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Study of the factors influencing the breeding of *Habrobracon hebetor* say (Hymenoptera: Braconidae) on its host substitution *Corcyra cephalonica* (Lepidoptera: Pyralidae) in real environnent in Niger

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Abstract
Using *Habrobracon hebetor* Say is an alternative solution for sustaining the fight against the borer millet. For a very long time, the mating of this parasitoid has posed methodological difficulties because it has to go through good synchronization with its surrogate host. In this study, the breeding of *H. hebetor* in real environment was carried out in three different breeding structures. The data were analyzed under Statview.rar. In general, male dominance over females is observed throughout the duration of the experiment. The comparison of the means according to breeding structures showed a dominance of adults emerged in hangar (90.8 ± 20.70) compared to other breeding structures. Thus over 96% of adults of *H. hebetor* have emerged in hangar against only 90% in the final material. Taking into account gender, it is clear from results found that sex is in favor of females in a shed and in favor of males under house of mud and solid materials. It appears that hangar farming can be a good place for mass breeding of *H. hebetor*. Depending on its surrogate host, the results seem to show that the higher the number of *C. cephalonica*, the more adults of *H. hebetor* increase. All these results constitute a good indicator for the technical services for a better management of the mass farms of *H. hebetor*.

Keywords: *Habrobracon hebetor*, *C. cephalonica*, mass farming, farming structures, Tahoua region

Introduction
Millet (*Pennisetum glaucum* (Leek) R.Br.) occupies more than 31 million hectares per year in the semi-arid tropical regions of Asia, Africa and Latin America, in more than 40 countries (FAO, 2015) [8]. West Africa supplies around 80% of millet production (ROCAFREMI, 2002) [15]. It is the staple food of the 50 million inhabitants of the Sahel. Extremely drought resistant and well adapted to poor soils, it remains the only crop that truly corresponds to environmental conditions and traditional eating habits. In this area, millet cultivation suffers significant damage each year from pests including insects. Millet is the victim of pests of all kinds: insects (leafminer caterpillars, stem borers, dipteran pests, beetles), diseases (downy mildew, smut, ergot), weeds (Striga, Annual Dicotyledons, Annual grasses, Cyperaceae), grain-eating birds (Quelea quelea, Q. erythrops, Passer luteus), harmful rodents (*Arvicunthis niloticus*, *Mastomis* sp), stock insects (*Sitotrogo cf! rf*! allela, *Tribolium castaneum*, *Rhiwperta dominica*), iules (*Peridon topyge rubescens*, *P. conani*) (MBAYE, 1993) [14]. To reduce the impact of these insects and increase the productivity of millet, control methods (chemical, cultural, biological, variety) were developed. Taken individually, however, each method has limitations. In this context, biological control remains one of the most clean and efficient solutions peasant backgrounds. Biological control is a method of controlling populations of pest species by using another species which acts by predation, parasitism, competition (Bal A.B., 1998) [3]. Biological control methods therefore exploit the natural regulation ectoparasites of phytophagous populations. In this study, we are talking about the use of *Habrobracon hebetor* Say, a larval ectoparasite hymenoptera for the effective control of the millet caterpillar. Little work has been done on millet insects in Niger. It is therefore necessary, for an effective control of these pests, to determine the conditions necessary for a better breeding in real environment in Niger.

Methodology

Materials used

During this study several materials were used including among others:

- Plastic buckets: for the breeding of *C. cephalonica*
- Mosquito net fabric to cover plastic buckets
- Plastic ring: use to seal the mosquito net to the buckets
- Petri dishes: small dishes used for the breeding of *H. hebetor*
- Soft tongs: for sorting *C. cephalonica* larvae
- A hand magnifier: for counting cocoons and adults of *H. hebetor*.
- A vacuum cleaner: to capture *H. hebetor*
- Para film: used to seal the petri dishes
- A thermometer and a hygrometer for the temperature and humidity reading

Mass farming techniques for adults and larvae of *Corcyra cephalonica*

The mother strain of *C. Cephalonica* used for breeding comes from the laboratory of the General Direction of Plant Protection of Niger. The strain was raised in mass in a real environment. The technique of mass rearing consists in introducing the adults (males and females) of *Corcyra cephalonica* in new plastic buckets with a capacity of 20 liters (Madougou, 2015) [13]. Each bucket is half filled with millet and covered with mosquito net held in place with a plastic ring. The eggs are laid on millet. After the incubation time, the eggs hatch and then give caterpillars. The latter continue to feed on millet. At the end of 4 weeks the caterpillars passed successive clouds. The caterpillars having reached stages 3 and 4 are sorted and are used for the breeding of *Habrobracon hebetor.*

Mass breeding technique for the parasitoid *Habrobracon hebetor*

The mother strain used by *H. hebetor* for breeding also comes from the laboratory of the General Directorate of Plant Protection of Niger. For the mass breeding of *H. hebetor*; caterpillars of *C. cephalonica* of 4th and 5th stage were sorted and subjected to the parasitoid. After ten (10) days of incubation at room temperature; emergencies were observed and adults recovered. The adults of *H. hebetor* were placed in the mating cage for 48 hours. After these two days, the pregnant females were chosen and used for the conduct of the tests.

Conduct of experiments

Production of *H. hebetor* in three breeding environments (Hangar, House made of mud, house made of final materials)

The experiments were carried out in three farming environments, namely the Hangar, the mud house and the house made of final materials. Temperatures and relative humidity were recorded during the study period.

The experiment consists, in each breeding environment, of introducing five pregnant females into a box containing 20 caterpillars of *C. cephalobica* as a surrogate host. This experiment is repeated, for each case, 20 times.

After 8-10 days, emergences began and adults were noted.

The females of *H. hebetor*, after one hour of time paralyze all the caterpillars and lay eggs thereafter. After the eggs hatch, the larvae pass their entire development by feeding on the caterpillar. At the end of their development, the *H. hebetor* larvae pupate around the dead caterpillar, each in a white cocoon which they weave and from which the parasitoid imagines emerge later. The biological cycle of *Habrobracon hebetor* lasts 8 to 12 days. Adults hardly eat anything.

So after 10 days we see the emergence of new wasps which are used for the production of release bags or other petri dishes for direct releases.

At the end of this experiment, several parameters were determined:

- Variation in emergence rate of *H. hebetor* according to breeding structure
- Sex-Ration variation of *H. hebetor* according to breeding structure

Mass breeding of *H. hebetor* according to the number of *C. cephalonica*

A variable number of *C. cephalonica* (15, 20, 30) is used, when not chosen, as a surrogate host. The same procedure was followed and adults are noted on emergence.

The parameters determined are as follows:

- The emergence rate of *H. hebetor* as a function of the number of *C. cephalonica*
- Sex-Ration of *H. hebetor* as a function of number of *C. cephalonica*

Data analysis and interpretation methods

After collecting the test data, this data is entered into Excel before being submitted to the Statview.rar software, version 1999 for analysis; this is how the averages were determined through ANOVA; and the comparison of the means two by two between breeding structures and according to number of *Corcyra cephalonica* was done using the Fischer test under statview.

Results

Variation of temperature and relative humidity during the study period

Table N ° 1 presents the monthly averages of temperatures and wet conditions during the study period. Thus, the highest values of temperature are recorded seem in September where the extreme averages reach of temperature 36.3 °C, 33.7 °C and 30.5 respectively in the house in final materials, house in mud and Hangar. The lowest relative humidity is recorded in November.

Table 1: Reading of the temperature and relative humidity of the Tahoua urban community

Study period	Hangar		Banco house		House in final materials	
	T°	H%	T°	H%	T°	H%
September	30,5	58,9	33,7	53,8	36,3	51,9
October	30,1	51,4	32,4	50,9	35,6	50,1
November	30	51,1	31,3	49,9	35,0	50

Variation in the emergence rate of *H. hebetor* adults according to breeding structure.

Table N ° 2 shows the variation of the emergence rate according to breeding structures. Analysis of the data shows that the emergence rate of *H. hebetor* appears to be higher in the hangar (96.5%) than the other breeding structures. Statistical analysis shows a significant difference between the hangar and the other breeding structures (Hangar/banco house: P = 0.006; Hangar / House in final materials: P = 0.0008).

Table 5: Average number of cocoons, average number of adults of *H. Hebetor* and rate of emergence.

Breeding structures	Average number of cocoons	Average of *H. hebetor* adults	Adult emergence rate (%)
Hangar	94 ±21.60 a	90.8 ± 20.70 a	96.5
Banco house	75.8 ± 18.18 b	71.93 ± 17.38 b	94.84
House in final materials	74.46 ± 17.71 b	67.33 ± 15.05 b	90.42

In the same column, the means followed by the same letter are not significantly different (Fisher test)

Variation of Sex-Ratio according to breeding structure

Table N ° 3 shows the variation of the sex-ratio according to the breeding structures. Thus, the analysis of the data shows that the sex ratio is in favor of females in the hangar (60.85%) and in the other breeding structures this sex ratio is in favor of males (Female: Banked house: 43.27% and final house in M. 35.83%). Statistical analysis shows significant differences in all breeding structures in females (Hangar/Banco house: P = 0.0001; Hangar/House in final materials: P = 0.0001 and Banco House/House in final materials P = 0.0418) and no difference for all breeding structures in males (Hangar/Banco House: P = 0.2332; Hangar/House in final materials: P = 0.0855 and Banco House/House in final materials P = 0.5844).

Table 3: Average number of Sex-Ratio according to breeding structure.

Breeding structure	Emerged adults (%)	Males (%)	Females (%)	Sexe-Ratio (%)
Hangar	90.8	35.53± 14.89 **a**	55.26 ± 11.22 **a**	60.85
Banco house	71.93	40.8 ± 9.32 **a**	31.13 ± 8.56 **b**	43.27
House in final materials	67.33	43.2 ± 10.84 **a**	24.13 ± 7.12 **c**	35.83

In the same column, the means followed by the same letter are not significantly different (Fisher test)

Evolution of adults of *H. hebetor* by sex

Figure 1 shows the evolution of the emergence of *H. hebetor* during the trial period. Thus we see a more or less constant evolution for the sexes. The variation in sex is very remarkable with a predominance of males throughout the breeding period.

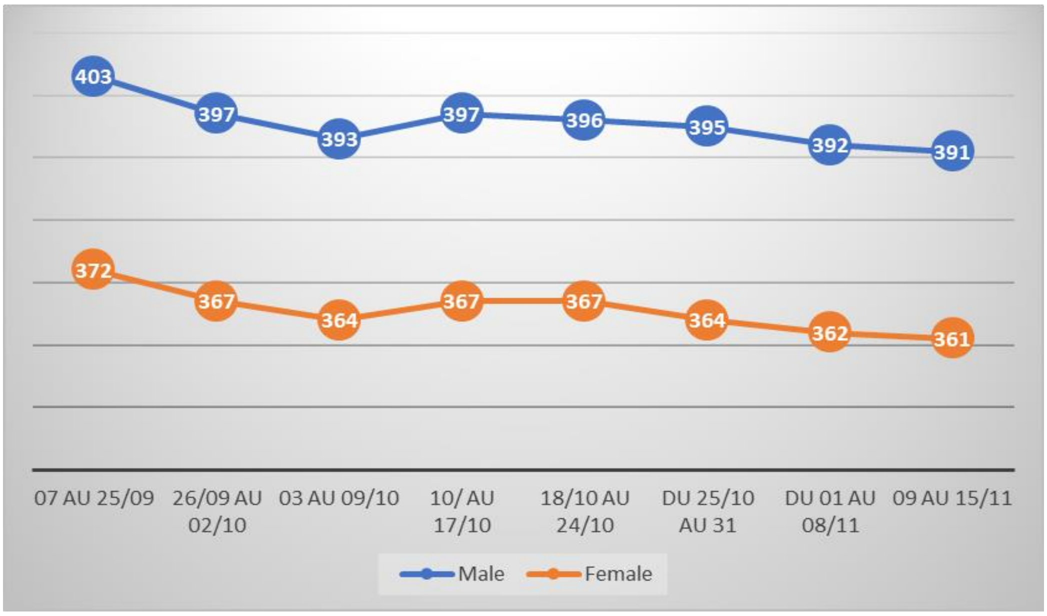

Fig 1: Evolution of the emergence of *H. hebetor* according to sex

Variation in the average number of adults of *H. hebetor* according to the number of larvae of *C. cephalonica*

The data recorded in table N ° 4 show the variation of the rate of emergence according to the larvae of *C. cephalonica*. Thus, the analysis of the data shows a significant difference in all the food carriers of the *H. hebetor* larvae (15 Larvae / 20 Larvae: P = 0.0001; 15 Larvae / 25 Larvae: P = 0.0001 and 20 Larvae / 25 Larvae P = 0.0063).

There is also a significant difference everywhere with regard to the production of males (15 Larvae / 20 Larvae: P = 0.0001; 15 Larvae / 25 Larvae: P = 0.0001 and 20 Larvae / 25 Larvae P = 0.0058). For females (15 Larvae / 20 Larvae: P = 0.0328; 15 Larvae / 25 Larvae: P = 0.0041 and 20 Larvae / 25 Larvae P = 0.4092).

It seems that the larger the number of *C. cephalonica* larvae, the better the *H. hebetor* larvae feed, hence the good production of *H. hebetor* adults.

Table 4: average of emerged adults by sex as a function of the number of *C. Cephalonica* larvae.

Number of *C. cephalonica* larvae	Emerged adults of *H. hebetor*	Males	Females
15	55,6± 6,75 a	28,26 ± 7,82 a	27,33 ± 13,35 a
20	80,6 ± 14,66 b	41,26 ± 7,43 b	39,33 ± 18,46 b
25	93,86 ± 14,79 c	50,00 ± 9,312 c	43,86 ± 12,08 b

In the same column, the means followed by the same letter are not significantly different (Fisher test)

Discussion

Biological control is one of the most preferred alternatives for a sustainable fight against the earbug. This presents methodological difficulties. Successful operations require good synchronization of the breeding of the two insects. The system put in place allowed continuous production of the larvae.

Temperature and humidity conditions were favorable for the development of *C. cephalonica* and *H. hebetor*. There is a very marked emergence of males on all tests compared to females. In the breeding of *H. hebetor* since 2000, interesting results have been obtained in the laboratory. This year, the cocoon emergence rate obtained is 94% in a hangar, 75.8% in a mud house and 74.46% in a house made of final materials. Each larva of *C. cephalonica* served as a nutritional support for the production of 4.07 cocoons of *H. hebetor* on average.

The proportion of females produced respectively by environment (Hangar, mud house and a house made of final materials) varied by 55.26%; 31.13% and 24.13%. This rate (for Hangar) greatly exceeds those obtained by Abdourazak (2018)[1] where an emergence rate of 60% males and 40% females has been reported.

This work made it possible to understand the difficulties encountered by farmers' organizations; because the majority use mud houses where the temperature is more or less high. Climatic conditions are abiotic factors that affect the abundance, development, reproduction and distribution of ectotherms as well as the relationships between species (Bale, 1992) [5]. The most important abiotic factor is temperature which affects the performance of ectotherms (Huey & Kingsolver 1989) [12].

These performances gradually increase from the critical thermal minimum to the optimum, then decrease rapidly.

The shortcomings noted mainly concern fertility. Each *H. hebetor* female produced an average of 15.33 adults, including 7.37 females. This seems insufficient to us since it is known that a single fertilized female can produce an average of 173.7 adults (Youm and Gilstrap 1993) [16]. This problem may be due to the number of host larvae presented to females. In this study, a ratio of 3 is obtained; 4 and 5 larvae of *C. cephalonica* for a female of *H. hebetor*, while a female alone can parasitize up to 10 larvae (Garba S., 2000) [8].

The temperature and relative humidity of the breeding environment is also not to be excluded because our breeding environments are totally different from that of the laboratory. Insects that survive after exposure to cold can suffer from sub-lethal damage that affects development, reproduction and longevity (Ball and *al.*, 2015) [4]. If exposure to cold affects the larval development stages, adults from these larvae may also present morphological anomalies which prevent flight, prevent mating or make the search for trophic resources more uncertain (Adarkwah C. 2010) [1].

The photoperiod is an environmental signal often used by insects during the year and adjust their life cycle accordingly and in particular the lifting of diapause Danks (2000) [7]; Yadav[16] and *al*. (2008) [16]. Indeed, the photoperiod can affect certain parameters of development, survival, or for example, Yadav and *al.* (2008) [15] have shown that by raising *Micomus tasmaniae* Walker pupae (Neuroptera: Hemerobiidae) under two different photoperiod regimes (16L and 12L: 12D), the emerging under the short-day regime to assess fitness photoperiod.

Conclusion

This study which results in the conduct of tests on the possibility of breeding in rural areas of *Habrobracon hebetor* Say according to the ambient temperature and the relative humidity in the region of Tahoua (urban community of Tahoua); allows us to better grasp our theoretical knowledge and draw the following conclusions. One of the questions that has arisen since the 2000s has been the transfer of Habrobracon hebetor Say breeding to rural areas.

Thus in recent years experimental tests have been conducted, but this was faced with difficulties such as the predominance of emergence of males over females; the accidental infestation of breeding boxes of *C. cephalonica* by *H. hebetor* which suddenly leads to the rupture of the alternative support larvae for breeding this parasitoid. The production technique of *H. hebetor* in rural areas is increasingly mastered by pilot producers trained for this purpose.

The diversity of the breeding environment has a significant influence on the fertility and survival of *H. hebetor*. Like what is happening at the level of farmers' organizations in the context of the transfer of this technology, the temperature of the environment affects the fragility of farms, in particular the sex ratio. In our conditions, the hangar is the best simple place to achieve optimal breeding of *H. hebetor*. During the test period, the average temperature recorded was 30 °C in Hangar, 32 °C in the house in Banco and 35 °C in the house in final materials. A difference of 2 °C is very significant for breeding. Use the sheds in livestock because the temperature is lower compare to other environments Building sheds would be simpler and applicable for all producers. Make ventilation openings on mud houses; and houses made of final materials are to be avoided.

Reference

1. Abdou Razak. Reproduction capacity of *Habrobracon hebetor* according to the number of caterpillars available in the DGPV laboratory, end of study. memory 2018, 42
2. Adarkwah C. Ability of the larval ectoparasitoid *Habrobracon hebetor* (Say, 1836) (Hymenoptera. Braconidae) to locate the rice moth *Corcyra cephalonica* (Stainton, 1865) (Lepidoptera: Pyralidae) in bagged and bulk stored rice in Journal of Plant Diseases and Protection. 2010; 117(2):67-70, ISSN 1861-3829.
3. Bal AB. Mass breeding of *Bracon hebetor* (Say) and its use for biological control against *Heliocheilus albipunctella* (De Joannis); training session for officers from the Niger Plant Protection Directorate; DFPV / AGRHYMET Regional Center, 1998, 14-16,
4. Bal AB, Kogo S, Dankoulou A, Gagaré S. Breeding and release guide for *Habrobracon hebetor* Say (Hymenoptera, Braconidae) parasitoid of the millet caterpillar and its surrogate host *Corcyra cephalonica* (Stainton) Lepidoptera Pyralidae. Technical Document, AGRHYMET Center, Niamey, Niger, 2002, 15
5. Bale AB. The main millet insects in Senegal: importance of parasitism and methods of control. In Integrated control against the enemies of food crops in the Sahel. Seminars & colloquia. Second seminar on the integrated fight against the enemies of food crops in the Sahel. Bamako, Mali, 4-9 January 1990, 13-23.
6. Ball SL, Woodcock BA, Potts SG, Heard MS. Size matters: Body size determines functional responses of ground beetle interactions. Basic and Applied Ecology - Journal. 2015; 16 :621-628.

7. Danks. Déshydratation chez les insectes dormants ? Journal of Insect Physiology. 2000; 46(6):837-852
8. FAO, March food security and humanitarian implications in West Africa and the Sahel, N ° 63 March, essentials, 2015, 6.
9. Garba Saley,: biological fight against the millet miner, *Heliocheilus albipunctella* de Joannis with the use of the parasitoid, Bracon hebetor Say, thesis of agronomist, Katibougou (IPR / IFRA), 2000, 53
10. Guevremont H. Study on the entomofauna of millet. Annual research report for the year 1980, second part, National Center for Agronomic Research (CNRA) of Tama, Maradi, Niger, 1981, 31.
11. Guevremont H. Studies on the cob miner and other millet insects. Annual research report for the year 1981, CNRA de Tama, Maradi, Niger, 1982, 57.
12. Huey RB, Kingsolver JG. Evolution de la sensibilité thermique des performances ectothermiques. Trends in Ecology and Evolution, 1989; 4:131-135.
13. Madougou Garba, Anne Loiseau, Laure Benoit, Nathalie Gauthier. A new suite of twenty-two polymorphic microsatellite loci in the parasitic wasp, *Habrobracon hebetor* (Hymenoptera: Braconidae): Promising molecular tools for studying the population genetics of several beneficial braconid species, European Journal Entomoly. 2016; 113:265-269
14. Mbaye DF. Phytosanitary constraints of millet in the Sahel: State of knowledge and perspectives, ISRA / CNRA of Bambey, Senegal, 1993, 173, 186
15. Rocafremi. Selection and Provision of Peasants of Varieties and Appropriate Seeds. Results of the P1 Project: 2002, 1991-1996.
16. Yadav H, Jain S, Sinha PR. Oral administration of dahi containing probiotic *Lactobacillus acidophilus* and *Lactobacillus casei* ameliorated the Streptozotocin-induced oxidative stress and dyslipidemia in rats. Journal of Dairy Research. 2008 ; 75:189-195.
17. Youm O, Gilstrap FE. Dynamique des populations et parasitisme de *Coniesta ignefusalis*, *Sesama calamistis* et *Heliocheilus albipunctella* en monoculture de mil. International Journal of Tropical Insect Science. 1993; 14:419-426.