pest management; biological control.

RESUMO

Desenvolvimento biológico de *Euborellia annulipes* criada com dietas artificiais e ovos de *Ephestia kuehniella*

Uma das formas de manejo integrado de pragas é a criação de insetos com dieta artificial. A espécie *Euborellia annulipes* tem ganhado destaque por ser voraz com suas presas, demonstrando potencial para uso em programas de controle biológico. Objetivou-se avaliar o desenvolvimento biológico do predador *E. annulipes*, alimentado com dietas artificiais e ovos de *Ephestia kuehniella*. Ninfas recém-eclodidas do predador foram separadas em uma unidade experimental formada por 5 insetos, em 10 repetições e 7 tratamentos. Avaliaram-se a duração dos ínstares, período e viabilidade ninfal, posturas, número de ovos por postura, período de pré-oviposição e de incubação dos ovos e viabilidade dos ovos. Não houve diferença para os períodos ninfal, pré-oviposição e incubação dos ovos de *E. annulipes.* A oviposição variou de 23,8 a 73,0 ovos/postura, em função da dieta. Dietas artificiais à base de ovos de *E. kuehniella* podem ser utilizadas na criação de *E. annulipes*. Entretanto, ovos oriundos de criações alimentadas com farinha de arroz devem ser evitados, por reduzir a oviposição e influenciar no desenvolvimento de *E. annulipes*.

PALAVRAS-CHAVE: Dieta artificial; manejo integrado de pragas; controle biológico.

INTRODUCTION

The biological control of pests, in recent years, has been widely used in Brazil, with significant examples in integrated pest management (Pinto et al. 2005). One of the tools within integrated pest management is the possibility of insect rearing with artificial diets, with the same characteristics as those found in nature, aiming at studies related to plant resistance to insects, bioassays with insecticides, production of natural enemies, nutritional requirements studies, production of sterile insects, pheromone and semiochemical tests, as well as educational purposes (Parra 2001).

Among the biological agents with appropriate characteristics to be inserted in integrated pest management programs, the *Euborellia annulipes* Lucas, 1847 (Dermaptera: Carcinophoridae) species has called a great attention, due to its high capacity of preying large numbers of prey and easiness of rearing it in the laboratory (Silva et al. 2010a).

Euborellia annulipes is an effective predator of *Hyadaphis foeniculi* (Passerini) (Hemiptera: Aphididade) (Silva et al. 2010a and 2010b), *Brevicoryne brassicae* (Linnaeus) (Hemiptera: Aphididade) (Miranda et al. 2012) (Coleoptera: Curculionidae) (Ramalho & Wanderley 1996, Lemos et al. 1998) and *Spodoptera frugiperda*

1. Manuscript received in Feb./2018 and accepted for publication in Sep./2018 (http://dx.doi.org/10.1590/1983-40632018v4851729).
2. Universidade Federal da Paraíba, Departamento de Fitotecnia e Ciências Ambientais, Laboratório de Entomologia, Areia, PB, Brasil. *E-mail/ORCID*: izabelathais@hotmail.com/0000-0002-0351-6905, roberio_b19@yahoo.com.br/0000-0002-4590-9934, luanavikqueiroz@hotmail.com/0000-0001-6421-0451, jlnjunioragro@hotmail.com/0000-0003-0601-7295, jacinto@cca.ufpb.br/0000-0001-8860-8085.

(JE Smith) (Lepidoptera: Noctuidae) (Silva et al. 2009b).

This predator constitutes a terrestrial group of insects of nocturnal habits, which are easily recognized by the presence of cornea tweezers at the extremity of the abdomen, which differentiates sexual dimorphism. They are known as "scissors" or "spiders" and hide, during the day, under very narrow cracks, under rocks and in humid places. At night, they are very active, moving with the tip of the abdomen facing upwards and the forceps very approximated. They are insects with chewing-type mouthparts and most of them feed on different types of prey (Guimarães et al. 1992, Gallo et al. 2002).

Due to their diversified food habits, these predators present a high potential, being a possibility to use them in biological control programs, on different pests and in several crops, besides being possible to be used along with other control measures, encouraging the production of crops with less chemical residues and compatible with the purpose of integrated pest management (Silva et al. 2009b).

It is indispensable that studies related to its biology are developed. Thus, this research aimed at evaluating the biological development of *Euborellia annulipes* (Lucas) reared with artificial diets and *Ephestia kuehniella* Zeller eggs.

MATERIAL AND METHODS

The study was developed at the Universidade Federal da Paraíba, in Areia, Paraíba state, Brazil, in 2014, under controlled conditions of temperature (25 ± 1 ºC), relative humidity (70 ± 10 %) and photophase (12 h).

For the accomplishment of all the experimental tests, insects reared in laboratory were used. Nymphs and adults of *E. annulipes* were individualized in Petri dishes (9.0 cm in diameter x 1.5 cm in height), containing absorbent paper moistened daily and feed composed of a standard diet (5 g) used to feed the scissors (Lemos et al. 1997) and *E. kuehniella* eggs (0.02 g) from different diets (Table 1). The diet was supplied in plastic containers of 5.5 cm in diameter and 0.5 cm in height, replenished every two days. At three-day intervals, plaque papers were exchanged to control the incidence of microorganisms. To evaluate the biological development of the predator, seven treatments, with ten replicates, composed of five insects of *E. annulipes*, were used.

Observations were made daily, quantifying the duration of the nymphal phase and the instar change, registered in intervals of days, between ecdysis (presence of exuviae in the breeding vessel), or by observing the coloration of the nymphs. In some cases, individuals may feed on their own exudation after ecdysis. The estimated biological parameters were duration and survival of the immature stages.

In the adult phase, 10 couples of each treatment were separated in Petri dishes and kept with the same methods used for nymphs (diet of each treatment and environmental conditions). After verifying the occurrence of postures, the males were removed from the plates and the females were kept together with their eggs. Daily evaluations were carried out, measuring the female reproductive capacity by counting deposited eggs, pre-oviposition period, egg incubation period and viability of eggs (hatched eggs).

The experimental design was completely randomized, in a factorial scheme, with 7 diets x 4 instars, with 10 replicates per treatment. Data were submitted to analysis of variance (Anova) and the means were compared by the Tukey test ($p \leq 0.05$). The data obtained were analyzed by the statistical software SAS.9.1.3.

Table 1. Diets used to feed *Euborellia annulipes* and *Ephestia kuehniella* insects to obtain eggs.

Treatments	Diets
	E. annulipes
1	Brewer's yeast (220 g), milk powder (130 g), wheat bran (260 g), starter for broiler chicken (350 g) and nipagin (40 g) (Costa et al. 2007)
	E. kuehniella
2	Creole corn flour (50 %) + wheat flour (50 %) + brewer's yeast (3 %)
3	Transgenic maize cornmeal (50 %) + wheat flour (50 %) + brewer's yeast (3 %)
4	Cassava flour (48.5 %) + wheat flour (48.5 %) + brewer's yeast (3 %)
5	Rice flour (48.5 %) + wheat flour (48.5 %) + brewer's yeast (3 %)
6	Breadcrumb (48.5 %) + wheat flour (48.5 %) + brewer's yeast (3 %)
7	Oatmeal flour (48.5 %) + wheat flour (48.5 %) + brewer's yeast (3 %)

RESULTS AND DISCUSSION

It can be noted that, for the nymphal period of the *E. annulipes* scissors, there was no statistical difference among treatments, during the first, second and third instars. However, for the duration of the fourth instar, it was found that the treatment 3 had a significantly longer duration of nymphal status, if compared to the treatments 2, 5 and 6. The duration of the fourth instar nymph was greater than that of the rest in all treatments, except for the treatment 6, while the first and second instars were lower for the treatments 4 and 5 (Table 2).

No difference was observed for the nymphal period duration of *E. annulipes*, in relation to the diets tested, ranging from 41.2 to 50.6 days (Table 3). Silva et al. (2010a), considering Hemiptera: Aphididae from the first-second, third and fourth instars as preys, observed a nymphal period of 53.2, 59.5 and 63.2 days, respectively, and between 49.8 and 61.7 days, when fed with *S. frugiperda* eggs.

As for nymphal viability, the treatments 5 and 6, i.e., those fed with *E. kuehniella* eggs from rice flour, presented a survival rate of about 50 %, while all other treatments presented viability between 70 % and 80 %. There were significant differences between the treatments 2 and 7 (Table 3). The low survival of the nymphs fed with eggs of this Crambidae from diets 5 and 6 makes this food a restricted source for laboratory rearing.

The pre-oviposition period varied from 9.4 days, in the treatment 2, to 11.6 days, in the treatment 6 (Table 3), and there was no significant difference between the diets tested. However, for the number of eggs per posture, the treatment 5 had a lower number of eggs (23.8 eggs/posture), differing significantly from the treatments 1 and 6, with 71.6 and 73.0 eggs/laying. Pinto et al. (2005), when testing *E. kuehniella* eggs for this predator, obtained an average of 52.1 eggs/posture, every three days. This indicates that the diet that is used in the mass rearing of the eggs that are supplied to the predators influence directly in the development of the adult phase and, consequently, in its oviposition.

The mean egg incubation period ranged from 9.6 (treatment 3) to 11.0 (treatment 2) days and did not differ significantly among treatments. Regarding egg viability, the treatment 5 presented

Table 2. Mean values ± standard deviation for the duration (days) of the nymphal instars of *Euborellia annulipes* fed with *Ephestia kuehniella* eggs from different diets (see Table 1).

Treatment	Instar			
	1º	2º	3º	4º
1	7.8 ± 0.9 aC*	5.5 ± 2.6 aC	13.4 ± 4.5 aB	20.6 ± 6.2 bcA
2	9.1 ± 5.3 aB	9.1 ± 6.1 aB	11.6 ± 4.8 aB	21.3 ± 6.7 bcA
3	7.0 ± 0.0 aB	6.3 ± 1.0 aB	9.0 ± 1.4 aB	27.4 ± 4.8 aA
4	7.2 ± 0.4 aC	7.7 ± 2.1 aC	12.4 ± 3.1 aB	22.6 ± 4.2 abcA
5	7.1 ± 0.3 aC	6.1 ± 0.3 aC	12.7 ± 4.4 aB	19.1 ± 6.8 cA
6	7.0 ± 0.0 aB	8.9 ± 2.6 aB	13.5 ± 4.7 aA	18.0 ± 5.4 cA
7	6.7 ±1.0 aB	7.8 ± 1.1 aB	11.0 ± 2.8 aB	25.1 ± 6.7 abA

* Means followed by the same letter, lowercase in the column and upper case in the row, do not differ from each other by the Tukey test at 5 % of probability.

Table 3. Mean values ± standard deviation of the nymphal period (NP), nymphal viability (NV), pre-oviposition period (POP), number of eggs/posture (NEP), egg incubation period (EIP) and egg viability (EV) of *Euborellia annulipes*.

Treament	NP (days)	NV (%)	POP (days)	NEP	EIP (days)	EV (%)
1	47.3 ± 4.7 a*	70.0 ± 14.1 ab	9.5 ± 4.6 a	71.6 ± 14.8 a	1.3 ± 1.0 a	99.6 ± 1.3 a
2	4.3 ± 7.5 a	80.0 ± 26.7 a	9.4 ± 3.7 a	39.0 ± 33.4 ab	11.0 ± 0.0 a	95.0 ± 5.0 ab
3	49.7 ± 3.8 a	72.0 ± 10.3 ab	10.8 ± 2.2 a	67.8 ± 21.5 ab	9.6 ± 1.3 a	93.0 ± 4.5 ab
4	49.9 ± 1.3 a	74.0 ± 23.2 ab	11.2 ± 1.3 a	69.5 ± 14.1 ab	10.5 ± 0.6 a	93.0 ± 3.6 ab
5	41.2 ±13.2 a	48.0 ± 23.5 b	11.3 ± 6.6 a	23.8 ± 31.3 b	10.5 ± 0.7 a	60.0 ± 5.0 b
6	47.4 ± 6.7 a	56.0 ± 15.8 ab	11.6 ± 2.1 a	73.0 ± 4.0 a	10.6 ± 0.5 a	95.0 ± 4.1 ab
7	50.6 ± 5.1 a	7.0 ± 15.8 a	11.3 ± 4.2 a	53.4 ± 31.3 ab	10.0 ± 1.0 a	96.8 ± 4.7 a

* Means followed by the same letter do not differ by the Tukey test at 5 % of probability.

a viability of 60 %, differing statistically from the treatments 1 and 7, with a viability greater than 95 % (Table 3).

These results were close to the data found by Pinto et al. (2005), who observed an average incubation period of 8.2 days for *E. annulipes* on *Anagasta Kueniella* Zeller eggs. Similar results were found by Silva et al. (2009c), who observed a mean incubation period of 13.3 days for *E. annulipes* fed with *S. frugiperda* (Smith, 1797) (Lepidoptera: Noctuidae), with a viability of 94.5 %. This predator showed a mean incubation period of 12.9 days, when it was fed with *Hyadaphis foeniculi* Passerini (Hemiptera: Aphididae) (Silva et al. 2010a).

Studies conducted by Drankin et al. (1995) and Silva et al. (2010a) reported that, during the incubation period, *E. annulipes* females protect both the eggs and first instar nymphs after hatching, positioning themselves on or around them, and even moving the eggs with their jaws, rotating them by means of fast movements to the original position. This procedure is a form of asepsis or cleaning of the eggs to avoid the attack of fungi or mites, in its absence.

CONCLUSIONS

1. The development time and biological parameters related to the reproduction of *Euborellia annulipes* may vary as a function of the *Ephestia kuehniella* feeding, whose eggs are used for the mass rearing of this Dermaptera;
2. *E. kuehniella* eggs originated from rearing with rice flour reduce the oviposition and negatively influence the biological development of *E. annulipes*.

REFERENCES

COSTA, N. P. et al. Influência do nim na biologia do predador *Euborellia annulipes* e estudo de parâmetros para sua criação massal. *Revista de Biologia e Ciências da Terra*, v. 7, n. 2, p. 1-10, 2007.

DRANKIN, S. M.; PALMER, J. O.; LAROCQUE, L. Life history characteristics of ringlegged earwig (Dermaptera: Labiduridae): enphasis on ovarian development. *Annals of the Entomological Society of America*, v. 88, n. 6, p. 887-893, 1995.

GALLO, D. et al. *Entomologia agrícola*. Piracicaba: Fealq, 2002.

GUIMARÃES, J. H.; TUCCI, E. C.; GOMES, J. P. C. Dermaptera (Insecta) associados a aviários industriais no estado de São Paulo e sua importância como agentes de controle biológico de pragas avícolas. *Revista Brasileira de Entomologia*, v. 36, n. 3, p. 527-534, 1992.

LEMOS, W. P. *Biologia e exigências térmicas de Euborrelia annulipes (Lucas, 1847) (Dermaptera: Anisolabididae), predador do bicudo-do-algodoeiro*. 1997. 132 f. Monografia (Graduação em Agronomia) - Universidade Federal da Paraíba, Areia, 1997.

LEMOS, W. P.; MEDEIROS, R. S.; RAMALHO, F. S. Influência da temperatura no desenvolvimento de *Euborellia annulipes* (Lucas) (Dermaptera: Anisolabididae), predador do bicudo-do-algodoeiro. *Anais da Sociedade Entomológica do Brasil*, v. 27, n. 1, p. 67-76, 1998.

MIRANDA, J. R. et al. Capacidade predatória de *Euborellia annulipes* sobre *Brevicoryne brassicae*. In: CONGRESSO BRASILEIRO DE ENTOMOLOGIA, 24., 2012, Curitiba. *Anais...* Curitiba: SEB, 2012. p. 5.

PARRA, J. R. P. *Técnicas de criação de insetos para programas de controle biológico*. Piracicaba: Fealq, 2001.

PINTO, D. M.; STORCH, G.; COSTA, M. Biologia de *Euborellia annulipes* (Dermaptera: Forficulidae) em laboratório. *Revista Científica Eletrônica de Agronomia*, v. 4, n. 8, p. 1-7, 2005.

RAMALHO, F. S.; WANDERLEY, P. A. Ecology and management of the boll weevil in South American cotton. *Transactions of the American Entomological Society*, v. 42, n. 1, p. 41-47, 1996.

SILVA, A. B.; BATISTA, J. L.; BRITO, C. H. Capacidade predatória de *Euborellia annulipes* (Lucas, 1847) sobre *Spodoptera frugiperda* (Smith, 1797). *Acta Scientiarum Agronomy*, v. 31, n. 1, p. 7-11, 2009a.

SILVA, A. B.; BATISTA, J. L.; BRITO, C. H. Influência de produtos de origem vegetal na oviposição e no desenvolvimento embrionário de *Euborellia annulipes* (Dermaptera: Anisolabididade). *Engenharia Ambiental*, v. 6, n. 3, p. 54-65, 2009b.

SILVA, A. B.; BATISTA, J. L.; BRITO, C. H. Aspectos biológicos de *Euborellia annulipes* sobre ovos de *Spodoptera frugiperda*. *Engenharia Ambiental*, v. 6, n. 1, p. 482-495, 2009c.

SILVA, A. B.; BATISTA, J. L.; BRITO, C. H. Aspectos biológicos de *Euborellia annulipes* (Dermaptera: Anisolabididae) alimentada com o pulgão *Hyadaphis foeniculi* (Hemiptera: Aphididae). *Revista Caatinga*, v. 23, n. 1, p. 21-27, 2010a.

SILVA, A. B.; BATISTA, J. L.; BRITO, C. H. Capacidade predatória de *Euborellia annulipes* (Dermaptera: Anisolabididae) sobre *Hyadaphis foeniculi* (Hemiptera: Aphididae). *Revista de Biologia e Ciências da Terra*, v. 10, n. 1, p. 1-8, 2010b.