such responses to stress and showed that developmental effects of lead exposure (15 ppm) in the same recombinant inbred strains assayed by Hirsch *et al*. (2009) significantly alters transcription at approximately 2,500 loci out of about 19,000 assayed (Ruden *et al*., 2009), including the *cacophony* locus that alters courtship song frequency in males (Schilcher, 1976). It is possible, therefore, that genotype-dependent variation in response to lead exposure results from differential effects on gene expression and possibly differences in sets of loci that respond to lead. Finally, our data are also consistent with the possibility that lead is an endocrine disruptor (Hirsch *et al*., 2010).

References: Hirsch, H.V., J. Mercer, H. Sambaziotis, M. Huber, D.T. Stark, T. Torno-Morley, K. Hollocher, H. Ghiradella, and D.M. Ruden 2003, Neurotoxicology 24: 435-442; Hirsch, H.V.B., D. Possidente, S. Averill, T.P. Despain, J. Buytkins, V. Thomas, W.P. Goebel, A. Shipp-Hilts, D. Wilson, K. Hollocher, B. Possidente, G. Lnenicka, and D.M. Ruden 2009, Neurotoxicology 30: 305-311; Hirsch, H.V.B., D. Possidente, and B. Possidente 2010, Physiol. & Behav. 99: 254-259; Hoffmann, A.A., and P.A. Parsons 1991, *Evolutionary Genetics and Environmental Stress*. Oxford University Press, Oxford, UK; Ruden, D.M., M.D. Garfinkel, V.E. Sollars, and X. Lu 2003, Semin. Cell. Dev. Biol. 14: 301-310; Ruden, D., C. Lang, D. Possidente, B. Possidente, P. Rasouli, L. Wang, X. Lu, M.D. Garfinkel, H.V.B. Hirsch, and G.P. Page 2009, Neurotoxicology 30: 305-311; Sanders, T., Y. Liu, V. Buchner, and P.B. Tchounwou 2009, Rev. Environ. Health 24: 15-45; Schilcher, F.V., 1976, Behav. Biol. 17: 187–196.

Drosophila fauna of Dharwad District with a report of *Drosophila latifshahi* from South India.

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Abstract

Drosophila species were collected from different localities of Dharwad district. It revealed a total of 21 species belonging to different groups which includes a rare species *D. latifshahi*, Gupta and Raychaudri, belonging to *Polychaeta* subgroup, for the first time from South India.

Introduction

The fruit fly, *Drosophila* is considered as a model organism for the studies of ecology, evolution, and population genetics. At present the total number of Drosophilids described all over the world is about 4217, which includes 1178 species belonging to genus *Drosophila*, among which 751 species belong to subgenus *Drosophila* and 335 species belong to subgenus *Sophophora*, whereas the remaining 92 species belong to other subgenera (Bachli, 2014). Some species are cosmopolitan and some are endemic to certain regions.

According to Fartyal and Singh (2001) a total of 283 species of Drosophilids have been reported. Among genus *Drosophila* 140 species were reported in India of which south India has only 50 species (Hegde *et al*., 2001). Most of the faunal analysis of *Drosophila* was mainly concentrated on the surrounding areas of Mysore in South Karnataka (Reddy and Krishnamurthy, 1974) and Dandeli and Ambikanagar of North Kanara district in northern part of Karnataka (Nagaraj and Krishnamurthy, 1980; Vasudev *et al*., 2001) and the Western Ghats, which includes Bababudangiri and Kemmannugundi hill ranges (Prakash and Reddy, 1978 1979), Biligirirangana hills (Ranganath and Krishnamurthy, 1972), Charmadi ghat (Gowda and Krishnamurthy, 1972), three different localities of Maharashtra state (Hegde and Krishnamurthy, 1980), Kodagu, Mysore, and Dakshina Kannada (Mangalore) districts (Prakash and Ramachandra, 2008), and so forth. Most of the other localities in South India have remained unexplored. In view of this present study, a survey of *Drosophila* in Dharwad District was carried out.

Materials and Methods

Study Area: Dharwad district lies in the north western sector of Karnataka state with varied climate consisting of rugged foothills (part of Western Ghats) and plain lands (maidan). It lies between the latitudinal parallels of 15° 15' and 15° 35' North and longitudes of 75° 00' and 75° 20' East. Dharwad district is divided into 5 different taluks (Dharwad, Kalghatgi, Hubli, Navalgund, and Kundagol).

Collection of *Drosophila* was carried out from different localities of all the 5 taluks of Dharwad district. Bottle trapping and net sweeping methods were employed for collection as described by Hegde *et al.* (2001). Bottles of the flies collected were brought to the laboratory and were segregated according to their sexes. Male flies were identified by referring to keys given in Markow and Grady (2006). The female flies were cultured for next progeny using wheat cream agar medium to identify the flies (Shivanna *et al.*, 1996).

Results

A total of 21 species were identified from different localities of Dharwad District. Among 21 species 11 species belonged to subgenus *Sophophora* while 6 species belonged to subgenus *Drosophila*; 2 species belonged to genus *Scaptodrosophila*; the remaining species belong to genus *Zaprionus* and *Phorticella*. Among 11 species belonging to subgenus *Sophophora*, 3 belong to *ananassae* subgroup, 4 belong to *montium* subgroup whereas the other individual species belonged to *melanogaster*, *suzukii*, *eugracilis*, *takahashii* subgroups. In the case of subgenus *Drosophila*, 2 species belong to *nasuta* and *polychaeta* subgroups, whereas remaining individual species belong to *immigrans* and *repleta* subgroups, respectively (Table 1). The two rare species belonging to *Polychaeta* subgroup, *D. daruma* Okada and *D. latifshahi* Gupta and Raychaudri, were reported for the first time in Dharwad district, Karnataka of South India.

A few morphological characters of *D. latifshahi* are as below.

Length of imago: male 2.4 mm; female 3.2 mm

Head: Arista has 5 ventral and 4 dorsal branches excluding terminal fork.

Antenna: Dark yellowish; carina broad and sulcate; anterior orbital bristle larger than middle orbital but smaller than posterior orbital bristle; anterior orbital bristle proclinate; middle and posterior orbital bristle reclinate; eye dark reddish.

Thorax: Dark yellowish in color; Acrostichal hairs in 7 – 8 irregular rows; extra pair of dorsocentral bristles present prior to anterior dorsocentral bristle; anterior dorsocentral smaller than posterior dorsocentral (Figure 1a). Sterno-index 0.8; legs yellowish with 3 prominent bristles on the femoral region among which 2 are larger; sex combs absent; preapicals on all tibia (Figure 1b).

Wing: Costa with 2 breaks; humeral crossvein not clear; anterior and posterior crossveins clear (Figure 1d).

Wing Indices:

Male; C – index 1.8; 4V index – 2.1; 4C index – 1.2; 5X index – 1.6

Female; C – index 1.9; 4V index – 2.4; 4C index – 1.4; 5X index – 1.5

Wing indices calculated according to Okada (1956).

Abdomen: Tergites are darkish; Sternites pale.

Periphallic Organ: Genital arch narrower; broader at anterior side with about 32 bristles. Primary surstylus present with 6 – 7 long primary teeth, Secondary surstylus absent; Anal plate oval, elongated and independent of genital arch and detached from surstylus with about 59 – 60 bristles. Toe pointed and heel prominent (Figure 1c).

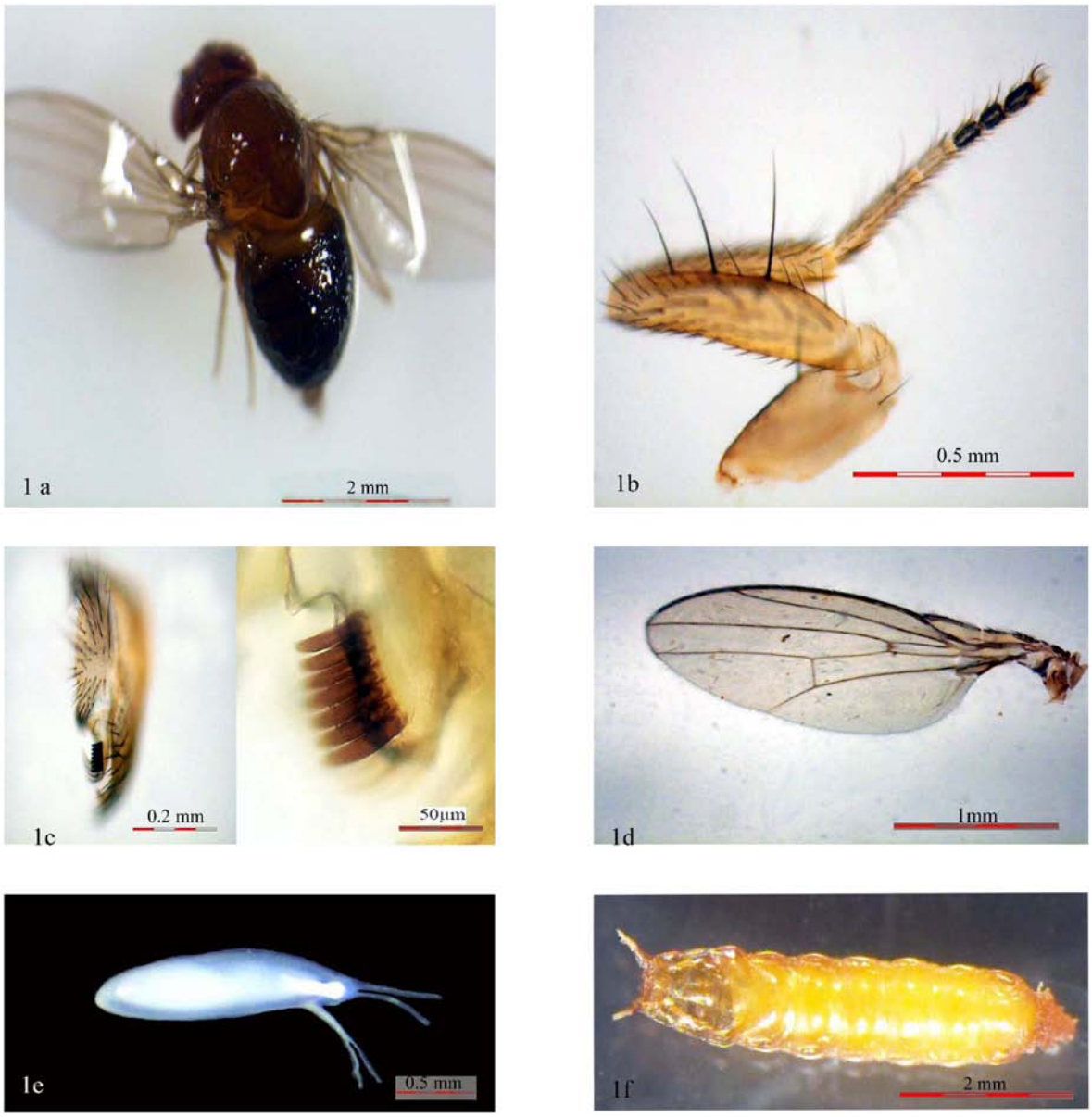

Figure 1. 1a, imago fly; 1b, foreleg; 1c, periphallic organ; periphallic organ primary teeth enlarged; 1d, wing venation; 1e, egg; 1f, pupa.

Phallic organ: Aedal apodeme as long as aedeagus; posterior parameres absent.

Egg: egg with 4 filaments (Figure 1e); Egg guide: Slender at anterior and broader at posterior end with about 14 small marginal teeth; Pupa: yellowish consists of 16 – 20 spiracles (Figure 1f).

Specimens examined: 2 ♂♂, 1♀, India: Karnataka, Dharwad, Jogyellapur, 15°23’31.25’’ N and 75°00’45.96’’ E, 2240 ft. Coll. Srinath B.S 2012

Distribution: India, Bangladesh, China

Table 1. Different species of *Drosophila* collected from Dharwad District.

Genus *Drosophila* Fallen 1823
Subgenus *Sophophora* Sturtevant 1939
Species group *melanogaster*
Subgroup *melanogaster*
1. *Drosophila melanogaster*# Meigen 1830
Subgroup *ananassae*
2. *D. ananassae*# Doleschall 1858
3. *D. malerkotliana* Parshad and Paika 1964
4. *D. bipectinata* Duda 1923
Subgroup *suzukii*
5. *D. rajasekari* Reddy and Krishnamurthy 1968
Subgroup *eugracilis*
6. *D. eugracilis* Bock and Wheeler 1972
Subgroup *montium*
7. *D. kikkawai* Burla 1954
8. *D. jambulina* Parshad and Paika 1964
9. *D. punjabiensis* Parshad and Paika 1964
10. *D. bhagamandalensis* Muniyappa, Reddy and Krishnamurthy 1981
Subgroup *takahashii*
11. *D. takahashii* Sturtevant 1927
Subgenus *Drosophila* Sturtevant 1939
Species group *immigrans*
Subgroup *immigrans*
12. *D. immigrans* Sturtevant 1921
Subgroup *nasuta*
13. *D nasuta nasuta* Lamb 1914
14. *D sulfurigaster neonasuta* Sajjan and Krishnamurthy 1973
Species group *repleta*
15. *D. repleta* # Wollaston 1858
Species group *polychaeta*
16. *D. daruma** Okada 1956
17. *D. latifshahi* * Gupta and Raychaudhuri 1970
Genus *Scaptodrosophila* Grimaldi 1990
18. *Scaptodrosophila nigra* Grimshaw 1901
19. *S. krishnamurthyii* Sajjan and Reddy 1975
Genus *Zaprionus* Coquillet 1902
Subgenus *Anaprionus*
20. *Zaprionus bogoriensis* Mainx 1958
Genus *Phorticella* Duda 1923
Subgenus *Xenophorticella* Duda 1929
21. *Phorticella striata* Sajjan and Krishnamurthy 1975

16 * First time reported in South India; 17* present report; # Cosmopolitan species

Discussion

Family Drosophilidae with its varied diversity has still remained unexplored in most parts of India. Dharwad district with its varied climate and vegetation has proved to be a good example in collection of some

rare and endemic species, out of which 3 species are cosmopolitan and a remaining 18 species are endemic to South Asia. Most of the species collected have revealed to belong to subgenus *Sophophora* and *Drosophila*. Among the *Sophophoran* subgenus all the species belong to *melanogaster* species group. This is on par with the conclusion of Bock and Wheeler (1972) that the *melanogaster* species group must have originated from the South Asian or Indian subcontinent. This result may provide further insights into the evolutionary origin and diversification of *melanogaster* species group. Further the diversity of the *Drosophila* subgenus has also proved to be interesting with the Indian species of *D. daruma* reported for the first time from South India (Srinath and Shivanna, 2012). *Z. bogoriensis* belonging to subgenus *Anaprionus* is also a rare species, which was reported by Yassin and David (2010) from Bangalore, India; they also discussed its morphological characters.

Gupta and Raychaudri (1970) described *D. latifshahi* for the first time from Chakia forest in North India. They categorized this species under subgenus *Scaptodrosophila.* The *Polychaeta* species group is characterised with 3 pairs of dorsocentral bristles and surstylus with more or less pubescent flap (Toda and Peng, 1989). Later Toda and Peng (1989) reported this species for the first time from Guangdong province, China. They reclassified the taxonomic status of this species and categorized it under *Polychaeta* species group of the subgenus *Drosophila*. The species collected from Dharwad district in North Karnataka of South India has the similar characteristic feature of *Polychaeta* species group. It is one of the rare species which was not reported by earlier workers from South India.

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References: Bachli, G., 2014, Taxodros: The database on taxonomy of Drosophilidae. URL: http:// www.taxodros.unizh.cw; Bock, I.R., and M.R. Wheeler 1972, Univ. Texas. Pub. 7213: 1-102; Fartyal, R.S., and B.K. Singh 2001, Dros. Inf. Serv. 84: 30-38; Gupta, J.P., and S.P. Raychaudhuri 1970, Proc. R. Entomol. Soc. (B) Taxonomy 39(5-6): 57-72; Gowda, S.L., and N.B. Krishnamurthy 1972, Dros. Inf. Serv. 48: 38; Hegde, S.N., and N.B. Krishnamurthy 1980, Dros. Inf. Serv. 55: 60-61; Hegde, S.N., V. Vasudev, and M.S. Krishna 2001, In: *Trends in Wildlife Biodiversity Conservation and Management* (Hosetti, B.B., and M. Venkateswarulu, eds.). Daya Publishers, New Delhi, pp. 55-68; Markow, T.A., and P.M. O'Grady 2006, Drosophila, *A Guide to Species Identification and Use*. Academic Press, London. 247 pp.; Mateus, R.P., M.L.T. Buschini, and F.M. Sene 2006, Braz. J. Biol. 66(2B): 719-729; Nagaraj, H.J., and N.B. Krishnamurthy 1980, Dros. Inf. Serv. 55: 114; Okada, T., 1956, *Systematic Study of Drosophilidae and Allied Families of Japan*. Gihodo Co. Ltd., Tokyo, Japan. 183 pp.; Prakash, A., and N.B. Ramachandra 2008, Dros. Inf. Serv. 91: 82-87; Prakash, H.S., and G.S. Reddy 1978, Entomon. 3(1): 85-90; Prakash, H.S., and G.S. Reddy 1979, Proc. Indian Acad. Sci. 88(1): 65-72; Ranganath, H.A., and N.B. Krishnamurthy 1972, Dros. Inf. Serv. 48: 132; Reddy, G.S., and N.B. Krishnamurthy 1974, J. Univ. Mysore 26(B): 54-64; Shivanna, N., G.S. Siddalingamurthy, and S.R. Ramesh 1996, Genome 39: 105-111; Srinath, B.S., and N. Shivanna 2012, Biosystematica 6(1): 39-42; Toda, M.J., and T.X. Peng 1989, Zool. Science 6(1): 155-166; Vasudev, V., H.J. Nagaraj, Nagabhushana, and S.N. Hegde 2001, Entomon 26(special issue): 326-331; Yassin, A., and J.R. David 2010, Zookeys 51: 33-72.

Latitudinal clines of allozymes in Indian natural populations of *Drosophila ananassae.*

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Animal species are known to live in environments that vary through time and space. In many situations, such environmental heterogeneity can act as a strong selective force causing adaptive differentiation among populations. Evolutionary biologists try to quantify the magnitude of adaptive differentiation among