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Study of the reproductive parameters of *Corcyra cephalonica* (Stainton) according to the type of food substrate

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Abstract

Rice is a cereal strategy for Senegal given its place in the household and its weight on our trade balance. Imports of rice amounted in 2013 to 902526 tonnes worth of more than 191 billion CFA francs. In Africa, 70% of the production of mils comes from the west of the continent. Thus, it becomes imperative to pay more attention on the stocks of these cereals, which are often attacked by insect pests such as *Corcyra cephalonica*, to ensure the food security of the country. It is in this context that this study aims to determine the effect of the substrate on the reproduction of *C. cephalonica*. To achieve this objective, samples were collected in a packing station of the seed of Senegal, located in the centre of the groundnut basin in order to establish a mass rearing. Eggs from moths female from this breeding, were used to conduct tests necessary for the study of the reproductive potential of the moth. The results obtained showed that the difference of ranks between the number of egg-laying in the grain was significant (p-value = 0,0090 < 0,05), between the eggs laid in the grain was also high (p-value = 0,0237 < 0,05). However, the difference of rank between the hatch rates of eggs in the grains was not significant (p-value = 1 > 0,05). On the other hand, tests of correlations revealed that there was no relationship between the total number of eggs laid on mil and the longevity of female mites (Sig.= 0,904 > 0,05), the number of oviposition and the total number eggs laid on mil (Sig.= 0,785 > 0,05), the number of oviposition and the total number of eggs laid on rice (Sig.= 0,188 > 0,05), the total number of eggs laid on mil and the longevity of the moths on rice (Sig.= 0,589 > 0,05), the total number of eggs laid on mil and the total number of eggs laid on rice (Sig.= 0,742 > 0,05). However, there is a strong correlation between the total number of eggs laid on rice and the longevity of female mites on rice (Sig.= 0,021 < 0.05 and Spearman Correlation coefficient = 0,878).

Keywords: *Corcyra cephalonica*, peanut basin center, food substrates, reproductive potential

1. Introduction

The population of rice consumers is increasing by 1.8% per year. The current annual production of rice is 560 million tons and is expected to be increased to 850 million tons by 2025. Thus, rice varieties with a yield potential and yield stability higher are required to meet the challenges of increased rice production and meet the needs of a growing world population [11]. The rice is grown and eaten in 38 countries in sub-saharan Africa. The local production of this cereal can not meet the growing demand for rice in many african countries [4]. The pearl millet (*Pennisetum typhoides* (Stapf. and Hubb.)), staple food of the population, is far and away the cereal with the most important in Senegal, for both planted area and production. It is grown throughout the country, in particular Kaolack, which represents 26 % of the cropped area and 39 % of the national production, estimated to be more than 528 000 t [15]. According to [17] at least fifteen species of insects attack the stocks of food grains in rural areas and among major species, four Beetles such as *Sitophilus zeamais* (Motsch.), *S. oryzae* (L), *Rhyzopertha dominica* (F.) and *T. castaneum* (Herbst) and three Lepidopteran, *Sitotroga cerealella* (Oliv.), *Ephestia cautella* (WLK) and *Corcyra cephalonica* (Staint.). This last is a formidable pest of grain inventories and deserves special attention. It infests the rice, the millet, the wheat, the corn and the crops legumes [14]. All the activities of life depend on the type and quality of the food material of an individual. [2] have said that the longevity and reproductive potential of insects are influenced by the components of the environment, including temperature, moisture and food. What would be the effect of grain crops (millet and rice) on the parameters for breeding of *C. cephalonica* ? These two grains have compositions and nutritional values different, which would have a base on the bio-ecology of the insect. It is in this context that this study aims to determine the effect of the nature of the grain on the reproductive potential of *Corcyra cephalonica* (Stainton).

2. Materials and methods

2.1. Climatic Conditions of experimental

The monitoring of reproductive activities of the borer of rice was done in temperatures ranging from a minimum of 27.9 °C to a maximum of 35.5 °C with an average of 30,44 ± 1,96 °C and a relative humidity average of 73,21 ± 1,74 %.

2.2. Sites of sampling

The choice of the site being sampled has been done in reference to its importance in storage capacity, and its geographical position with the agro-ecological zones. The sampling was performed in a station seed processing set 14°

39’ 4,5’’ N ; 16° 15’ 19,36’’ W belonging to the center of the groundnut basin and in the zone, Sahelo-Sudanian (SAS).

Upon arrival to the storage centres and during warehousing, the quality and state of conservation of the products has been verified. To obtain a representative several samples elementary have been taken : these, once collected and mixed in a clean container, formed the sample on which the necessary checks have been carried out. In the parking lot of conditioning, the grains were stored in sacks. Thus, for a batch of grain, the number of bags on which the samples were taken depended on the total number of bags stored. In fact, on a batch of 100 bags, 10 have been randomly selected to compose the overall sample and the samples were produced by survey. This technique was to directly collect samples basic by introducing into the bags selected probes hollow (probes, bags and cannes probes). Fifty (50) grams per bag of 100 kg rice or millet have been collected, sufficient to compose a global sample of at least 500 g. Once collected, the samples elementary have been carefully blended.

2.3. Breeding of the moth

To monitor the different parameters of the breeding of the moth, it is necessary to establish a mass rearing. It was carried out in the laboratory using strains of *C. cephalonica* from samples of millet and rice to the packing station. In fact, the harvested cereals (millet and rice) have been put in jars of livestock farm placed in a chamber atmospheres are controlled up to the emergence of the adults. They had stayed 24 hours in the jars to encourage the meeting of both sosexes, thereafter, they were harvested with the aid of a test tube, sexés as a function of the presence or absence of palps labial (females have palps labial and males are lacking). After sexing, the moths were individually placed in drums minus mesh fine mesh to collect the eggs laid by the females and to study the bio-ecology of the insect. The dates of emergence of the butterfly, from egg-laying and hatching of eggs are noted. These eggs will be used for the study of reproductive parameters.

2.4. Study of the reproduction

Ten drums, each containing one female of *C. cephalonica* Sheep copulée in the boxes-breeding, were placed in a chamber for emergence of the laboratory. The females have laid a significant amount of eggs in the drums.

2.4.1. Incubation of the eggs

The incubation period of the eggs or the duration of embryonic life is the time that elapses between the issuance of an egg and its hatching. The eggs laid by the females were incubated in Petri-dishes placed in the chamber atmospheres are controlled. The control was daily under the microscope cold light in order to count the eggs hatched by the total eggs.

2.4.2. Fertility of eggs

The fertility of eggs corresponds to the number of eggs hatched per total eggs released during a spawning. The eggs hatched counted to determine the incubation period themselves had served as an index to determine the fertility of eggs laid by female.

2.4.3. Number of egg-laying

The number of spawning corresponds to the number of times that a female releases eggs. The deposition of the eggs begins 24 hours after copulation and is spread over a long period of the life of the female. The activities of laying hold 60% to the life of the imaginal and the speed of spawning decreases regularly during this period [13]. [7] note that in natural conditions the insects will mate often with multiple partners, and lay eggs on several occasion.

2.4.4. The eggs laid by female

The eggs were poured through the wire mesh of the drum and recovered at the level of the cap, secondary of the latter. Eggs were counted each day after each egg laying until the end of egg-laying and the death of the female. Thus, the total number of eggs laid by a female corresponding to the set of eggs from all clutches of a female was determined. The ponte is a phase of extremely important to the life of an insect, it must be accomplished at the right time and in a suitable location in order to maximize the survival probabilities of the offspring [10,16]. The fertility and the number of egg-laying were calculated after 24 hours of laying.

3. Statistical Analyses

The parameters of reproduction of the stem borer of rice have been treated with the software EXCEL® 2016, XLSATAT 2014.lnk and IBM SPSS Statistics-24. The Excel spreadsheet had enabled the collection of data. XLSTAT was used for the comparison tests, non-parametric Mann-Withney since the variables are discrete, independent, and quantitative with two groups (the substrate type of food: millet and rice). The IBM SPSS software version 24 was used for the realization of the correlation type Spearman, between quantitative variables in order to identify their degree of binding and the significance of the test. The differences of averages between the different populations taken two at a time were compared by the smallest difference significant at the 5% level.

4. Results

4.1. Comparison of the activity of oviposition of the moths from the drains of millet and rice.

The data in tables 1 and 2 provide information on the activity of oviposition of the moth on the grain. Thus, the number of nesting females varies from a minimum of 2 to a maximum of 9 layings with an average of 6.5 ± 0,85 laying on the grains of millet ; a minimum of 2 spawns to a maximum of 3 clutches with an average of 2.33 ± 0,21 laying on grains of rice. The difference of ranks between the clutch size of females from the grains of millet and rice is significant (p-value. = 0,0090 < 0.05) (table 3).

The follow-up to the total number of eggs laid per female for the whole of their laying proved to be a minimum of 18 and a maximum of 157 eggs with an average of 86,75±16,66 eggs on the grains of millet ; a minimum of 5 and a maximum of 46 eggs, with an average of 21.83±6,98 eggs on the grains of rice (table 2). The average number of eggs laid by egg-laying evolves in the same sense that the number of oviposition for moths from rice grains ; it is much higher than the number of clutches increases, and vice versa (see figure 1) ; and vice versa for that of the moths from the grains of millet (see figure 2). The difference of rank between the eggs laid in the grain was significant (p-value = 0,0237 < 0,05) (see table 4).

Table 1: *C. cephalonica* spawning activities on millet

Layers	1	2	3	4	5	6	7	8	9	Nb. P	Nb. T O P
Nb. observations	8	8	8	8	8	8	8	8	8	8	8
Minimum	5	2	3	1	1	1	2	6	1	2	18
Maximum	89	38	40	42	17	15	23	9	3	9	157
Average	37,13	12,50	11,86	11,29	4,83	7,33	7,17	7,50	2	6,5	86,75
Standard deviation of the mean	12,26	4,05	4,88	5,60	2,47	2,54	3,34	1,50	1	0,85	16,67

Legend: Nb. P = Number of egg-laying; Nb. TOP = Total Number of Eggs Laid.

The trend line in Fig. 1 shows a gradual decrease in the number of eggs per clutch as the number of layers increases.

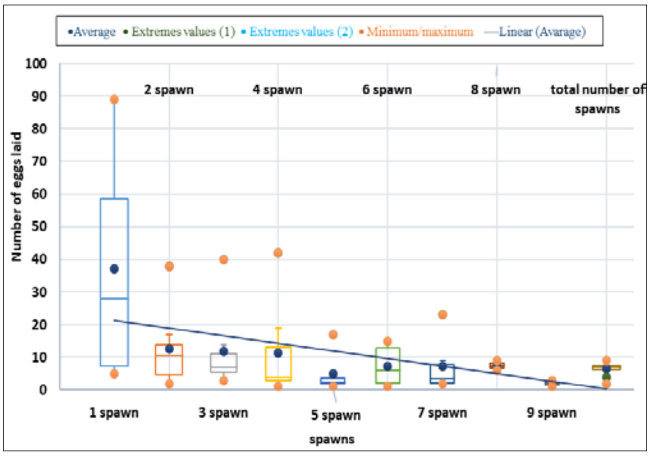

Fig 1: Evolution of the spawning activities of the moth on millet.

Table 2: *C. cephalonica* spawning activities on rice

Layers	1	2	3	Nb. of spawns	Nb. total eggs laid
Nb. observations	6	6	6	6	6
Minimum	1	2	2	2	5
Maximum	14	30	24	3	46
Average	5,83	11,67	13	2,33	21,83
Standard deviation of the mean	1,85	5,37	11	0,21	6,98

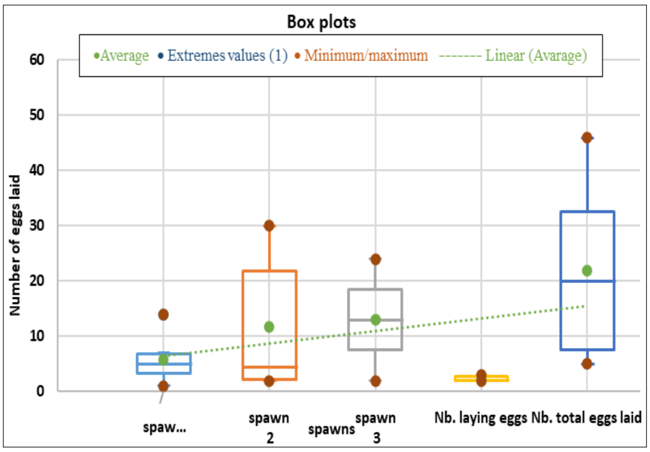

Fig 2: Evolution of the egg moth egg-laying activities on rice.

Table 3: Comparison between the number of *C. cephalonica* eggs laid in the grains

U	44,0000
Expectation	24,0000
Variance (U)	55,7802
p-value (bilateral)	0,0090
alpha	0,05
An approximation was used to calculate the p-value.	

Table 4: Comparison between the total numbers of eggs laid in the grains

U	42,0000
Expectation	24,0000
Variance (U)	59,8681
p-value (bilateral)	0,0237
alpha	0,05
An approximation was used to calculate the p-value.	

4.2. Egg fertility

The fertility of eggs laid by females varies from a minimum of 10 to a maximum of 90% with an average of 36.11 ± 30.73 % for rice; of a minimum of 20 and a maximum of 40% with an average of 28.33 ± 7.33% for millet (Table 5). The difference between the hatching rates of female moth eggs from rice and millet grains is not significant (p-value = 1 > 0.05) (Table 6).

Table 5: hatching rate according to millet and rice cereals

Variable	Observations	Minimum	Maximum	Average	Standard deviation
% of hatching rice	6	10	90	36,11	30,73
% hatch mil	6	20	40	28,33	7,53

Table 6: Correlation between hatch rates of *C. cephalonica* eggs in grains

U	18,0000
Expectation	18,0000
Variance (U)	37,7727
p-value (bilateral)	1,0000
alpha	0,05
An approximation was used to calculate the p-value.	

4.3. Effect of butterfly longevity on egg-laying activity

Sig. = 0.785 > alpha significance level = 0.05 which implies that there is no relationship between the number of spawns and the total number of eggs laid per millet (Table 7).

Table 7: Analysis of the relationship between the number of layings and the total number of eggs laid by females from millet grains

			Number of lays	Total number of eggs laid
Spearman's Rho	Number of spawns	Correlation coefficient	1,000	0,116
		Sig. (bilateral)	.	0,785
		N	8	8
	Total number of eggs laid	Correlation coefficient	0,116	1,000
		Sig. (bilateral)	0,785	.
		N	8	8

Sig. = 0.188 > level of significance alpha = 0.05 which implies that there is no relationship between the number of layings and the total number of eggs laid on rice (Table 8).

Table 8: Analysis of the relationship between the number of layings and the total number of eggs laid by females from rice grains.

			Number of spawns	Total number of eggs laid
Spearman's Rho	Number of spawns	Correlation coefficient	1,000	0,621
		Sig. (bilateral)	.	0,188
		N	6	6
	Total number of eggs laid	Correlation coefficient	0,621	1,000
		Sig. (bilateral)	0,188	.
		N	6	6

There is no correlation between: the total number of eggs laid on millet and the longevity of moths on rice (Sig. = 0.589 > 0.05), the total number of eggs laid on millet and the total number of eggs laid on rice (Sig. = 0.742 > 0.05). However, there is a strong correlation between the total number of eggs laid on rice and the longevity of female moths on rice (Sig. = 0.021 < 0.05 and Spearman's Correlation = 0.878) (Table 9).

Table 9: Analysis of the relationships between the total number of eggs laid on millet, longevity on rice and the total number of eggs laid on rice

			Longevity on rice	NTOPM	NTOPR
Spearman's Rho	Longevity on rice	Correlation coefficient	1,000	0,227	0,878*
		Sig. (bilateral)	.	0,589	0,021
		N	8	8	6
	NTOPM	Correlation coefficient	0,227	1,000	0,174
		Sig. (bilateral)	0,589	.	0,742
		N	8	8	6
	NTOPR	Correlation coefficient	0,878*	0,174	1,000
		Sig. (bilateral)	0,021	0,742	.
		N	6	6	6
*. The correlation is significant at the 0.05 level (two-tailed).					

Legend: NTOPM = Total number of eggs laid per millet; NTOPR = Total number of eggs laid on rice.

Sig. = 0.904 > level of significance alpha = 0.05 which implies that there is no relationship between the total number of eggs laid on millet and the longevity of female moths on millet (Table 10).

Table 10: Analysis of the relationships between the total number of eggs laid on millet, longevity on millet

			NTOPM	Longevity on mil
Spearman's Rho	NTOPM	Correlation coefficient	1,000	-0,051
		Sig. (bilateral)	.	0,904
		N	8	8
	Longevity on mil	Correlation coefficient	-0,051	1,000
		Sig. (bilateral)	0,904	.
		N	8	8

5. Discussion

According to our results, the number of oviposition and number of eggs laid by the moths, the female are very variable from one grain to another with a difference in ranking significant (p-value. = 0,0090 < 0.05 for the number of egg-laying and 0,0237 < 0.05 for the total number of eggs laid). Thus, it has been noted a minimum of 2 and a maximum of 9 layings with an average of 6.5 ± 0,85 laying on the grains of millet; a minimum of 2 spawns to a maximum of 3 clutches with an average of 2.33 ± 0,21 laying on grains of rice [9]. reported an oviposition period ranging from 6 to 8 days on the mil. this corroborates our results obtained on the mil. The follow-up bin to the total number of eggs laid per female for all of its captains has revealed a minimum of 18 to a maximum of 157 eggs with an average of 86,75 ± 16,66 eggs on the grains of millet ; a minimum of 5 to a maximum of 45 eggs with an average of 21,83 ± 6,98 eggs on the grains of rice. The difference of rank between the eggs laid in the grain was significant (p-value = 0,0237 < 0,05). A similar trend has been noted by [3], which reported, respectively, 298 and 226 eggs on the sorghum and rice. These differences can be explained by the environmental conditions (temperature and air humidity, among others), the nature and quality of the grain or the strain of the insect [6]. reports that the change in the number of eggs laid in each spawn depends on the age and fertility of the female as well as the rearing conditions such as temperature, the quality and quantity of the present study. The results also show that the percentage hatching of these eggs from these two types of cereals is higher with the eggs of the moths from rice than those from millet, with respective averages of 36.11 ± 30,73% and 28,33 ± 7,33%, but the difference in ranking is not significant (p-value = 1 > 0,05). This observation is also due to the nutritional quality of the grain. The rice would provide more vitamins and minerals than millet, so the rice would be qualitatively superior to the mil. This variation in reproductive potential as a function of the nature of the substrate food has been confirmed by the results obtained by [8, 12].

Moreover, there is no relationship between the number of oviposition and the total number of eggs laid on mil (Sig. = 0,785 > 0.005), the number of oviposition and the total number of eggs laid on rice (Sig. = 0,188 > 0,05), the total number of eggs laid on mil and the longevity of the moths on rice (Sig. = 0,589 > 0,05), the total number of eggs laid on mil and the total number of eggs laid on rice (Sig. = 0,742 > 0,05).

On the other hand, there is a strong correlation between the total number of eggs laid on rice and the longevity of female mites on rice (Sig. = 0,021 < 0.05 and Spearman Correlation coefficient = 0,878). The life of the butterfly seems to have a positive effect on the number of eggs from females who have completed their development in the grain of rice. This fact could be related to the nutritional quality of the grain.

6. Conclusion

Note that the type of food substrate has a significantly different effect on the parameters: number of layings, total number of eggs laid by female moths, total number of eggs laid on rice and the longevity of female moths on rice. However, the type of food substrate had an insignificantly different effect on the percentage of eggs hatched. This new information on the reproductive potential of the European moth according to the type of food substrate, makes it possible to identify the best food support for the rearing of the ringworm, but also an integrated management of the populations of *C. cephalonica* dependent on cereal stocks in order to to guarantee food security and the advancement of research in this field.

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