Evolutionary biologists can use the extensive knowledge about mechanisms of aging to assess whether the assumptions and predictions of the evolutionary theory have been met or whether they need refinement. At the same time, molecular biologists have become interested in asking questions about aging that are inspired by evolutionary concepts (Flatt and Schmidt, 2009).

The evolutionary theory of aging makes several assumptions and predictions that have been tested empirically in the laboratory. The evolutionary plasticity of aging and longevity is now an established experimental fact (Gavrilov and Gavrilova, 2002; Partridge and Gems, 2007). The molecular causes for the aging process are multiple, involving both genetic and environmental factors. Since 1990’s genetic screening efforts with invertebrates have unraveled multiple genetic pathways that suggest longevity is promoted through the manipulation of metabolism and the resistance to oxidative stress to those based on the prosenescence role of genes important for fitness early in life (Charlesworth, 1993). The major molecular pathways regulated by genes, that increase healthy life expectancy are calorie restriction, stress resistance pathway and insulin like signaling pathway, which have raised an enormous depth in understanding life span extension and its variation in different organisms (Lin et al., 1998; Parkes et al., 1998; Rogina et al., 2000; Tatar et al., 2001; Rattan, 2004; Partridge and Gems, 2006). Hormetic effects are widely used in aging research and so far studied model organisms are *D. melanogaster*, *Caenorhabditis elegans* and rodents (Le Bourg, 2009).
The members of nasuta-albomicans complex (NAC) of Drosophila offer a unique opportunity to understand both evolutionary and molecular dynamics of aging since they have introgressed genome. The evolution of this complex of Drosophila took place in the laboratory through interracial hybridization between D.n.nasuta (coorg strain) and D.n.albomicans (Okinawa strain) which belongs to the frontal sheen complex of the nasuta subgroup of the immigrans species group of Drosophila (Wilson et al., 1969; Kitagawa et al., 1982). To evolve this kind of cytoraces in nature it would have taken 1000s of years, whereas, here in the laboratory it has taken only a decade. The nasuta subgroup is one such group under Drosophila genus whose genome sequence is not out and phylogenetic relationship of this group is poorly known. For evolutionary studies in this species group, it is necessary to develop an historical framework of the timing of speciation events and the degree of separation between taxa. Whether the mechanisms of aging evolutionarily conserved or lineage-specific? What is the molecular basis of plasticity in life span in the members of NAC of Drosophila? In order to understand these, the present investigation was taken up. The findings and implications of these studies are compiled as follows:

**SECTION I:** reviews about NAC of Drosophila, longevity studies in Drosophila, interventions of mild stresses in extending regular longevity, oxidative stress resistance and its correlation with longevity and the molecular evolution of longevity genes.

**SECTION II:** presents the assessment of lifespan and establishment of short-lived and long-lived cytoraces of NAC of Drosophila and it is dealt in three parts: A)
Lifespan assessment of unmated and mated flies of all the members of NAC of *Drosophila* B) Three replicate assessments and C) Crossing experiment.

**SECTION III:** deals with understanding the mechanisms of longevity using short-lived and long-lived cytoraces of NAC of *Drosophila*. It has three main parts: A) Dietary restriction B) Hormetic effect on lifespan and C) Oxidative stress resistance

**SECTION IV:** presents the cloning and analysis of Copper/Zinc Superoxide dismutase gene (*Sod1*) and Histone deacetylase gene (*Rpd3*), two candidate genes in *D.n.nasuta, D.n.albomicans*, short-lived and long-lived cytoraces.

**SECTION V:** summarizes the findings and brings the future prospects of these investigations.

**SECTION VI:** deals with appendices and bibliography.

**SECTION VII:** includes the list of publications made from this investigation.