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Full Length Research Paper

Spatio-temporal distribution of drosophilids: A study at Jnanabharathi Campus, Bangalore, Karnataka, India

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Though studies associated with the geographic distribution of Drosophilidae in India have taken rapid strides in last few years, only a cursory survey has been undertaken in certain areas, whereas a vast area of the Indian subcontinent still awaits exploration. In view of this, an attempt has been made to record the Drosophilid fauna of Jnanabharathi habitat, which is a completely virgin field, to explore with a view to furnish a spatio-temporal distribution pattern of Drosophilid species. The present study has revealed that species diversity has enriched in undisturbed region where human habitat is poor. On the other hand, the diversity and distribution of the Drosophilids have been affected enormously where human habitat is frequently sensed. In addition to this seasonally related environmental factors have a direct or indirect effect on the population density and distribution pattern of *Drosophila* in space and time.

Key words: *Drosophila* fauna, biodiversity, distribution pattern, spatial, temperature.

INTRODUCTION

The Drosophilidae family encompasses 3,952 species distributed in 73 genera and two subfamilies (Steganinae and Drosophilinae). The subfamily Drosophilinae is the most diversified one and includes 3,240 species distributed across 44 genera, of which *Drosophila* is the most speciose, with 1,159 species recorded (Bächli, 2009). Some of these species are endemic, while others are cosmopolitan and may often disperse in association with human activities (Tidon-Sklorz and Sene, 1999). The *Drosophila* species are observed in essentially any environment, from the sea level to considerable altitudes, and in temperate as well as in equatorial zones (Throckmorton, 1975). However, Lachaise (1979) suggests that these species are subject to restrictions as regards the habitats they live in. Sporadic reports are available in regard to eco-distributional patterns, altitudinal and seasonal variations in South India (Hegde, 1979; Hegde et al., 1989, 1999, 2000, Guruprasad et al., 2010).

The Indian subcontinent, with its subtropical climate and varied physiographic conditions, including variable altitudes and luxuriant flora offers an abode for the rich and wide distribution of *Drosophila* fauna. During recent years, considerable data have been accumulated regarding faunal composition of Drosophilid species as a result of extensive field collections in different ecological habitat by Ayala (1970). The Drosophilid flies thus obtained have been utilized for various studies *viz*., taxonomic, ecological, genetical, behavioral, and its distribution record. As a result more than 290 Drosophilid species have been reported so far from different ecogeographical areas in India (Gupta, 2005; Kumar et al., 2009) and most of them are new to the world of science. Studies on Drosophilid assemblages aim at offering a simplified explanation of the complex systems and circumstances that are repeatedly observed in different habitats. Thus the increased global habitat destruction, studies on the diversity of insects in various environments are highly important regarding the comprehension of biological assemblages and the devising of conservation strategies.

Other authors have also stressed the trend exhibited by certain species towards occupying inner forests or else some sort of open environment (Dobzhansky and Pavan, 1950). Studies that have evaluated Drosophilid assemblages in forest fragments demonstrate the clear segregation between the faunistic composition of the inner forest and the disturbed areas. Climatic variables

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such as humidity, rainfall, temperature and incidence of sunlight, among others, are determining factors in the occurrence of Drosophilid species (Pavan, 1959). Similarly, biotic factors like the kind of vegetation that form natural gradients and changes associated to latitude, for example, are also important (Powell, 1997). Therefore, the composition and structure of a Drosophilid assemblage depends on the habitat in which it was established. The recognition of patterns at these organizational levels affords to propose hypotheses about the ecology and evolution of the groups studied (Begon et al., 1990).

MATERIALS AND METHODS

Drosophila flies were collected at Jnanabharathi Campus in the first week of the months of May, August, November, 2009 and February, 2010 at three different localities that is, in open field (human activity is more) termed Locality 1, forest edge (human activity scarce) termed Locality 2, and inner forest (absence of human activity) termed Locality 3. The method used to collect the flies was by net sweeping (Markow and O'Grady, 2006). The rotten mixed fruits were spread in the evening of the previous day. The fermented fruit was spread in each distant trap collection spots. Such bait as fermenting fruits retains its attractive odour for a long time. The collections were made early in the morning by sweeping in each traps at least three times and transferred to six quarter pint milk bottles filled with standard agar medium sprayed with yeast. The collected flies were brought to the laboratory, etherized, categorized, counted and species were identified under Leica Stereozoom Microscope. The males were studied as such but the individual females, which could not be identified, were isolated and allowed to breed in separate vials containing standard laboratory food medium. The progeny obtained from such single gravid females were used for species identification.

RESULTS

The field collection of Drosophilid from the Jnanabharathi Campus in different seasons have yielded a total of 3488 flies during year 2009 - 2010 (1609 males and 1879 females). The males were grouped on the basis of morphological characters and analyzed taxonomically on the basis of genital structure and sex comb. The taxonomic analysis on the basis of genital structure has helped us to identify several species of Drosophilids.

Distribution of different species of *Drosophila* and their numbers found during collections along with temperature and rainfall in Jnanbharathi Campus, Bangalore, Karnataka, India during 2009 - 2010. The data (Table 1) from the present survey has revealed 12 different species of *Drosophila* with no new species found distributed in different localities of JB Campus namely, *Drosophila melanogaste > Drosophila ananassae> > Drosophila bipectinata > Drosophila biarempis > Drosophila simulans > Drosophila kikkawai > Drosophila malerkotliana > Drosophila takashi > Drosophila jambulina > Drosophila nigra > Drosophila neonasuta > Drosophila nasuta* Of which, *D. ananassae* is more abundant than other 11 species in all the spots of the assessments. In addition to this, *D. nasuta* was not found to appear in the month of May and February in L-1 and L-2, but it was recorded in the month of August and November IN L-1 and L-2. Interestingly, very fewer number of *D. nasuta* was found in all the above assessed months in L-3 locality. Accordingly, *D. melanogaster* and *D. ananassae* are more adapted to the prevailing environment and *D. nasuta* is more sensitive to the temperature and the locality.

Figure 1 depicts the percent distribution of different species of *Drosophila* at different localities of the JB Campus in open field (L-1) is about 28.78%. At Forest edge that is, at L-2 location about 30.90% of flies were collected and subsequently at the Forest interior L-3 site 40.30% of flies were sampled. It clearly shows that the Drosophilid distributions are largely affected by the human habitat where disturbance gradient is frequent in L-1 and also at the edges of forest. The number of *Drosophila* species found was increasingly high at L-3 locality of the present study and least number (Figure 2).

The collection of flies' season wise (Figure 3a – c). It appears that the flies were found to be collected more in number in the month of August and November and lesser in the month of May and February. Thus the temperature has an impact on the development and the distribution of the flies. The sampling size varies with the season and temperature and it is as follows: November > August > May > February.

DISCUSSION

A better understanding of how different species are affected by current climates and why they sometimes respond differently to climate change is necessary for predicting future effects of climate change (Weatherhead, 2005). The *Drosophila* species are observed in essentially any environment, from the sea level to considerable altitudes, and in temperate as well as in equatorial zones (Throckmorton, 1975). However, Lachaise (1979) suggests that these species are subject to restrictions as regards the habitats they live in. Other authors have also stressed the trend exhibited by certain species towards occupying inner forests or else some sort of open environment (Dobzhansky and Pavan, 1950; Sene et al., 1980).

Studies that have evaluated Drosophilid assemblages in forest fragments demonstrate the clear segregation between the faunistic composition of the inner forest and the disturbed areas. In relation to these studies the present data also implies on the distribution of *Drosophila* flies depends on spatio-temporal factors. Out of 3488 flies recorded in JB Campus at different seasons of the year, about 28.78% of the flies (1004) were found in the highly disturbed niche. Whereas, 30.90% (1078) of flies in the niche edges and 40.30% (1406) of flies were

Table 1. Spatio-Temporal distribution pattern of different species of *Drosophila* at three different localities of JB Campus, Bangalore.

Locations	**Open field (human activity is more)- LI**				**Forest edge (human activity scarce)-LII**				**Inner forest (absence of human activity)- LIII**			
Months	**May**	**Aug**	**Nov**	**Feb**	**May**	**Aug**	**Nov**	**Feb**	**May**	**Aug**	**Nov**	**Feb**
Temperature (℃)	32	28	27	30	32	29	27	30	32	29	27	30
Rainfall (mm)	154	83.2	118.8	3.2	154	83.2	118.8	32	154	83.2	118.8	3.2
D. melanogaster	48	38	55	36	59	44	55	39	59	64	70	33
D. annanassae	44	66	69	33	47	75	69	35	57	85	85	45
D. bipectinata	45	44	47	36	49	52	47	40	51	62	67	40
D. biarempis	36	42	48	24	37	46	48	28	39	49	58	30
D. simulans	12	19	23	08	17	22	23	11	19	32	38	17
D. kikkawai	18	21	24	06	21	20	24	14	23	30	34	20
D. malerkotliana	12	19	22	09	15	25	22	05	19	29	32	12
D. takashi	04	09	10	00	08	11	10	03	07	17	19	07
D. jambulina	10	15	19	00	18	17	19	00	16	20	29	09
D .nigra	06	02	11	03	09	02	11	04	14	06	16	07
D.s.neonasuta	02	04	00	00	06	07	00	00	00	05	03	05
D. nasuta	00	02	03	00	00	00	08	00	03	08	07	09
Total	237	281	331	155	286	277	336	179	307	407	458	234

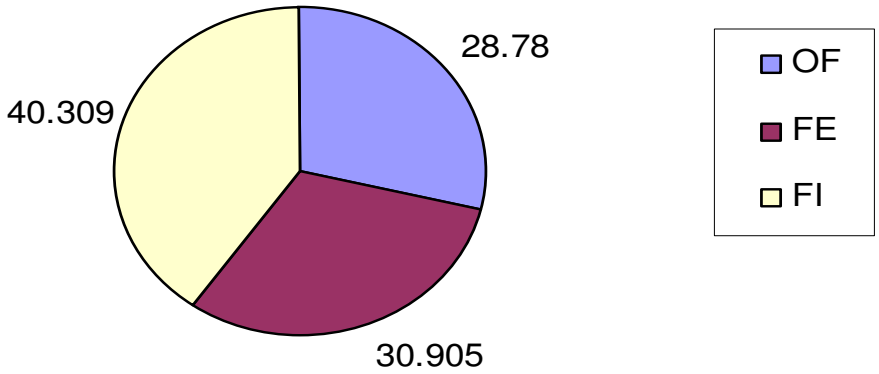

Figure 1. Percent distribution of *Drosophila* species at different localities (OF = Open field; FE = Forest edge; FI = Forest interior) of JB Campus.

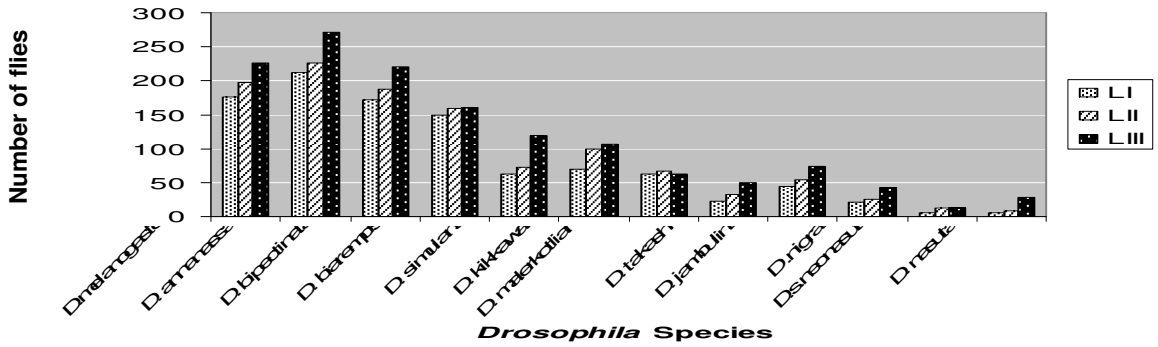

Figure 2. Number of *Drosophila* species at different localities (LI = Open field; LII = Forest edge; LIII = Forest interior) of JB Campus.

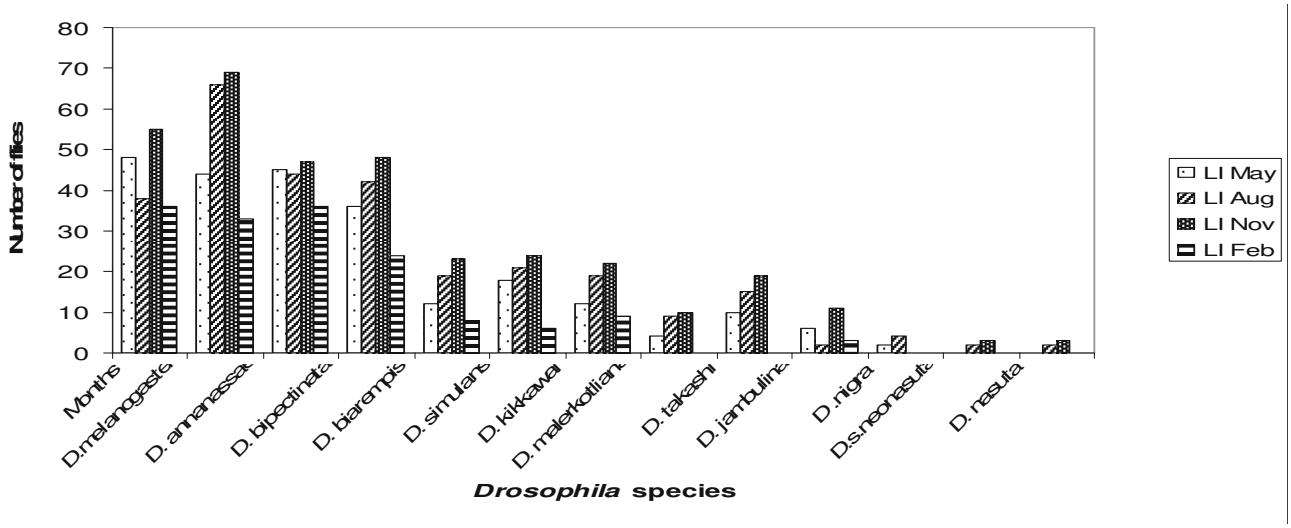

Figure 3a. Number of flies recorded in different months at LI locality at JB Campus.

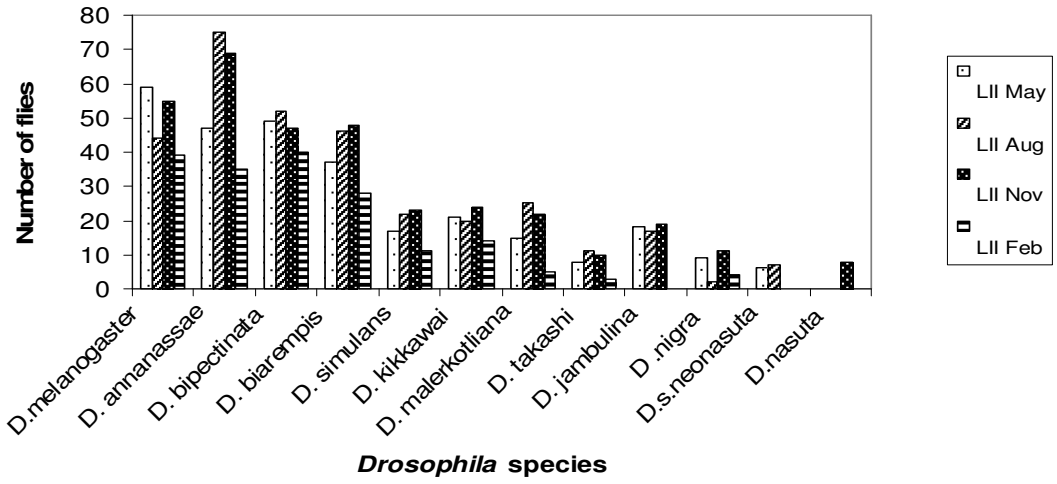

Figure 3b. Number of flies recorded in different months at LII locality at JB Campus.

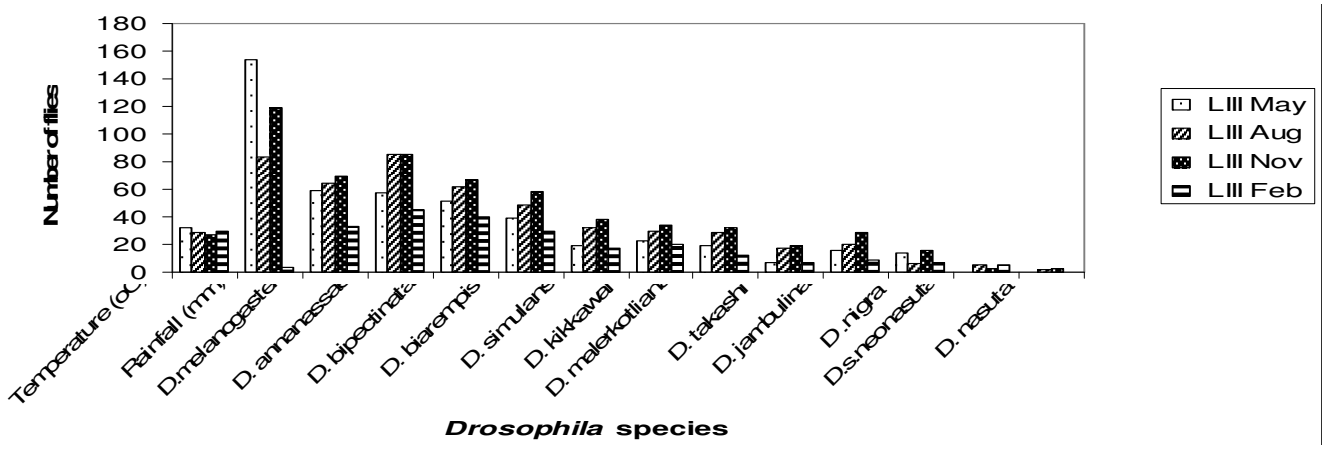

Figure 3c. Number of flies recorded in different months at LIII locality at JB Campus.

recorded and collected in the undisturbed area of the JB Campus (Figure 1). It is evident that, the flies are less sampled in the area were the human habitat is frequently seen. Species that are habitat specialists make up much of biodiversity, but the evolutionary factors that limit their distributions have rarely been considered, such species are likely to be constrained in their evolutionary responses to future climate changes (Kellermann et al., 2009).

Interestingly, it was also observed that the increase in temperature during the month of May and February the flies were less recorded, and with decreased temperature that is, during the month of November and August the collection was increasingly high. According to Hegde et al. (2000) the growth and size of the population depend on several environmental factors in addition to genetic structure. The fluctuation in population size of *Drosophila* through different seasons reflects the close relationship between populations. It should be emphasized that the months with higher species richness occur during the rainy season.

The present study also implies that the climatic variables such as humidity, rainfall, temperature are determining factors in the occurrence of Drosophilid species as suggested by (Pavan, 1959). Therefore, the composition and structure of a Drosophilid assemblage depends on the habitat in which it was established. Studies on Drosophilid assemblages aim at offering a simplified explanation of the complex systems and circumstances that are repeatedly observed in different habitats. The recognition of patterns at these organizational levels affords to propose hypotheses about the ecology and evolution of the groups studied (Begon et al., 1990). Greater divergence between a species pair involved divergent selection on both niche dimensions. The dimensionality of selection may complement genetic and geographic explanations for the degree of diversification in nature (Nosil and Sandoval, 2008).

Thereby the present study provides information on the spatial and temporal distribution of the Drosophilidae family in three environments (open field, forest edge and inner forest) along the four seasons during one year 2009 (May, August and Novenmber) to 2010 (February) in Jnanabharathi Campus at Bangalore, Karanataka, India. The study opines, diversity and distribution of the Drosophilids have been affected enormously where human habitat is frequently sensed. In addition to this seasonally related environmental factors have a direct or indirect effect on the population density of *Drosophila*. Thus the presence or absence of a species in an ecological niche, and its richness or abundance in that area is an indicator of both biological and ecological diversity of that ecosystem. In addition to physical and biotic factors, the topography and season also affect the animal distribution. *Drosophila* a representative system for population geneticists to understand genetic basis of ecological differentiation at the levels of population and species. *Drosophila* is ecologically a rather highly specialized but closely knit group which offers valuable opportunities for studies on organisms-environment relations.

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REFERENCES

Ayala FJ (1970). Competition, coexistence and evolution. In: Essays in Evolution and Genetics in Honour of Theodosius Dobzhansky (Hecht, M.K., and W.C. Steere, eds.). Appleton-Century-Crofts, New York): pp.121-158.

Bächli G (2009). TaxoDros: The database on Taxonomy of Drosophilidae.Electronic Database accessible at http://www.taxodros.unizh.ch.

Begon M, Harper JL, Townsend CR (1990), Individual,s Population,s

and Communities. Ecology Blackwell Scientific Publications, Melbourne, Australia., p. 876.
Dobzhansky T, Pavan C (1950). Local and seasonal variations in relative frequencies of species of *Drosophila* in Brazil. J. Anim. Ecol., 19: 1-14.
Gupta JP, (2005), A monograph on Indian Drosophilidae. J. Sci. Res., 5: 1-252.
Guruprasad BR, Hegde SN, Krishna MS (2010). Seasonal and altitudinal changes in population density of 20 species of *Drosophila* in Chamundi hill. J. Insect Sci., 10: 1-12.
Hegde SN (1979). Studies on cyto taxonomy and genetics of a few members of the melanogaster species group of Drosophila (Ph. D. Thesis) University of Mysore, Mysore, India.
Hegde SN, Vasudev V, Krishna MS, Shakuntala V (1999). Description of two new species of montium subgroup of Drosophila (Diptera: Drosophilidae from South India). Entomon., 24: 149-156.
Hegde SN, Vasudev V, Shakuntala V, Krishna MS (2000). Drosophila fauna of Palani hills Tamilnadu, India. Droso. Inf. Ser., 81: 138.
Kellermann V, Van Heerwaarden B, Sgrò CM, Hoffmann AA (2009). Fundamental evolutionary limits in ecological traits drive *Drosophila* species distributions. Science, 325: 1244-1246.
Kumar R, Ajai K (2009). Studies on Drosophilidae (Diptera: Drosophilidae of Gujarat state in India. Dros. Inf. Serv., 92: 106.
Lachaise D, Pignal MC, Roualt J (1979). Yeast flora partitioning by Drosophilid species inhabiting a tropical African savanna of the ivory-coast (*Diptera*). Ann. Soc. Entomol., 15: 659–680.
Markow TA, O'Grady PM (2006). Drosophila : a guide to species identification and use. Elsevier Inc. Academic press pub., pp. 1-247.
Nosil P, Sandoval CP (2008) Ecological niche dimensionality and the evolutionary diversification of stick insects. PLoS One, 3: 1-11.
Pavan C (1959). Relationship between natural populations of Drosophila environment. Bolm. Fac Filos. Hist S. Paul, Biol. General, 11: 1-81.
Powell JR (1997). Progress and Prospects in Evolutionary Biology, The Drosophila Model (Powell, J.R., ed.), New York, Oxford University Press.
Sene F, Val FC, Vilela CR, Pereira MA (1980). Preliminary data on the geographical distribution of *Drosophila* species within morphoclimatic domains of Brazil. Pap. Avul. Dep. Zool. Sec. Agric., 33: 315-326.
Throckmorton LH (1975). In: Handbook of Genetics (King, R.C., ed.)Plenum Press, New York, pp. 421-467.
Tidon-Sklorz R, Sene FM (1999). Terrestrial invertebrates. Biodiversity of the State of São Paulo. Synthesis of Knowledge at the End of the Twentieth Century, FAPESP, São Paulo. p. 5.
Weatherhead PJ (2005). Effects of climatic variation on timing of nesting reproductive success and offspring sex ratios of red-winged black birds, Oecologia, 10: 1007.