

in either a monomeric or dimeric form. Although not conclusive, this detail does strengthen the likelihood that only one gene, CG17337, is responsible for the coding of *Dip-A*.

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### **Distribution of *Drosophila* flies in eight different altitudes of three districts of Karnataka, India.**

**Aryatu, Prakash, and Nallur B. Ramachandra.** *Drosophila* Stock Centre, Department of Studies in Zoology, University of Mysore, Manasagangotri, Mysore 570 006, INDIA; Phone: 91 821 2516056; For Correspondence: [nallurbr@gmail.com](mailto:nallurbr@gmail.com).

### **Introduction**

*Drosophila* fauna is more abundant in Kodagu, Mysore, and Dakshina Kannada districts of Karnataka, South India (Gai, 1985). Studies on cytogenetic aspects of these species were carried out extensively which revealed an interesting situation. However, studies on natural populations of these two sympatric species at different altitude are limited. Here we report the collection of *Drosophila* flies at eight altitudinal regions in three districts of Karnataka state, India at four different months in a year (2001-02) and establishment of isofemale lines of *D. nasuta nasuta* and *D. sulfurigaster neonasuta* to study the morphophenotypic variations and fitness differentiation of these two sympatric species.

### **Materials and Methods**

#### *Collection of flies:*

*Drosophila* flies were sampled from eight geographically and altitudinally distant places in three districts of Karnataka state, South India, namely Dakshina Kannada, Kodagu, and Mysore (Figure 1). The general eco-geographical features, the topographical features, climatic factors and the types of vegetation of these localities are briefly described below.

Dakshina Kannada district (Figure 1; Table 1) is located in the south of Karnataka, which is a coastal belt of Arabian Sea and is situated between 120.25'–130.10' latitude north and 740.50'–750.45' longitude east. The normal annual rainfall during 2001 to 2002 was about 3781 mm and humidity was 82%. The collections were made in two regions. The first spot was near Belma village, which is about 12 km from Mangalore City towards Mangalore University Campus, called as DK-1. The second spot was near Mudipu village located about 25 km from Mangalore City, called as DK-2. The distance between these two spots is 13 km. Both these places are situated at an altitude of 0 MSL and are directly exposed to the southeast monsoon. The main vegetation of this area includes *Nothapodytes foetida*, *Ixora coccinea*, *Zizyphus jujuba*, *Anacardium occidentale*,

*Tamarindis indica*, *Acacia* species, *Lantana camera*, *Ficus religiosus*, *Ficus bengalensis*, *Autocarpus integrifolia*, *Mangifera indica*, and many shrubs including cactus.

Kodagu district (Figure 1; Table 1) is about 160 km from Mangalore towards Mysore and is a part of Western ghats. It is situated between 120–120.50' latitude north and 750.25'–760.15' longitude east. The normal annual rainfall during the year 2001 to 2002 was 3,289 mm and humidity was 86%. The flies were collected in three regions in the Kodagu Sampaje ghat. The first collection was made near Devarakolli area at an altitude of 250MSL and this spot was called as KS-1. The middle region of the ghat near the village of Madhe area at an altitude of 695 MSL was the second spot and called as KS-2. The third spot was selected at the top region of the ghat near Thalathamane area at an altitude of 790 MSL and was called as KS-3. All these collection spots have a distance of about 15 km. It is directly exposed to the southeast monsoon. The vegetation is influenced more by the abundance and distribution of the seasonal rainfall than the atmospheric temperature. Introduction of plantation crops like tea, coffee, rubber and extension of teak in southern regions and cultivation of eucalyptus had also resulted in the destruction of large virgin forests. The forest was characterized by multistoried canopies of vegetations like, trees and shrubs, herbs, climbers, stranglers and epiphytes. The ground layer and trees themselves were carpeted with mosses, ferns, orchids and lichens, and thus form a characteristic biological spectrum providing large number of natural environs for the colonization of the members of genus *Drosophila*.

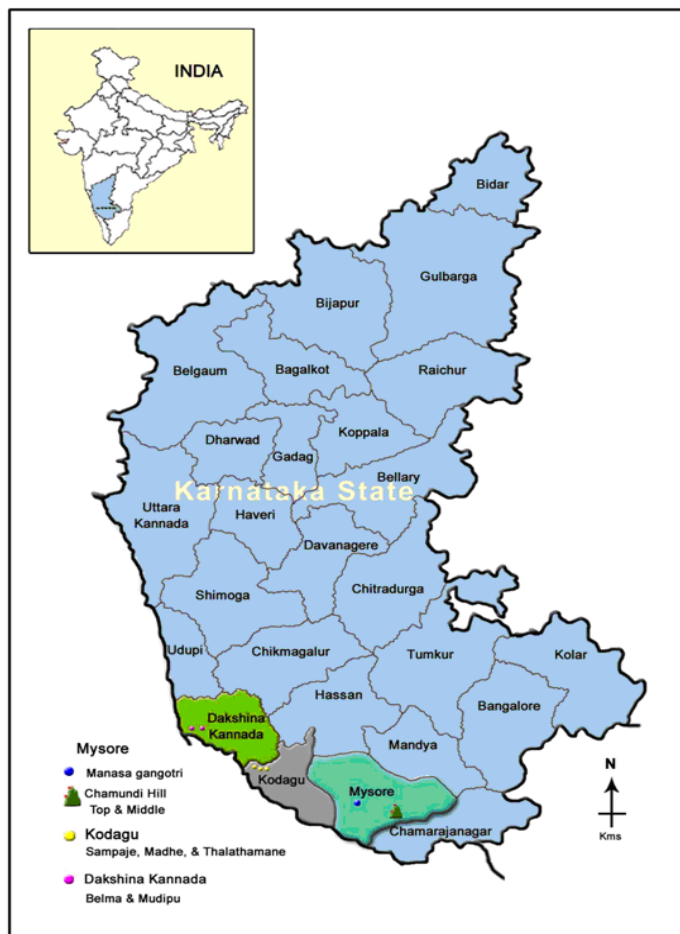


Figure 1. Collection spots of *Drosophila* flies in three districts of Karnataka State, India.

Mysore district (Figure 1; Table 1) is situated about 140 km from Kodagu towards south and is located between 110.30'–120.40' latitude north and 760.55'–770 longitude east. The normal annual rainfall during the year 2001 to 2002 was 294 mm and humidity was 79%. The flies were collected from three different altitudinal localities. The first spot was Sapota garden of Manasagangotri (MG) located in the Mysore University Campus and with an altitude of 615MSL. The land was well irrigated, whose vegetation mainly consist of *Mangifera indica*, *Achras Sapota*, *Tamarindus indicus*, *Ficus bengalensis*, *Embellica officinalis* (goose berry), and bushes of *Lantana*. The other two spots were selected from Chamundi hill, which is located to the east of Mysore University Campus at a distance of about 15 km. The second spot selected

was the middle region of Chamundi hill (MC-1) at an altitude of 650 MSL and the third spot was the top region of Chamundi hill (MC-2) at an altitude of 710 MSL. It is partially exposed to the southeast monsoon. The main vegetation of this area consists of *Anacardium occidentale*, *Tamarindis indica*, *Acacia* species, *Lantana camera*, *Ficus religious*, *Ficus bengalencis*, *Autocarpus sintegrifolia*, *Mangifera indica*, and many shrubs including Cactus. In each collection spot, flies were collected and pooled from 4 distant traps in that area. The ecological conditions of above eight collection localities in three districts differ in different months of the year. The flies were collected four times, *i.e.* in the first week of the months of May, August, November of 2001 and February of 2002.

Table 1. Description of *Drosophila* collection regions along with their environmental conditions during 2001-2002

Locations	Altitude MSL	Latitude	Longitude	Annual rain fall (mm)	Humidity (%)	Temperature (°C)
Dakshina kannada 1 Belma region (DK-1)	0	120.25'-130.10'	740.50'-750.45'	3781	82	14.2-38
Dakshina kannada 2 Mudipu Area.(DK-2)	0	120.25'-130.10'	740.50'-750.45'	3781	82	14.2-38
Kodagu-Devarakolli Area (KS-1)	250	120-120.50'	750.25'-760.15'	3289	86	10.6-32
Kodagu-Made Area (KS-2)	695	120-120.50'	750.25'-760.15'	3289	86	10.6-32
Kodagu-Thalathamane Area (KS-3)	790	120-120.50'	750.25'-760.15'	3289	86	10.6-32
Manasa Gangothri Area (MG)	615	110.30'-120.40'	760.55'-770	294	79	12.8-36.2
Mysore Chamundi hill-middle (MC-1)	650	110.30'-120.40'	760.55'-770	294	79	12.8-36.2
Mysore Chamundi hill- top (MC-2)	710	110.30'-120.40'	760.55'-770	294	79	12.8-36.2

(Data on the ecological conditions are obtained by meteorological survey of India, Bangalore)

#### Collection procedure:

The method used to collect the flies was by net sweeping. The rotten mixed fruits were spread in the evening of the previous day. About one kilogram of the fermented fruits was spread in each distant trap of the 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. Hence from each collection spot, the flies were collected in twenty four bottles. Then the traps were brought to the laboratory, flies were isolated, counted and categorized. The *D. n. nasuta* and *D. s. neonasuta* species were sexed, and isofemale lines were established.

#### Results

The details of the spots of the collection of flies were presented in Table 1 and Figure 1. The collection of *Drosophila* flies from eight spots of three districts in four different months during 2001-2002 is reported in Tables 2a-c. A total of 11 species of *Drosophila* were identified and classified by using taxonomical key. No new species of *Drosophila* was found. In both DK-1 and DK-2 spots, the

maximum number of *Drosophila* flies was recorded in the month of February. Overall, the flies of *Drosophila ananassae* were the most abundant, while the flies of *D. nigra* were the least abundant (Table 2a). The flies of *D. nasuta nasuta* were more than *D. sulfurigaster neonasuta* in all the months of collection in both the spots.

In the three spots of Kodagu district, the maximum numbers of *Drosophila* flies were recorded in the month of May. Altogether, the number of flies of *D. ananassae* was the highest and the flies of *D. takashi* were the least abundant (Table 2b). Similarly, the flies of *D. n. nasuta* were higher than *D. s. neonasuta* in all the months of collection. In the three spots of Mysore district, the maximum numbers of *Drosophila* flies were observed in MG, MC-1, and MC-2 spots in the months of November, August, and February, respectively. In the overall, the flies of *D. ananassae* were the most abundant in MC-1 and MC-2 spots, whereas, the flies of *D. melanogaster* and *D. n. nasuta* were the highest in MG spot, and flies of *D. takashi* was the least abundant in all the three spots (Table 2c). Similarly, the flies of *D. n. nasuta* were more abundant than *D. s. neonasuta* in all the months of collection in all the spots.

Table 2a. Different *Drosophila* species and their numbers found during collections along with temperature and rainfall in DK-1 and DK-2 spots of Dakshina Kannada district of Karnataka, India during the year 2001-02.

Locations	DK-1				DK-2				
	Months	May	Aug	Nov	Feb	May	Aug	Nov	Feb
Temperature (°c)		30	29	28	31	30	29	28	31
Rain Fall (mm)		342.6	613	37.6	0	342.6	613	37.6	0
<i>D. n. nasuta</i>		103	90	58	33	101	50	60	39
<i>D. s. neonasuta</i>		37	39	32	22	38	20	27	13
<i>D. immigrans</i>		5	13	6	15	8	9	13	6
<i>D. rajasekari</i>		19	10	14	25	26	12	17	36
<i>D. melanogaster</i>		74	65	79	90	65	45	65	115
<i>D. bipectinata</i>		96	32	31	175	73	22	26	160
<i>D. malarkotliana</i>		115	73	86	250	99	54	53	170
<i>D. ananassae</i>		210	85	93	315	156	63	90	250
<i>D. takashi</i>		1	0	0	0	0	1	1	0
<i>Phorticella striata</i>		13	26	13	19	24	14	10	29
<i>D. nigra</i>		0	0	0	3	0	0	0	0
Total		673	433	412	944	590	290	362	818

## Discussion

*Drosophila* is found primarily in tropical regions. It is a cosmopolitan holometabolous insect, found in all warm countries. In the present investigation, eight spots with different altitudes were selected. The minimum distance between these spots is about 15 km. It is well known that the home range of *Drosophila* is around one mile (Dobzhansky *et al.*, 1976). Therefore, each spot of the present study represent a new population. In Dakshina Kannada district, during May the flies are more abundant, since in this premonsoon period the fermented fruits of jack and cashew favoured the

increased number of *Drosophila* flies. In Kodagu district, since there was heavy rain during May 2001, which is a premonsoon period with various types of fermented fruits which made a congenial environment for building up of large progeny of *Drosophila*. In Mysore district, *Drosophila* flies were more abundant in the month of November, August, and February, which are the favourable environment for building up of large progeny of *Drosophila*.

Table 2b. Different *Drosophila* species and their numbers found during collections along with temperature and rainfall in KS-1, KS-2 and KS-3 spots of Kodagu district of Karnataka, India during the year 2001-02

Locations	KS-1				KS-2				KS-3			
	May	Aug	Nov	Feb	May	Aug	Nov	Feb	May	Aug	Nov	Feb
Temperature (°c)	31	24	23	30	30	20	19	29	29	21	18	28
Rain Fall (mm)	145.3	838.4	107.8	18.2	145.3	838.4	107.8	18.2	145.3	838.4	107.8	18.2
<i>D. n. nasuta</i>	43	45	35	29	44	28	29	36	46	44	28	34
<i>D. s. neonasuta</i>	23	21	20	14	19	25	23	12	21	26	24	14
<i>D. immigrans</i>	24	24	15	20	32	4	21	25	31	18	15	20
<i>D. rajasekari</i>	32	34	30	23	40	13	35	30	32	29	46	22
<i>D. melanogaster</i>	26	20	26	28	36	44	38	23	49	64	42	35
<i>D. bipectinata</i>	16	18	15	13	25	20	5	13	22	25	6	13
<i>D. malarkotliana</i>	39	37	59	43	53	45	64	43	60	53	56	35
<i>D. ananassae</i>	95	82	67	75	84	64	115	63	113	71	86	84
<i>D. takashi</i>	2	2	0	1	0	0	1	0	0	0	1	0
<i>Phorticella striata</i>	34	31	3	25	22	14	0	15	19	22	3	10
<i>D. nigra</i>	3	2	1	2	1	1	1	0	1	0	1	1
Total	337	316	271	273	356	258	332	260	394	352	308	268

Table 2c. Different *Drosophila* species and their numbers found during collections along with temperature and rainfall in MG, MC-1 and MC-2 spots of Mysore district of Karnataka, India during 2001-02

Locations	MG				MC-1				MC-2			
	May	Aug	Nov	Feb	May	Aug	Nov	Feb	May	Aug	Nov	Feb
Temperature (°c)	30	29	29	30	30	29	28	30	30	29	27	30
Rain Fall (mm)	152	83.2	118.8	3.2	152	83.2	118.8	3.2	152	83.2	118.8	3.2
<i>D. n. nasuta</i>	34	56	50	43	44	46	43	65	42	55	57	64
<i>D. s. neonasuta</i>	17	28	28	25	16	28	16	29	25	25	28	31
<i>D. immigrans</i>	35	40	65	10	16	24	26	13	20	32	35	19
<i>D. rajasekari</i>	20	26	26	46	38	43	31	52	49	41	36	39
<i>D. melanogaster</i>	38	53	39	54	56	64	35	69	75	56	39	96
<i>D. bipectinata</i>	20	26	19	18	19	26	14	22	26	19	16	24
<i>D. malarkotliana</i>	32	40	44	22	52	65	53	45	55	53	67	61
<i>D. ananassae</i>	30	43	39	39	83	103	90	70	73	86	86	86
<i>D. takashi</i>	0	1	1	0	1	0	0	1	1	0	0	2
<i>Phorticella striata</i>	15	15	21	14	16	23	10	21	9	24	13	19
<i>D. nigra</i>	0	0	0	3	3	1	0	1	2	0	1	0
Total	241	328	332	274	344	423	318	388	377	391	378	441

The differences in the latitude and longitude between the collection spots of the present study is negligible; however, altitudinal differences are seen between seven collection spots. The altitudinal range is from 0 MSL to 790 MSL. The two collection spots namely, DK-1 and DK-2 (0 MSL) of Dakshina Kannada district, have the lowest altitude and longitude, with increased latitude, annual rainfall and temperature than the spots of other two districts. Similarly, the type of vegetation also varies in all these eight collection spots.

In the present study, a total of eleven different species are recorded with no new species. In overall *Drosophila ananassae* is more abundant than other 10 species in all the spots of assessments. In DK-1 and DK-2 spots, which are at a 0 MSL altitude, the number of flies of both males and females of *D. n. nasuta* were greater than other spots in the month of May. Thus, almost all these natural populations are heterogeneous assemblages of the members of different *Drosophila* species. When comparisons are made between the abundance of flies of *D. n. nasuta* and *D. s. neonasuta*, the flies of *D. n. nasuta* were more in number than *D. s. neonasuta* in all the assessments. Similarly, the sibling species *Drosophila melanogaster* and *D. simulans* present strong morphological similarities; they were often confused until Sturtevant (1921) described *D. simulans* as a close relative of *D. melanogaster*. These two cosmopolitan species are widely distributed in both temperate and tropical regions. However, while they are sympatric in many places, their relative proportions are not always the same (Capy *et al.*, 1993). Environmental abiotic stresses play an important role as factors determining the distribution and abundance of species. (Bubliy *et al.*, 2000).

Thus, 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). *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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### **Polytene chromosomes of *Drosophila huancavilcae* (repleta group, inca subgroup).**

**Romero-Estevez, Gabriela C., and Ana B. Mafla-Mantilla.** Evolutionary Genetics Laboratory, School of Biological Sciences, Pontificia Universidad Católica del Ecuador. [gabrielaromero83@gmail.com](mailto:gabrielaromero83@gmail.com); [amafla@puce.edu.ec](mailto:amafla@puce.edu.ec).

## **Introduction**

The *inca* subgroup was created in 1989 as part of the *repleta* group and consists of three species: *Drosophila inca*, *D. huancavilcae* (Rafael and Arcos, 1989), and *D. yangana* (Rafael and