International Journal of Pure and Applied Zoology
Volume 3, Issue 4, pp: 354-357, 2015
http://www.ijpaz.com

ISSN (Print) : 2320-9577
ISSN (Online): 2320-9585
Rishan Publications

Research Article

OBSERVATION OF BODY SIZE IN DIFFERENT GEOGRAPHICAL POPULATION OF GRASSHOPPER *NEORTHACRIS ACUTICEPS ACUTICEPS* (BOLIVAR)

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Article History: Received 24th October 2015; Accepted 12th November 2015; Published 16th November 2015

ABSTRACT

N.a.acuticeps shows sexual dimorphism that fits into Rensch's rule and dimorphism is female biased. Analysis of variation in body size with reference to different geographical climatic conditions has been carried out. Colder climatic conditions have produced slightly larger body size for males, but in warmer zones females did not show body size variations during summer. In semi arid zone these insects appeared only during winter indicating shift in life cycle.

Keywords: Dimorphism, Rensch's rule, geographical regions, Femur length, Abdomen size.

INTRODUCTION

Body size and mass are one of the basic features that influence all other aspects of biology, size and mass correlates with fitness as well act as determinants of fitness. Thus these two components have formed targets of natural selection (Whitman 2008). Male and females of almost all animals differ in their body sizes; this phenomenon is referred to sexual size dimorphism. The degree and direction of this dimorphism vary considerably among taxa including the population within the species. Major amount of this variation is considered to be due to sex differences in body size plasticity. This phenotypic plasticity is almost found in all organisms (Nylin and Gothard, 1998; Blackenhorn, 2009; Teder and Tammaru 2005; Stillwell *et al.*, 2010). This plasticity trait affects not only morphology and physiology but also life history trait of organisms.

Many biotic and abiotic factors can influence the individual body size and reproduction in grasshoppers. Many ecological variables such as food availability, population density and interspecific interactions change from region to region. Only a few studies have examined the influence of these variables as mediators of selection on body size and will also explain biogeographic patterns of body size (Ho *et al.*, 2010).

MATERIAL AND METHODS

Adult males and females of *Neorthacris acuticeps acuticeps*, a wingless grasshopper collected from different regions of east part in Southern region of India, during the months of December to May. Specimens were collected from Krishnarajanagara, Holenarasipura, Hassan, Coimbatore and Challakere. The body size, girth, hind leg femur length and abdominal length were measured by using digital Vernier caliper (Make of Aerospace, China) as described by Yoshikazu *et al.* (2008). The measurements are recorded in a tabular column for analysis.

The photographs are made using Sony X camera and prints were taken using HP printers. A minimum of five individuals of males and females from each region were used for body size analysis.

RESULTS

Neorthacris acuticeps acuticeps is a wingless grasshopper known by its common name as mulberry grasshopper. Individuals from five different geographical locations were posed for body size analysis. The collection was done in two different seasons- rainy/summer and winter. Winter (November-December) population has females and males visibly larger in size than those appear in rainy/summer

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season (last week of May to First week of July). To examine the effect of geographical conditions like temperature, insects were collected from the warmer region Challakere (Figure 1) and Coimbatore with high temperature round the year compared to other areas. Specimens collected from Coimbatore locality provided two angles of analysis 1 related to altitudinal cline and 2 related to temperature. The data represented here are the average measurements of the body size of males and females from each geographical locality. Likewise the graphical representation of the data is represented in Figure 1. Larger males for the body size were observed during winter compared to rainy/summer seasons in four localities. In Challakere region grasshoppers were not available during rainy season; hence measurements represented here are only for winter population.

Climatic conditions for the site of collection study has been recorded as per the standard annual records, of these , Krishnarajanagar is located 765 m above sea level, having thick vegetation, average rainfall and semi cold condition, whereas Hassan has cold climate, thick vegetation and high humidity. Challakere (msl 585 m) is a semi arid zone, warmer, lowest rainfall, has poor vegetation. Coimbatore is located at MSL of 411 meters and has spread vegetation, average rainfall and had warm climatic condition located below the Western Ghats on eastern side.

Table 1. Showing the average measurements for *N.a.acuticeps.*

Sl. No.	Population	Season	Body length		Abdomen length		Girth		Hind femur length	
			Male	Female	Male	Female	Male	Female	Male	Female
1	K.R.Nagar	Summer	13.8	18.2	7.2	9.3	2.27	2.2	6.83	7.2
2	K.R.Nagar	Winter	17.2	23	10.1	13.2	2.43	2.3	7.45	9.4
3	Holenarasipura	Summer	15.2	17.9	7.16	7.2	2.6	3.3	6.03	7.9
4	Holenarasipura	Winter	16.9	22.5	6.46	6.9	2.31	3.1	7.01	7.5
5	Hassan	Summer	15.3	18.2	7.9	7.9	3	4	8.8	9.69
6	Hassan	Winter	17.6	23	11.3	11.3	2.8	4.5	9.85	9.71
7	Challakere	Winter	19.1	28.2	8.62	15.1	3.33	3.6	8.96	11.2
8	Coimbatore	Summer	16.8	23.6	9.29	10.1	2.67	3.1	7.63	8.3
9	Coimbatore	Winter	18.9	23.3	8.32	9.2	3.12	3.6	8.56	9.2

Figure 1. *Neorthacris acuticeps acuticeps* male and female of **A)** Challakere population and B) K.R. Nagar population.

DISCUSSION

Body size in insects is determined by genes, the environment and their interaction, thus phenotype is the product of nature and nurture (Blackenhorn, 2009). 30% of the body size variation in population is heritable and the remaining 70% is due to phenotypic plasticity produced by environmental factor interactions (Whitman and Ananthakrishnan, 2009). Modern insects are much smaller than the ancient insects which were three times heavier than the present day insects. The intriguing question is that whether there are factors that have changed over 400 million years of insect evolution resulting in their smaller body size. Thus all researches regard to body size variation in insects in one way or other examines this question to find a possible answer (Polet, 2011). In insects, in general within species variation in body size is related to sexual differences in life history, behavior and morphology. Sexual dimorphism occurs in a wide variety of traits including wing size, shape and color as well in UV reflection on the wing as in Lepidopterans, body size and body composition, size and shape of genitalia (Allen *et al.,* 2006). These variations are linked to feeding, mate location, dispersal and oviposition, central to life history evolution (Polet, 2011).

Grasshoppers are sexually dimorphic insects; sexual dimorphism is defined as differences in adult body size between males and females in a population. This variation is one of the most visible forms of difference between the sexes. Rensch's rule (1960) assumes that the male body size varies more among population/species or shows evolutionary divergence faster than doe's female body size. Our observations coincide with this rule for the body size of male specimens examined in all the regions (Dharbal *et. al.* 2015). In colder regions, the male body size was comparatively smaller than those of the warmer regions. According to Rensch's rule the sex size dimorphism increases with the increasing average body size in taxa where males are larger than females, often this is referred to male biased sex size dimorphism and decreases when females are larger, this is termed female biased sex size dimorphism. Both these patterns are part of the same evolutionary trend.

Smaller males in grasshoppers have been discussed to be the result of several phenomenon such as protandry, small size imply low predation density or decrease in food requirements, avoids competition for resources between the sexes, for increased motility (Bidau *et al.,* 2013) but in vertebrates the sex size dimorphism is male biased.

Many of the individual traits vary with geographical changes more often in insects. It is noted body size of animals increase with increase in the latitude (Stillwell 2010), both in ectothermic and endothermic animals. Because temperature changes systematically with latitude, gradient in temperature is assured to create increase in body size. This phenotypic plasticity of the body has been assumed to be adaptive to the changing environmental conditions. Temperature size rule is very well examined by several workers (Stillwell *et al.,* 2010; Davidowitz, 2008). According to this theory body size of ectothermic animals typically increases with decreasing developmental temperature. Our study also examines effect of temperature and other environmental factors such as aridity, vegetation distribution on the body size of the grasshopper *N.a.acuticeps*, insects from different region with varying temperature and other mentioned features were collected and the body size of those insects correlated. Hassan, zone had individual males and females larger than that of the other two cold climatic zones. Krishnrajanagar and Holenarsipura almost had the similar climatic conditions produced males with lesser body size compared to Hassan; the two extreme zones of temperature Coimbatore and Challakere produced slightly variable body size for males. Challakere a semiarid zone had high temperature ranging up to 47°C (least 38°C) in summer and about 25 to 36°C during winter. The male body size of Coimbatore recorded average of 16.8 mm and 19.1 mm during summer and winter respectively female measured about 22.6 mm and 28.2 mm during summer and winter respectively. Whereas Challakere population had 19.1 mm size for males and 28.2 mm for females during winter.

In these warmer zones body size is slightly more for female sexes compared to the cold zone Hassan .Whereas moderate zone Krishnarajanagar produced comparatively lesser body sized males. Male body size of Hassan zone is almost similar to that of moderate zones. These observations confirm that female body size is slightly larger in warmer zones compared to cold zones. The male body size show variations. We have not tested the influence of food availability as a factor causing variation. But can be predicted that in warmer zones predation on grasshoppers is more frequent due to lesser density of insects. To escape from the predation these females might have gained larger body size. The average size difference between the seasons for males of K.R. Nagar is 3.4 mm, of H. NPura the difference in body size for males is about 1.7 mm and for Hassan population males had 3.2 mm difference in body size, for both the seasons. This difference reflects the increased body size of males during winter. The female body also increased size variation during winter than that of summer in cold zones, whereas in warmer zone it had almost similar body size. In cold zone the average increase is about 4.6 to 4.8 mm for females. This reflects the seasons have impact on the body size variation in grasshopper *N. a. acuticeps* (Davidowitz, 2008).

Variations in femur length are recorded for males and females of all the zones. Femur length of males has been debated to have more evolutionary advantage compared to that of the females. Applying the concept short femur length is more productive (Sugano *et al.,* 2008) in gaining copulation, the moderate zone males have more chances and have that condition. Whereas males of warmer zone though have slightly longer femur, there is imminence of capturing available female as the insect density is low. Our study has recorded longer femur length in individual females with larger body size during winter, but in summer population the body size of female is comparatively less so also the femur length. Increased abdomen size of both male and female has been considered to be more advantageous; in females it is helpful in accommodating large number of egg clutches (Akman and Whitman, 2008). Hence the temperature dependent body size ratio though seems to be positive here it has to be tested with more number of individuals.

CONCLUSION

Body size of males is more influenced by geographical conditions than females which show least variation in between the regions studied. In Challakere region these grasshoppers could be collected during cold season but not in the warmer season implies this species has set a trend to change its life cycle to cold season. In all other geographical regions these insects were available in good numbers in both the seasons indicates, that the conditions are favorable for the existence of these insects.

ACKNOWLEDGEMENT

The authors are thankful to the Head of the institution Government Home Science College, Holenarsipura for the facilities provided to carry out this work.

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