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

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Abstract

The current study was aimed to determine the influence of millet and rice food substrates on the biological parameters of *C. cephalonica, a* pest of stored cereals. To achieve this objective, millet and rice grains were collected from the largest seed conditioning station in Senegal, precisely in the centre of the groundnut basin. The eggs from the female moths from this farm were used to carry out the necessary tests to study the development parameters of the grain-borne rice borer. The results obtained from our work show that the type of grain has an effect on the biological parameters of the insect. The average duration of the insect's development cycle is longer in millet grains than in rice grains. In addition, the type of food substrate has a significantly different effect on the parameters: duration of immature stages, size and longevity of adults. The size of the imago is significantly higher in millet grainsthan in rice grains.

Keywords: *Corcyra cephalonica,* groundnut basin, food substrates, biological parameters

1. Introduction

Millet is the most widely grown cereal in Senegal, with 71% of the area sown to cereals in the 2011-2012 agricultural season and 65% in the 2012-2013 season. It weighs on average 42% of the total cereals produced on our territory although it only represents 26% of the quantity of cereals present in the Senegalese diet (CGER, 2014) [6]. After millet, rice is also a highly appreciated commodity. In 2012, rice will account for only 11% of the area under cereal crops, representing 38% of the country's cereal production. Mainly cultivated by the irrigation system in the Senegal River Valley (Saint-Louis) with 57% of the area under rice, it is at the centre of Senegal's food self-sufficiency policy. It is also rainfed in Ziguinchor and Sédhiou, with 17% and 15% of the area under rice respectively. It should be noted that Saint-Louis and Ziguinchor devote 87% and 70% of their cereal-growing areas to rice cultivation, respectively (CGER, 2014) [6]. However, farmers pay little attention to millet, rice and maize stocks (Ndiaye and Niang, 2010) [15] which are attacked by insect pests such as *Corcyra cephalonica* (Stainton) which is a pest exclusively dependent on cereal stocks. It infests rice, millet, wheat, maize and leguminous crops (Malek & Parveen, 1989) [11]. All activities of life depend on the type and quality of an individual's food supply. (Andrewartha and Birch, 1954) [1] have stated that the longevity and reproductive potential of insects are influenced by environmental components, including temperature, humidity and food. Several studies have shown that the nature of the food substrate can influence the development of insects, as in the case of *Tribolium castaneum* (Gueye *et al.*, 2015, Sow, 2019) [9, 17]. The grains of the two cereals millet and rice would have different compositions and nutritional values, which would have a bearing on the insect's bio-ecology. What would be the effect of the two cereals millet and rice on the development parameters of *C. cephalonica* ? It is in this context that the present study aims to determine the effect of the nature of the cereal on the development parameters of *C. cephalonica* (Stainton).

2. Materials and methods

Sampling site

The choice of the sampled site was made with reference to its importance in terms of storage capacity and its geographical position with the agro-ecological zones. Sampling was carried out in a seed packing station located at 14° 39' 4.5" N ; 16° 15' 19.36" W belonging to the central groundnut basin and the Sahelo-Sudanian zone (SAS). As the grains were stored in bags, the number of bags from which samples were taken depended on the total number of bags stored. In fact, out of a batch of 100 bags, 10 were selected at random to make up the overall sample and the samples were taken by sampling. Fifty (50) g per 100 kg bag of rice or millet were taken, sufficient to make up an overall sample of at least 500 g.

2.1 Moth breeding

Breeding was carried out in the laboratory using strains of *C. cephalonica* from millet and rice samples from the packing station. The harvested cereals (millet and rice) were placed in rearing jars placed in a controlled environment chamber until adult emergence. The adults had been in the jars for 24 hours to encourage the meeting of the two sexes, after which they were harvested using a test tube, sexed according to the presence or absence of labial palps (females have labial palps and males do not). After sexing, the moths were individually placed in minuscule drums of fine-mesh wire mesh to collect the eggs laid by the females and to study the insect's bio-ecology.

2.2 Study of the development of the rice borer

2.3.1 Duration of embryonic development

The eggs laid by the female were incubated in Petri dishes placed in the controlled environment chamber. Monitoring was daily under a cold light magnifying glass to count the eggs hatched in relation to the total laid. Incubation was used to determine the egg incubation or embryonic life span, which is the time between the release of an egg and its hatching.

2.3.2 Duration of larval development

Twenty (20) boxes with wire mesh lids were used and divided into two batches of ten (10) boxes each. The tins in lot 1 each contain 20g of millet and those in lot 2 each contain 20g of rice. The moth eggs, although visible to the naked eye, were recovered, placed on a white sheet of paper and checked under magnifying glasses (binocular and hand held) to form batches of ten (10) eggs. For sowing, using the head of a fluted probe, each ten (10) eggs were slipped and placed on a box placed under and at the edge of the sheet. The development of the insects took place in these boxes until the emergence of the adults. This allowed us to determine the duration of the larval stage or larval-pupation duration, which is evaluated from larval emergence to the beginning of pupation.

2.3.3 Nymph development time

The duration of pupal development is the time between the beginning of pupation and the emergence of the butterfly. To determine this, the technique consisted of rearing the larvae in small plastic boxes containing grains of millet or rice.

Development is monitored and the dates of appearance of nymphs and adults have been determined.

2.3.4 The lifespan of adult males and females

The lifespan of the butterfly or longevity of the adults was assessed from the emergence of the butterfly until its death.

2.3 Biometry of larval stages of *C. cephalonica*

The technique consisted in sieving through a column of sieves superimposed in decreasing order of mesh size (from coarse to fine mesh) on millet and rice cereals in order to recover the various developing larvae from the rearing jars. These larvae were then killed with alcohol at 95° and the size (length and width) for the different stages of development was measured using graph paper under a binocular magnifying glass.

2.4 Adult biometry of *C. cephalonica*

Adults from all 20 culture boxes were sexed. Biometric measurements were taken under a binocular magnifying glass equipped with a graph paper. They consisted of measuring the length and width of the codling moth.

2.5 Sex-ratio

The ratio between the number of individuals in both sexes is called the sex ratio. The primary sex ratio gives the male-female ratio at the time of fertilization, it is generally 50/50 in most species. The secondary sex ratio is determined in the sampled population, so it incorporates differences in Embryonic mortality, birth (or hatching), juvenile development, and the different behaviours of the two sexes (Marmonier, 2006) [12]. The sex ratio or sex distribution index is the proportion of female offspring to total offspring (Do Thi Khanh, 2005) [8]. It has been calculated by the following formula: Sex-ratio **= (∑♀/∑♂+∑♀).**

2.6 Conditions of insect development

The monitoring of rice rootworm development activities was carried out 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 an average relative humidity of 73.21 ± 1.74 %.

2.7 Statistical analysis

Rice borer development parameters were processed using EXCEL® 2016 and XLSTAT 2014.lnk software. The Excel spreadsheet was used for data collection. XLSTAT has been used to do ANCOVA (Analysis of Covariance) which can be seen as a mix of ANOVA and linear regression since the dependent variable is the same, the model is also a linear model, and the assumptions are identical. This type of analysis, on independent samples, made it possible to verify the effect of a qualitative variable (food substrate) on a quantitative variable (larval stage duration, pupal duration, adult longevity, biometry of larval and adult stages, sex ratio, life cycle, egg incubation) and to detect interaction effects (Interaction: the effect of one factor depends on the modality of the second factor (example : the cereal effect depends on the sex)) between the different factors (inertia at level 2) supplemented by more powerful parametric tests for the rejection of the null hypothesis (multiple pairwise comparison of Tukey HSD type) while complying with the ANCOVA validity conditions (independence of residues, diagnosis of normality, diagnosis of homogeneity of variances and diagnosis of out of norm residues). If these conditions were not verified, non-parametric Mann-Withney type tests, more robust are performed since the variables are discrete, independent and quantitative. The differences in means between the different populations taken in pairs were compared by the smallest significant difference at the 5% threshold.

3. Results

3.1 Duration of embryonic development

The embryonic development times of female millet and rice grain eggs were equal (4,8±1,0328 and 4,8±0,4216 days respectively) and their mean difference was not significant (p-value = 0.5810 < 0.05).

3.2 Lifespan of the larval stage in grains

The average duration of the larval stage of *C. cephalonica* varied according to grain type. It was 54.1 ± 1.10 days in millet and 38.30 ± 0.67 days in rice. The difference in larval stage duration was highly significant (p-value = 0.0001) < significance level alpha = 0.05).

3.3 Duration of the pupal stage

Monitoring of pupal longevity revealed an average duration of 21.75 ± 5.60 days on millet grains and 10.63 ± 0.92 days on rice grains. The difference between the durations of the nymphal stage was highly significant (p-value = 0.0008 ; < alpha significance level = 0.05).

3.4 Lifespan of adult males and females

Monitoring of the longevity of adults of *C. cephalonica* showed that the longevity of adults of *C. cephalonica* varied depending on the food. It averaged 12±3.7417 days on millet grains and 6.25±2.1448 days on rice grains. Thus, longevity is higher on millet than on rice. The difference in means between the adult longevity was significant (p-value < 0.0001 ; < significance level alpha = 0.05). The longevity of the male butterfly is greater than that of the female butterfly for both cereals combined. Since the p-value Calculated (0.5737) with the Mann-Whitney/Two-tailed Test is above the significance level alpha = 0.05, the difference in longevity between the two sexes in grains is not significant.

3.5 Life cycle of *C. cephalonica* on millet and rice grains

Monitoring of the life cycle of the moth shows that it is longer on millet grains (92.94±7.23 days) than on rice grains (57.44±4.147 days). The difference in cycle length was highly significant (p-value = (< 0.0001) < alpha significance level = 0.05) (Tables 1).

Table 1: duration of the different phases of development of the rice moth depending on the nature of the cereal

Duration (in day)	millet	rice	N
Incubation	4,8±1,03280	4,8±0,42164	20
Larval stage	54,1±1,10050	38,3±0,67495	20
Pupal	21,75±5,59974	10,6250±0,91613	16
Male adults	14,1250±3,68152	6,8750±2,94897	16
Adult females	9,8750±2,47487	5,6250±0,51755	16
Male cycle	94,8750 ± 8,20170	60,8750±3,04432	16
Female cycle	91 ± 6,02376	54 ± 0,755 9 3	16
Total Cycle	92,9375±7,23389	57,4375 ± 4,14679	32

Biometry of larval stages

The biometry performed on the larvae showed six larval stages (see Figure 1):
Stage 1: The length varies from 1.1 to 2 mm and the width is 0.2 mm ;
Stage 2: the length varies from 3 to 4 mm and the width is 0.4 mm;
Stage 3: length varies from 2.8 to 5 mm and width varies from 0.4 to 0.5 mm;
Stage 4: The length varies from 4.5 to 9 mm and the width is 0.8 mm;
Stage 5: length varies from 3.5 to 9 mm and width varies from 0.8 to 1 mm;
Stage 6: length varies from 8 to 13 mm and width is 2 mm.

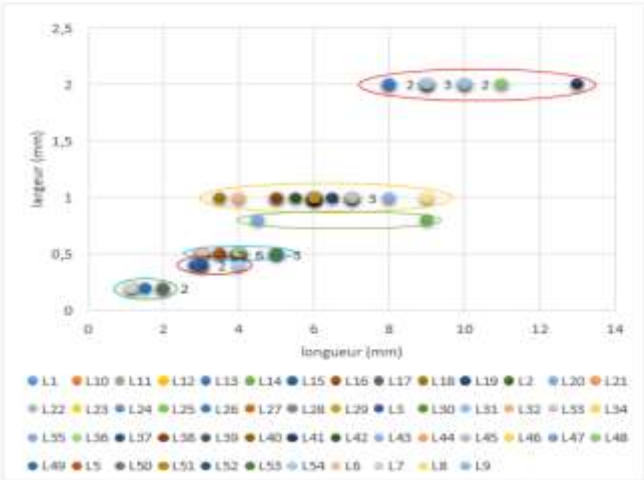

Fig 1: Larval stage biometry point clouds over Mil

Adult biometrics

Adult biometry revealed mean lengths of 10.23 ± 1.27 mm and 8.65 ± 1.23 mm for millet and rice, respectively. Thus, the length of the moth is higher in millet than in rice. This food-dependent difference in length was highly significant (p-value = 0.0001 < alpha significance level = 0.05). The insect has an average width of 2.08±0.19 mm on rice grains and 2.83±0.71 mm on millet grains. The mean difference between these two types of food substrate is significant (p-value = 0.0046 < alpha significance level = 0.05).

Synthesis of multiple pairwise comparisons for Cereals (Tukey (HSD)

Mean lengths of codling moth on millet and rice cereals are significantly different because they belong to different groups. The differences in average widths of the moth in millet and rice grains are significant because they belong to different groups (Table 2).

Table 2 : Pairwise multiple length comparisons for grains

Modality	Estimated average (length (mm))	Groups		Modality	Estimated average (length (mm))	Groups	
Millet	9,4571	A	Millet		2,8857	A	Millet
Rice	7,9667	B	Rice		2,0833	B	Rice

Synthesis of multiple pair-wise comparisons for Sex*Cereals (Tukey (HSD)

Legend : M*MIL = millet effect by male sex, M*RIZ = rice effect by male sex, F*MIL = millet effect by female sex, F*RIZ = rice effect by female sex. Estimated mean effects (F*RIZ and M*MIL), (F*RIZ and M*RIZ), over the length of the moth are not significantly different. However, the medium F* MIL effect on length is significantly different from the others (Table 3).

Table 3: Multiple pairwise comparisons of length for cereal effect by sex (gender * grain)

Modalité	Estimated average (length (mm))	Groups		
F*Millet	10,2000	A		
M*Millet	8,7143		B	
F*Rice	8,3333		B	C
M*Rice	7,6000			C

Synthesis for all the Y's

The size difference of *C. cephalonica* (length and width) is very significantly different. (Length : R^2=0.7918 and F=24.0832 ; Width : R^2= 0.4753 and F=5.7374 ; P-value<0,0001 for Length and 0.0057 for Width).

Summary (Estimated average) - Gender

Females are larger than males and grow in the same direction in both sexes (Length (females=9.2667 and males=8.1571 ; Width females=2.6833 and male=2.2857). The mean difference between males and females is significant for length and not significant for width (Figure 2).

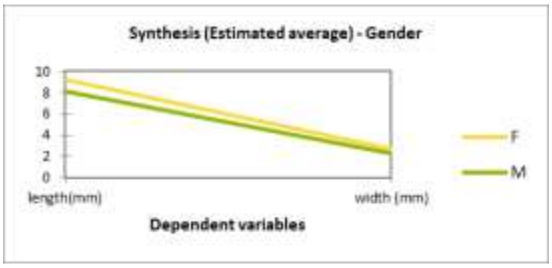

Fig 2: graph of size variation means by gender

Summary (Estimated average) - Cereals

The size of the insect is larger (length (mm)=9.4571 in Millet and 7.9667 in rice ; width (mm) = 2.8857 in millet and 2.0833 in rice) in millet grains than in rice. The difference in average in millet and rice grains is significant for both length and width.

Summary (Estimated Average) - Gender*Cereals :

The size is higher with the influence of the female sex on millet. Estimated mean F*RIZ and M*MIL effects on moth length are not significantly different ; F*RIZ and M*RIZ is also not significantly different. However, the mean of the F*MIL modality over length is significantly different with the others. The estimated means of the F*MIL and M*MIL modalities, and those of M*MIL, F*RIZ and M*RIZ over width are not significantly different. However, the F*MIL modality is significantly different from those of F*RIZ and M*RIZ (Figure 3).

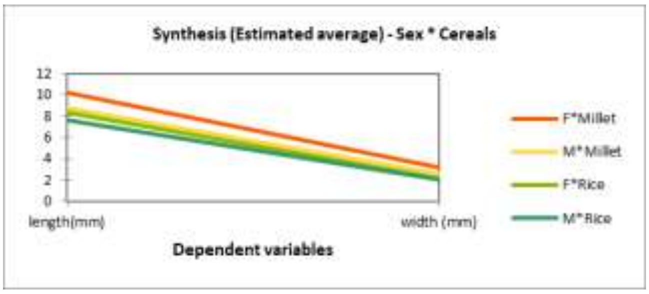

Fig 3: graph of the means of size variation according to the cereal effect according to sex (sex * cereals)

Regression of the length variable (mm)

The sex and cereal factors had highly significant effects on insect length (p-value = < 0.0001 □□0.05), whereas the cereal effect by sex (sex*cereals) had no significant effect on the length of C. *cephalonica (p-value* = 0.0904 □□0.05) (see Table 4).

Table 4: Analyse Type III Sum of Squares (Variable longueur (mm))

Source	DDL	Sum of squares	Average of squares	F	Pr > F
Sex	1	6.9401	6.9401	27.6910	< 0.0001
Cereals	1	12.5240	12.5240	49.9708	< 0.0001
Gender * Cereals	1	0.7978	0.7978	3.1833	0.0904

Analysis of Table 5 reflecting the model parameters reveals the nature of the effects of these factors. In fact, female sex and millet grain have significant positive effects on length while the effect of millet on female sex has a non-significant positive effect on moth length.

Table 5: Model parameters (Variable length (mm))

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Constant	7,6	0,22	33,95	< 0,0001	7,13	8,07
Sex-F	0,73	0,30	2,42	0,0258	0,10	1,37
Cereal-millet	1,11	0,29	3,80	0,0012	0,50	1,73
Gender-F * Cereal-millet	0,75	0,42	1,78	0,0904	-0,13	1,64

The graph of averages shows that the average length is higher at the female gender level (Figure 4a), at the millet cereal level (Figure 4b) and finally at the millet cereal and female gender level with the cereal effect by gender (Figures 4c and 4d). We can therefore talk about the sex, cereal and cereal effect as a function of sex (sex*cereal) on height (length).

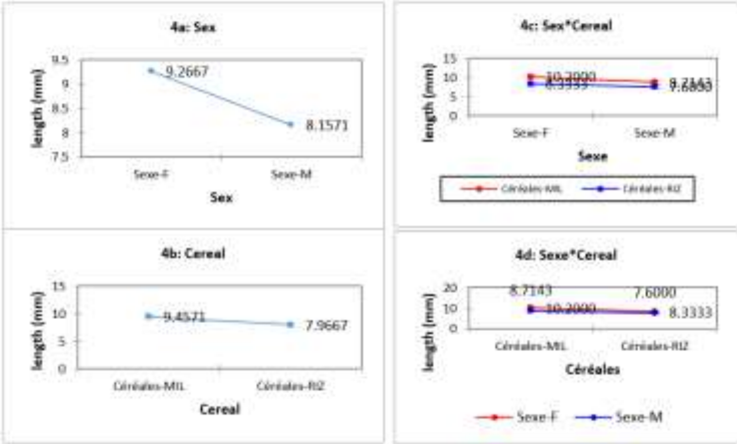

Fig 4: length graphs by sex, millet and rice cereals and cereal effect by sex (sex * cereals)

Regression of the variable Width (mm) :
Sex and sex*cereal factors had non-significant effects on insect width (p-values = 0.0771 and 0.2912, respectively, □□0.05). However, cereal type had a significant effect on the width of *C. cephalonica (p-values* = 0.0013 < 0. 05 (Table 6).

Table 6: Analyse Type III Sum of Squares (Variable Largeur (mm)

Source	DDL	Sum of squares	Average of squares	F	Pr > F
Sex	1	0,8913	0,8913	3,4934	0,0771
Cereals	1	3,6296	3,6296	14,2259	0,0013
Gender * Cereals	1	0,3007	0,3007	1,1786	0,2912

Legend : sex * cereals = interaction between sex and cereals.

The graphs of the averages show that the average width is higher for female gender (5a), millet cereal (5b) and finally at the female gender and millet cereal levels for the gender-specific cereal effect (5c and 5d).

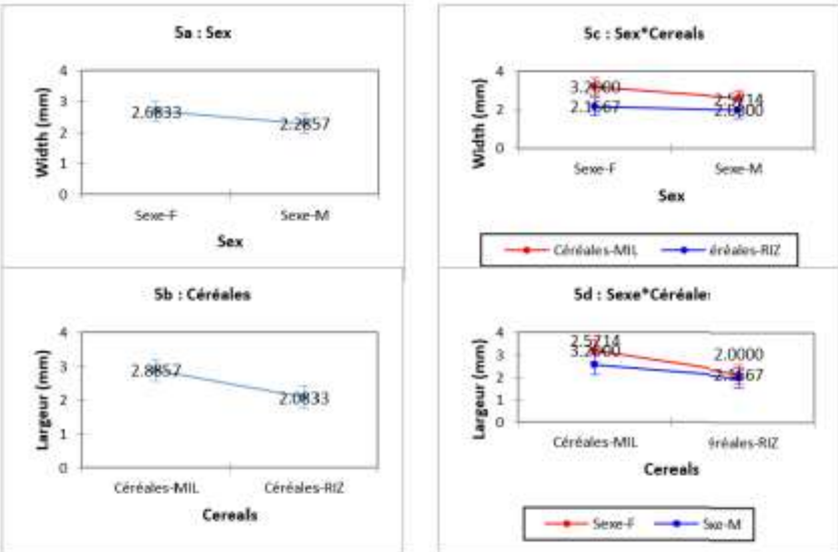

Fig 5: graphs of width averages by sex, type of grain and gender interaction * cereals

Sex-ratio

The sex ratio (percentage of females) evolves differently depending on the type of food substrate used. It is in favour of males (60.42%) on millet grains and in favour of females (75%) on rice grains. Figure 6 shows that the mode evolves differently depending on the type of grain. It is 7 for the male sex and 5 for the female sex on the millet ; 6 for females and 5 for males on rice.

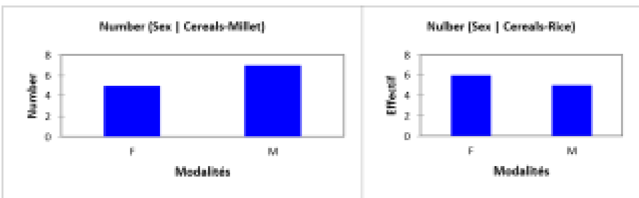

Fig 6: Bar diagrams showing the effect of cereal on the sex of the European moth

Discussion

The objective of this work is to determine the effect of cereals (millet and rice) on the development and reproduction parameters of *Corcyra cephalonica* populations, a pest of dry cereal grains in storage in Senegal. The results obtained from our work show that the type of cereal has an effect on the biological parameters of the insect. Monitoring of the incubation times of female millet and rice grain eggs showed that they were equal and their mean difference was not significant (p-value = 1 0□.05). This allows us to say that the type of cereal used does not have a significant effect on the embryonic development of the moth. The mean duration between larval emergence and pupal emergence (larval-pupation time) of *C. cephalonica* was longer in millet grains (54.1 ± 1.10 days) than in rice grains (38.30 ± 0.67 days) with a very significant difference in mean (p-value = 0.0001 0.□05). This could be explained by the low vitamin content of millet compared to rice, which also provides two fairly important sources of energy (carbohydrates and proteins). The duration of larval development found in rice for our study is close to that found by (Ashwani Kumar *et al.*, 2002) [2] which is 35 days on rice and by (Mbata, 1989) [13] who also reported a larval development period of 35.75 days on rice. (Ayyar, 1934) [3] determined a larval-pupation period of 57 days on sorghum and 53 days on rice, which is slightly longer. According to According to (Jagadish *et al*., 2009) [10], the larval-pupation period varies between 28 and 36 days with an average of 31.26 days on millet, which is slightly shorter compared to the duration we obtained on millet grains. Monitoring of pupal longevity revealed means of 21.75 ± 5.60 days and 10.63 ± 0.92 days on millet and rice grains respectively, with a highly significant difference (p-value = 0.0008 0.□05). This difference would be related to the nutritional quality of the grain used for larval development and the nature of the energy reserves required for pupation. According to (Bhandari *et al.* 2014) [4], the period of pupal development was not significantly different between the different feeds fed to *C. cephalonica*, but there is a slight numerical variation. According to them, the maximum duration was found on rice (10.33 days) followed by other diets. This is in disagreement with our results. (Jagadish *et al.*, 2009) [10], found a pupal period that varied between 9 and 16 days with a mean of 13.06±0.86 days for borers reared on millet grains. According to (Bhubaneshwaridevi *et al.*, 2013) □□□□, at the beginning of the pre-pupal period, the larvae stop, become less active, cannot move quickly and weave a silky white, very hard cocoon into the grain. According to them, the pupation is the ultimate transformation of the pre-pupal stage and a stage of non-feeding. The nymphs had a sturdy body and a gradually tapering abdomen. The body colour was dark brown and the nymphal period varied from 9 to 19 days. This is close to our results. The progressive reduction of their abdomen would be due to the use of the energy reserves accumulated during the larval period. Moreover, the lifespan of adult males is longer than that of adult females ; moreover, longevity is higher in millet than in rice. The difference in adult longevity was very significant (p-value = (< 0.0001) < significance level alpha = 0.05). According to (Andrewartha and Birch, 1954) [1], insect longevity was influenced by environmental components, including temperature, humidity and food. This may support our result. On the other hand, the greatest longevity of male moths was 21 days when their larvae were reared on millet grains and 11 days for those reared on rice grains. A similar trend in female longevity was also recorded due to the qualitative difference in the grains used during its development. The greatest longevity of female moths observed was 14 days when the larvae developed on millet grains while it was 6 days on rice grains. This difference in longevity between males and females could be explained by the egg-laying activity of females, which would require more energy and thus deplete the reserves of fertilized females more rapidly ; this is not the case for males, which, after copulation, remain inactive until death. These results are similar to those of (Nasrin *et al.* 2016) [14] who had obtained for male moths a maximum of 7.7 days when their larvae were grown on chopped wheat and 6.6 days on rice grain. (Ozpnar, 1997) [16] had obtained for the longevity of female moths a maximum of 7.2 days when the larvae developed on chopped wheat. This difference would probably be due to the nutritional quality of the rice grain, which would be better than that of chopped wheat and millet. The life cycle of the rice borers is highly dependent on the nature of the cereal grain used as a substrate for the growing medium. Our results showed life cycle durations with means of 92.94 ± 7.23 days on millet grains and 57.44 ± 4.15 days on rice grains. The difference between these durations was very significant (p-value = (< 0.0001) < alpha significance level = 0.05). (Devaraj & Mukherjee, 1966) [7] reported that improved feeding increased the longevity of both male and female moths, but shortened the total life span of *C. cephalonica* when they reared this month on groundnut and sesame. They found that the life span of groundnut was qualitatively superior to that of sesame. Total life span of 61.42 days in peanuts while 76.89 days in sesame was recorded by them. Their results are in agreement with ours in terms of the total lifespan of ringworm. However, with regard to the longevity of male and female moths, our results disagree. (Bhandari *et al.* 2014) [4] reports a total development period that was maximal in rice (57.98 days). (Ashwani Kumar *et al.*, 2002) [2] also reported similar results of 56.15 days in rice and 45.82 days in sorghum. Their results are similar to ours with regard to the cycle length of the moth on rice grains, but very different for the millet moth cycle length. The biometric study of the different larval stages revealed that the insect passes through 6 larval stages in the grains. This result is corroborated by (Usman, 1968) [18] and (Jagadish *et al.*, 2009) [10], which documented the same number of larval stages. The size of the imago is significantly higher on millet grains (length : 10.23±1.27 mm and width : 2.83±0.71 mm) than on rice grains (length : 8±0.19 mm and width : 2.08±0.19 mm). This indicates that millet grains, which are richer in protein, would increase the size of *C. cephalonica*. Thus, the nutritional quality of the grain has a bearing on the size of the grain moth. In reality, the adult does not feed, its size would depend on the quality and quantity of nutrients available to the larva. The mouthparts of *C. cephalonica* larvae are of the grinder type, so millet grains would be more accessible, therefore more nutrients and reserves for the moths, than those of rice, which are harder. This would explain this difference in the size of the moth depending on the food substrate. On the other hand, female sex, millet grain and the influence of sex on millet grain have non-significant positive effects on the width of the moth ; female sex and the influence of female sex on millet grain also have non-significant positive effects on the length of *C. cephalonica*. However, millet cereal alone had a significant positive effect on codling moth length. A significant cereal-sex effect was also noted on moth length, however the cereal-sex effect on moth length had a non-significant effect. For butterfly width, the cereal effect was positive and very significant, but the sex and sex*cereal effect was non-significant. From our results obtained under controlled conditions, the sex ratio varies according to the food substrate used. It was in favour of millet grains for males and rice grains for females. The variation of this ratio according to the cereal used for the development of the codling moth would have a consequence on the reproductive potential of the latter and would induce a competition phenomenon depending on the availability of females or males. In the same logic, the mode indicates a higher frequency of male moths (58,33 □) than female moths (41,67 □) on millet grains. On the other hand, this mode is in favour of female moths, which have a frequency of 54.55 □on male moths, which have a frequency of 45.45 □on rice grains. This corroborates the result obtained for the sex ratio and could open up other avenues of research. Thus, the sex ratio is also modulated according to the type of food substrate used : males prefer millet and females prefer rice.

Conclusion

The study of the development parameters of the rice rootworm gave us a clear idea of the influence of the type of food substrate on the duration of the different phases of the cycle, the size and the sex ratio. The comparative study between *C. cephalonica* populations infested in millet and rice grains showed that the average duration of the development cycle of this insect is longer in millet grains than in rice grains. The degree of *C. cephalonica* infestation of grains between these two cereals would then be more limited in millet grains than in rice grains because the number of generations is lower in millet grains. The study thus revealed a cereal effect, a sex effect and a sex influence effect on the cereal on the insect's development parameters. It should be noted that the type of food substrate has a significantly different effect on the parameters : larval stage duration, pupal duration, adult size and longevity. This new information will undoubtedly allow better management of cereal stocks in order to guarantee food security and the availability of quality seeds to the Senegalese population.

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