Diversity and Distribution of *Callosobruchus* spp. attacking stored Chickpea in Northern tracts of West Bengal.

ABRTRACT

Diversity of stored grain insects is often neglected, as many workers think that it has a limited or no diversity as the consumer tolerance towards insect's pest in stored grains is zero. In this context a survey was conducted in three districts i.e., Coochbehar, Alipurduar and Jalpaiguri districts of northern tracts of West Bengal to find the diversity of species of pulse beetle and its species abundance in stored chickpea during 2018-2020. In the collected chickpea seed samples, four species namely, *Callosobruchus chinensis* L., *C. maculatus* F., *C. analis* L. and *Callosobruchus* sp. (indet) unknown were observed. Coochbehar districts had highest diversity with species evenness (0.49), brillouin index (1.17), Simpsons index (0.68), Shannon index (1.23), Hill index (0.49) and effective diversity (3.43) followed by Jalpaiguri with Species evenness (0.46), Brillouin index (1.04), Simpson index (0.64), Shannon index (1.09), hill index (0.48) and Effective diversity (2.99). Alipurduar district found lowest species diversity indices. Community structure of *Callosobruchus* spp. in three districts follows Null model which found as best fit model. It is inferred from the study that the northern tracts of West Bengal four species of pulse beetles are prevailing and further study needs to be undertaken for any strain variation of the pulse beetle in these areas.

Key words: Species diversity, Diversity indices, Abundance, *Callosobruchus*, Chickpea.

1. INTRODUCTION:

Insects are the one of most dominant species on the earth with the number of known species exceeding over a million. From the 32 orders of the insects only three orders i.e.,

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Coleoptera, Lepidoptera and Psocoptera contains the major species that attacks the stored products (Rees, 2004). In India, more than 200 species of insects are known to infest various pulses. Seventy percent of those insects belong to coleopterans. A recent study showed that in India nearly about 4.3-6.1 % of pulses are lost every year during the harvest, post harvest operations, handling and storage. Chickpea crops as well as seeds are subjected to various stress of which insects and diseases the major hindrance in achieving its optimum yield. Among all the insects pests attacking chickpea bruchids causes major damage in storage. In addition to this improper storage practices caused higher losses (Jha *et al.,* 2015).

Chickpea is one of the most important pulse crop of the terai zone of west Bengal which is located at northern part. Terai zone is characterized by prevalence of warm and humid climate and these factors are congenial for infestation of different insects pests in different kinds of grains including pulses in storage. The prerequisite of adoption of any management practices for checking the available losses in store due to insect pests is the proper knowledge on the range of insect pests, their distribution over time and locations, abundance and damage potentials. Diversity is one of the most important community attribute which can determine the stability, productivity and migration (Stirling and Wilsey, 2001). It is most commonly used representation of the ecological diversity of any living organism Therefore, understanding the various insect pests species, their diversity and dominance is the basis for any management programmes. With this background the study was aimed to find out the diversity of *Callosobruchus* spp. attacking stored chickpea.

2. MATERIALS AND METHODS:

Diversity is a type of equilibrium maintained by nature which helps in deciding the carrying capacity of an ecosystem.

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Study area:

The experiment was carried out during 2018-20 in the three districts i.e. Coochbehar, Alipurduar and Jalpaiguri in terai zone of West Bengal.500g of chickpea seeds were collected from five grocery shops of three districts. The collected seed samples were kept a side until the emergence of pulse beetle. The emerged insect pests were collected and preliminarily identified by using the taxonomic key under microscope and then it was sent to taxonomist for confirmation and identified species were used for further analysis.

2.1. Relative abundance of species:

After emergence of the insects in the glass jar, randomly 100 insects were collected. Then the insects were separated and counted according to the species to study their relative abundance by using the following formula (Kishor *et al.,* 2018).

$$\textbf{Relative abundance} = \frac{\textbf{Number of individuals of one species}}{\textbf{Total number of individuals of all the species}} \textbf{ x 100}$$

2.2. Diversity indices:

Diversity indices were applied to the collected data; the available statistics are as follows: Species richness, Species evenness, Relative abundance, Shannon's index, brillouin index, Simpson's index, Hill index and effective diversity. Species richness is used to measure the number of species found in a sample. Since the larger the sample the more species we would expect to find (Hill, 1973). While Species evenness is used to measure how evenly the individuals in a community are distributed among the different species. Species evenness represents a positive correlation existing between diversity and equitability i.e. higher equitability represents the highest diversity of the species. Shannon's index is used to express the species

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diversity within a community and the uniformity of the important values taking into an account all the species in a sample (Shannon and weaver, 1949). Brillouin index is designed to reflect species abundance. Where the randomness cannot be guaranteed, for example when certain species are preferentially sampled, the Brillouin index (Pielou, 1969 and 1975) is a more appropriate form of the information index**.** Simpsons index one of the best known and earliest evenness measures. This index is used for large sampled communities. Simpson's index expresses the probability that any two individuals drawn at random from an infinitely large community belong to the same species. Simpson's index estimates the dominance of the species. The Hill numbers combine species richness and evenness. Hill defined a set of diversity numbers of different order (Hill, 1973). Effective diversity index is to express the number of same/ common species necessitates a value of effective diversity index which is, in real sense, the true diversity of a community. Based on these indices result, carrying capacity of the stored chickpea is explained. These indices were interpreted to draw some conclusions on the stored grain insects fauna associated with stored chickpea.

2.3. Species Abundance distribution:

Species abundance distribution (SAD) helps in characterizing the distribution of abundance of all the species within a sample or ecological community. These are used to study the structure of ecological communities by testing the fitting of data to theoretical models of relative species abundance (Green and Plotkin 2007, Pavoine and Bonsall 2011). Each model of distribution has statistical distribution, which can be derived by making some assumptions about the way that species interact in the community (Magurran, 2004). SADs are also examined for the insect communities we studied, choosing as the best model the one presenting the lowest value of the Akaike Information Criterion(AIC) (Henry *et al.* 2010) calculated with the rad.fit

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function through the diversity vegan package in the R 3.6.0 software. When examining the effect of disturbance and management practices on biodiversity, the full SAD is a better summary of ecological community characteristics than simple diversity indices.

3. RESULTS AND DISCUSSION:

Biodiversity helps in understanding the relationship between pests and natural enemies and helps in planning suitable control measures.

3.1. Relative Abundance of the *Callosobruchus* spp. recorded on stored chickpea in three districts:

After the emergence of the pulse beetles in the glass jars. Identification of the emerged species was done by using taxonomic and found that four numbers of insect species were emerged in stored chickpea namely, *Callosobruchus chinensis, Callosobruchus maculatus, Callosobruchus analis* and *Callosobruchus* sp. (indet).

Table 1. Relative Abundance of different species of Callosobruchus in the stored chickpea in Northern tracts of West Bengal

Districts	*C.chinensis*	*C.maculatus*	*C.analis*	C sp.indet
Coochbehar	43	30	20	7
Alipurduar	42	45	12	1
Jalpaiguri	45	20	34	1

The Data in the table-1 represents the relative abundance of *Callosobruchus* species available in chickpea seeds samples collected from three different districts and revealed that maximum percentage of *Callosobruchus* sp. harbored in chickpea seed sample of Coochbehar district was *Callosobruchus chinensis* (43%) followed by *Callosobruchus maculatus* (30%),

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Callosobruchus analis (20%) and *Callosobruchus* sp. (indet) (7%). While, in Alipurduar district three species were available, in which maximum was *Callosobruchus maculatus* (45%) and others were *Callosobruchus chinensis* (42%), *Callosobruchus analis* (12%) and *Callosobruchus* sp. (indet) (1%). In Jalpaiguri three species were available and maximum was *Callosobruchus chinensis* (45%) followed by *Callosobruchus analis* (34%), *Callosobruchus maculatus* (20%) and *Callosobruchus* sp. (indet) (1%).

The present findings are in agreement with the earlier works of Sahoo (2018), who found that *Callosobruchus chinensis* mostly attack the chickpea seeds in West Bengal. Chakraborty and Mondal (2016) also noticed *Callosobruchus chinensis*, *Callosobruchus maculatus* and *Callosobruchus analis* were more abundant species in North-East Indian regions which feeds on different hosts such as Bengal gram, Green gram, Red gram, Cowpea.

3.2. Diversity indices and distribution of insect pests recorded on stored pulses:

It is revealed from the Table- 2 that in stored chickpea, the species richness (4) and Relative abundance (100%) was recorded among the seeds of all the three districts i.e.Coochbehar, Alipurduar and Jalpaiguri. Coochbehar districts had highest diversity with species evenness (0.49), brillouin index (1.17), Simpsons index (0.68), Shannon index (1.23), Hill index (0.49) and effective diversity (3.43) followed by Jalpaiguri with Species evenness (0.46), Brillouin index (1.04), Simpson index (0.64), Shannon index (1.09), hill index (0.48) and Effective diversity (2.99). Whereas, Alipurduar was found lowest range of species evenness, brillouin index, Simpson index, Shannon index, hill index and effective diversity of 0.44, 0.97, 0.61, 1.02, 0.46 and 2.79 respectively (Table 2) .

Table: 2. Diversity indices of *Callosobruchus* spp. attacking stored Chickpea in Northern tracts of West Bengal

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Districts	Species Richness	Species Evenness	Relative Abundance	Brillouin index	Simpson Index	Shannon index	Hill index	Effective Diversity
Coochbehar	4.00	0.49	100.00	1.17	0.68	1.23	0.49	3.43
Alipurduar	4.00	0.44	100.00	0.97	0.61	1.02	0.46	2.79
Jalpaiguri	4.00	0.46	100.00	1.04	0.64	1.09	0.48	2.99

3.3. **Community structure model:**

The model describes how the species are distributed in an ecological community including the most abundant and rare species. The AIC values of Coochbehar district for different species abundance model are Null (23.32), Preemption (25.05), Log normal (25.52), Zipf (28.71) and Mandelbrot (27.54). While AIC values for Alipurduar districts by Abundance model are (32.92) Null model, (36.14) preemption, (39.72) Lognormal, (49.02) Zipf, and (39.89) Mandelbrot. AIC Values for Jalpaiguri district are (29.14) Null, (33.88) Preemption, (35.55) Lognormal, (43.14) Zipf, (37.36) Mandelbrot. Based on the values of Akaike Information Criterion (AIC) and SAD models (Table 3 & fig 1) community structure at the Coochbehar, Alipurduar and Jalpaiguri followed Null model which was found as benefit model.

Table 3: Species Abundance distribution model of *Callosobruchus* spp. in Northern tracts of West Bengal.

Species Abundance Distributions Model (SADs)	Akaike Information Criterion (AIC) value in each survey locality		
	Coochbehar	Alipurduar	Jalpaiguri
Null	23.37[a]	32.92[a]	29.14[a]

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Preemption	25.05	36.14	33.88
Lognormal	25.52	39.72	35.55
Zipf	28.71	49.02	43.14
Mandelbrot	27.54	39.89	37.36

(Values with letter “a” represents the lowest values of the AIC)

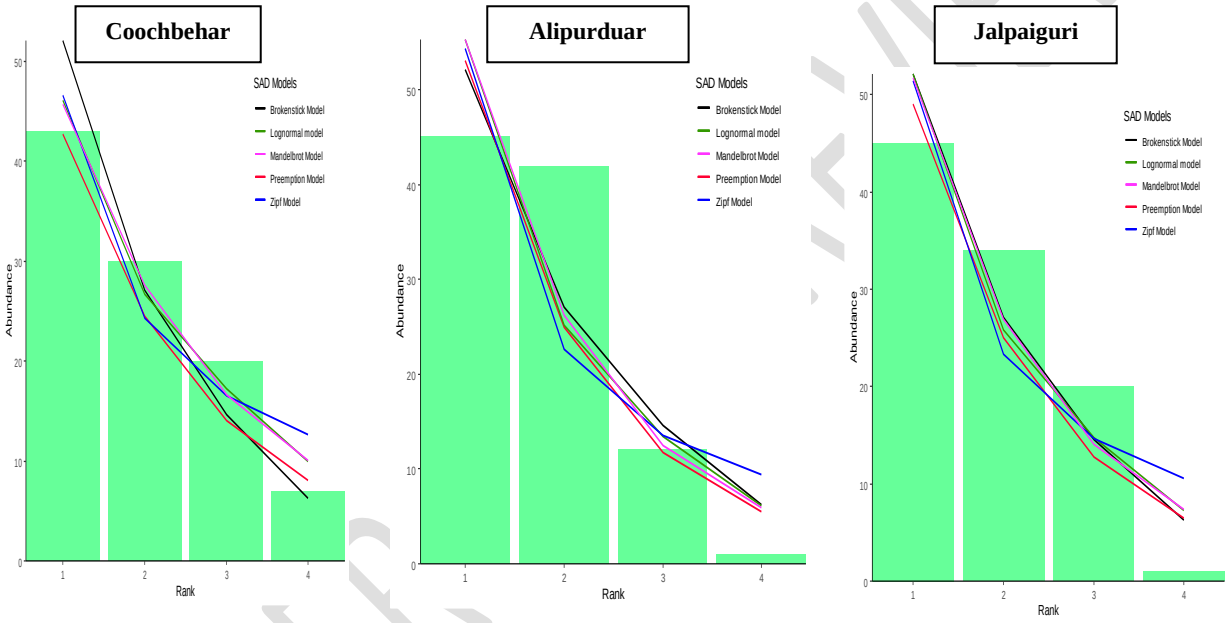

Fig 1: Species Abundance Distribution (SADs) model of species of Callosobruchus spp. in Stored Chickpea in Northern tracts of West Bengal.

Conclusion:

From the above study this is concluded that four species namely, *Callosobruchus chinensis* L., *C. maculatus* F., *C. analis* L. and *Callosobruchus* sp. (indet) unknown were observed. Coochbehar districts had highest diversity with species evenness (0.49), brillouin index (1.17), Simpsons index (0.68), Shannon index (1.23), Hill index (0.49) and effective diversity (3.43) followed by Jalpaiguri with Species evenness (0.46), Brillouin index (1.04),

Simpson index (0.64), Shannon index (1.09), hill index (0.48) and Effective diversity (2.99). While, Alipurduar district was found lowest species diversity indices on chickpea. Based on species abundance distribution values, all the three districts followed Null model. It is inferred from the study that the northern tracts of West Bengal four species of pulse beetles are prevailing and further study needs to be undertaken for any strain variation of the pulse beetle in these areas.

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