1.1 Flea:

The Siphonaptera are laterally compressed, wingless, holometabolous insects. Fleas (order Siphonaptera) are one of the major groups of blood-sucking insects. They belong to holometabolic group, like Diptera, Lepidoptera, etc. Fleas form a separate well differentiated order, although phylogenetically they are regarded to be closer to Diptera and Mecoptera.

Representatives of the order are known as vectors of plague microbes, murine typhus rickettsiae and some other pathogens. The great practical significance of fleas determines the necessity to study their fauna for the entire world and separate regions and to elaborate of systematics of the order. Epidemiological significance of fleas determined the great interest of specialists from different countries of the world. The world fauna of this relatively small insect order had been mainly studied by the 1970s-1980s.

The majority of fleas are closely associated with the host’s home (nest, burrow etc), attacking the host for feeding. Fleas are obligatory blood feeders parasitizing warm-blooded invertebrates. More than 94% of known species are parasites of the mammals and only about 5% of them occur on birds.

1.2 Evolution:

Fleas may have evolved as early as 140 million years ago (mya), along with their mammalian hosts. Only five flea species are known from fossil records: three from Baltic amber (35–40 mya: *Palaeopsylla baltica*, *Palaeopsylla dissimilis*, and *Palaeopsylla klebsiana*) and two from
Dominican amber (15–20 mya: *Pulex larimerius* and an undescribed species of *Rhopalopsyllus*). The specialized combs, setae, and appendages of these relics are very similar to those of their modern relatives. Molecular and morphological data suggest the small Mecopteran family of snow scorpion flies, (Boreidae), snow fleas is a sister group of Siphonaptera. Snow fleas are not actually fleas and are not parasitic, as are all members of the Siphonaptera.

Based on empirical evidence, some workers have divided the superfamily Pulicoidea into two subfamilies (Pulicinae and Tunginae), whereas others have considered them as two separate families (Pulicidae and Tungidae). DNA analyses conducted from 2000 to 2003 of taxa assigned to these subfamilies indicate that they are two distinct families. The family placement of many of the 244 genera remains to be defined by molecular studies. Until molecular studies redefine the genetic phylogeny, 16 families belonging to five superfamilies are recognized: Ceratophylloidea (Ancistropsyllidae, Ceratophyllidae, Ischnopsyllidae, Leptopsyllidae, and Xiphiopsyllidae), Hystrichopsylloidea (Chimaeropsyllidae, Coptopsyllidae, Ctenophthalmidae, Hystrichopsyllidae, Pygiopsyllidae, and Stephanocircidae), Malacopsylloidea (Malacopsyllidae and Rhopalopsyllidae), Pulicoidea (Pulicidae and Tungidae), and Vermipsylloidea (Vermipsyllidae). Of about 2,575 species (including subspecies), some 5% occur on birds, while the remaining 95% parasitize mammals. DNA analyses indicate that fleas originated on mammals, with some crossing over later to avian hosts. Fleas typically do not parasitize amphibians and reptiles.

Recent (after Snograss, 1946) studies of flea morphology were devoted to the anatomy and sensory organs of different imago segments. The
head anatomy was studied in a number of flea species (Amrine and Lewis, 1978). Comparative studies have been made of the structure of mouth apparatus, antennae (Medvedev, 1982, 1983) and head capsule (Medvedev, 1989a, 1989b). The anatomy *Xenopsylla cheopis* thorax was studied mostly in detail (Rothschild, Schlein, 1975). Comparative studies of thorax were done by Medvedev (1992a, 1992b).

1.3 Zoogeography:

The distribution of the siphonapterans are as Ceratophyllidae, Hystrichopsyllidae, Leptopsyllidae, Vermipsyllidae, Coptopsyllidae, and Ancistropsyllidae occur predominantly in the boreal continents of North America, Europe, or Asia, while some families restricted to the southern continents of Africa, Antarctica, Australia, or South America include Malacopsyllidae, Rhopalopsyllidae, Stephanocircidae, Pygiopsyllidae, Xiphiopsyllidae, and Chimaeropsyllidae and the remaining three families, Ctenophthalmidae, Ischnopsyllidae and Pulicidae, occur in both the Northern and Southern Hemispheres.

Fleas are widely spread on all continents, including Antarctica. They occur on hosts and in their nests in all types of habitats from the equatorial deserts and tropical rainforests to the northernmost regions of Arctic tundra. In general in Eurasia as in other continents the largest number of species and genera of fleas occur in several regions with temperate subtropical climate and predominance of mountain landscapes. The most numerous flea fauna is known for Eurasia.

The intensive studies have been carried out on major vectors of the arthropod born human and animal diseases in the twentieth century in different countries all over the world and have produced a sound body of
information regarding their distribution, habit and role in disease transmission. Certain groups of these arthropods such as vector of malaria, filariasis, dengue fever, yellow fever, trench fever, murine typhus, relapsing fever and plague have been the main foci of study by specialists in various disciplines of biology i.e. Parasitology, Entomology, Ecology and Health education etc.

The arthropods have been the major vectors of diseases since ancient times and have resulted innumerable deaths in many tropical and subtropical countries and to some lesser extent in temperate zones also. Besides the death toll by several insect born diseases like malaria, dengue, chikunguniya, trypanosomiasis, leishmaniasis, filariasis, scrub typhus, tick typhus and plague etc. they cause significant impediment to the economy of many countries. As the loss of working hands due to death, increased cost of treatment and controlling the pathogens and their vectors are major factors in economic development.

The inclusion of a chapter on ectoparasite control in a work otherwise devoted to vertebrates has a great deal of justification; the ecologies of vertebrates and their invertebrate parasites are inseparable, thus, the vertebrate control specialist is brought in to intimate contact with ectoparasites and related problems. In many cases, the need for vertebrate and ectoparasite control problems is one, and knowledge of techniques in both areas is required.

The term “ectoparasite” groups a broad array of invertebrate animals externally parasitic on larger animals; many of them blood feeders in at least one stage of their life cycles. The ecological relationships between them and their hosts may be exceedingly complex, involving ectoparasites as vectors of parasitic micro-organisms, and in some cases as reservoirs of infection as
well. In their role as vectors and also as bloodsucking parasites, they have a great impact on the ecology of animal and human populations.

The importance of many ectoparasite species, especially fleas, ticks, mites, and lice, to human welfare cannot be overemphasized. The roles of fleas in the transmission of plague and murine typhus are well known, as are those of ticks in a variety of viral, rickettsial, spirochaetal, and bacterial diseases, trombiculid mites in scrub typhus and lice in epidemic typhus. In addition, man may be exposed to painful bites resulting in direct pathological effects, both from wild animal ectoparasites or from others more directly associated with man and domestic animals.

The need for adequate ectoparasite control method is required. Ectoparasite control ranks with control of vertebrates and with immunology and clinical treatment as a potent tool in protecting man from zoonoses. In many cases, the ectoparasites are the most susceptible links in the chain of man transmission of diseases from sources in nature to man. In others, control of ectoparasites is capable of immediately alleviating potentially dangerous situations until more lasting control measures can be carried out. It should be borne in mind that human discomfort from ectoparasites and vector-borne diseases stems from a complex ecological situation and can be solved ultimately only by environmental management practices in which ecological factors are separated, analyzed, related, and adjusted in favour of man. The decision of how to control or whether to control ectoparasites should be based on knowledge of these factors.

Fleas as adults are obligate bloodsucking parasites. As larvae, they are general feeders on debris and other materials in habitat of the host. The larvae of rodent fleas are closely adapted to the nest or burrow conditions of the host; larvae of the dog and cat fleas (Ctenocephalides canis and
Ctenocephalide felis) and of the so-called human flea are more broadly distributed about the host habitation. While adult fleas are often found on the host in considerable number, far more are usually found in the nest or about the habitation. Some species are more prone to remain in the nest than others. These have been termed “nest fleas” by flea students, though the distinction is one of degree rather than a sharply discrete difference.

It is perceptible that different control measures are necessary to deal with rodent fleas than to deal with domestic fleas. In addition, the habits of various rodent groups make necessary variations in control measures against their fleas. Whatever the case, it is necessary to reach the fleas in the environment as well as those on the host in order the home and for fleas of wild and domestic rodents is discussed.

In the United States fleas are controlled solely because they bite man. Adult fleas are commonly found on the pets (on cats or dogs); while the eggs, larvae, and pupae found where the pets sleep. The infestation of adults, however, may spread throughout a home, into the yard area, and may include a whole neighborhood. Even though no cat or dog is known to occupy a residence at the time of infestation, infestations can invariably be traced to pets. Often, a family without dog or cat may move into a dwelling and find it infested, or a family with a pet returns from vacation and finds the home infested with fleas. In these cases, adult fleas have matured and may have been able to survive as long; as several months without food. Successful control depends on first identifying the species involved, locating the focus of infestation, and then applying appropriate control measures. The cat or dog flea is usually found in greatest numbers about the immediate living quarters of the pet, but may frequently be more widespread. The human flea is associated directly with man. Operators searching for sources of fleas
should examine pets and their living area for *Ctenocephalides* and primarily the bedroom for the human flea. One clue as to which species may be involved is the location of bites: bites around the ankles often mean the dog or cat flea; around the waist, the human flea.

First and foremost aspect of the fleas is to know their structure and their biology, and their control. Keeping these aspects in mind, the present study of morphometric variations, chaetotaxy, and biology and susceptibility status to some insecticide of fleas namely *Ctenocephalides canis* and *Ctenocephalides felis* has been taken.

**1.4 Habitat:**

Fleas parasitize hosts in virtually every conceivable terrestrial habitat, adapting to the microclimate of the nests, burrows, and body conditions. Such adaptations enable fleas to live in the most extreme environmental conditions. For example, *Glaciopsyllus antarcticus* occurs only in the frigid, sub-zero conditions of the Antarctic. They proliferate in the microclimate of the nest and in the down of their avian host, the southern fulmar (*Fulmarus glacialisoides*). Many species (*Ctenocephalides* and *Nosopsyllus*) thrive in the dry conditions of deserts, living in the burrows of their rodent hosts, where the temperature and humidity are optimal for their development. Adult fleas are found on mammalian hosts more frequently and in greater numbers than those species parasitizing birds. Fleas have adapted only to birds that use their nests over and over (swallows, seabirds, and some ground-dwelling birds and cavity dwellers). A few species (*Pulex* and *Ctenocephalides*), especially those inhabiting coastal, semitropical, and tropical regions, are free living, jumping on and off their hosts and proliferating in open environmental conditions, such as floors of homes, pathways, barnyards, animal pens, and pet beds.
1.5 Taxonomic status of Siphonaptera:

Various taxa of fleas are established using numerous characters which often show parallel trends of development on a homologous basis. This fact impedes the development of classification of this group, because their structures are often very similar, and the differences can only be revealed by a detailed analysis. It is probably for this reason that only several classifications of this order were proposed during the last 50 years. Among these, the best known are the systems of Wagner (1939), Jordan (1948), and Smit (1982), Medvedev (1994, 1998b). In 1948, K. Jordan published his classification of the order, which has become generally accepted with some additions. In an earlier publication (Jordan, 1947), the author outlined his approach to the flea taxonomy, stating that higher taxa of fleas can be established on the basis of character combinations, rather than individual characters, because every separate character may occur in representatives of other taxa as well. Unfortunately, Jordan did not have time to comment on his phylogenetic scheme, which was published in the Catalogue of Fleas in the British Museum (Hopkins, Rothschild, 1953-1971) and in the review of flea studies prepared by Holland (1964). The analysis of this scheme shows that its branching sequence reflects the decreasing peculiarity of taxa. The families Pulicidae and Tungidae, having the most vivid distinctive features, were separated by Jordan as the first branch, comprising the superfamily Pulicoidea.

A classification of siphonapteran families and scheme of their phylogenetic relationships are proposed (Medvedev, 1994, 1998a) on the basis of features of 50 structures of head, thorax, and abdomen. Four family complexes of evolutionary trends may be distinguished: they are infraorders Pulicomorpha, Pygiopsyllomorpha, Hystrichopsyllomorpha, and
Ceratophyllomorpha. One other classification of the order Siphonaptera was recently published (Smit, 1982). In the classification of Smit, the order is divided into five superfamilies: Hystrichopsylloidea, Ceratopsylloidea, Malacopsylloidea, and Pilicoidea. The last the most important news in flea systematic are recent investigations of DNA sequence (18 rDNA and etc) at Brigham Young University under Dr. Michael F. Whiting and Dr. Michael W. Hastriter which get new insight into phylogenetic relations of Siphonaptera.

1.6 Reproductive biology:

Fleas in the adult stage are recognized with ease. They are small, dark brown in color, laterally flattened, and with three pairs of legs modified for jumping. The body is more or less oval in shape and armed with spines and setae, adapting the flea for living among the hair of animals. The head is provided with mouthparts modified for sucking blood.

Fleas have a complete metamorphosis; that is, the life history involves four distinct phases: the egg, larva, pupa, and adult. Each adult female flea lays a number of eggs, 400 or more in some species, over a long period of time.

Some species lay eggs on their host, others do so indiscriminately in the environment, and still others place them in the burrow or nest of the host. The duration of each stage of the life cycle varies for each species. Common cat flea *C. f. felis* eggs are laid on the host within 48 hours of a blood meal. The eggs drop to the ground (most often in the lair of a cat or dog), hatch, and pass through three larval stages. The mature larva spins a silken cocoon and molts within, ultimately emerging as an adult. The developmental cycle is completed in two to three weeks under optimal conditions of temperature
and humidity but may take as long as three to four months. Across the order, sex ratios are approximately 1:1, and longevity of adults may range from only a few weeks to more than three years.

1.7 Diseases burden:

The *Ctenocephalides felis felis* is the most important ectoparasite of dogs and cats throughout the world, causing annoyce to the animals and acting as a vector of diseases (Rust and Dryden, 1997). Halliwell (1979) observed that *Ctenocephalides felis felis* cause the allergic dermatitis. Heavy infestation of *Ctenocephalides felis* can cause the iron deficiency anemia in young animals (Harvey *et. al.*, 1982). More than twenty different types of endosymbionts or pathogens have been found to be associated with species of *Ctenocephalides* as biological vectors or intermediate host, including bacteria, protozoa and helmenthis, thus representing a potential healthrisk for humans (Jellison, 1959; Jenkins, 1964; Linardi and Gumaraes 2000; Linardi, 2001). The cat flea also lodges other monoxenic organism, such as gregarines, microsporidians and trypanosomatids. The endosymbionts or pathogens found in *Ctenocephalides* species in Brazil are *Rickettsia*, *Mixomae molitor*, *Yersinia pestis*, *Nosema ctenocephali*, *Stenina species*, *Leptomonas ctenocephali*, *Dipylidium caninum* and *Dipetalonema reconditium* (De Avelar *et. al.* 2007 and 2008) these endosymbionts might be useful for biological control of *Ctenocephalides felis felis* in environments exhibiting high level of infestation. Coutinho and Linardi (2007) described the molecular techniques and Ferreira *et. al.* (2009a) recognized DNA of *Leishmania chagasi* in *Ctenocephalides felis felis*, thus opening new perspectives for mechanical transmission of canine visceral leishmaniasis.

De Avelar *et. al.* (2011) raised the possibility that Leptomonas of fleas may be pathogenic to humans and dogs because some people crush dog fleas
between their fingers and carry them to their mouths. Besides, dogs are likely to ingest flea gut contents or entire fleas when crushing the insects between their teeth or licking their own fur or that of other dogs.

According to Grain et al. (2001), it is possible that the numbers of human cases of infection with lower trypanosomatids is underestimated because of the morphological similarity to and cross-reactivity with Leishmania infantum chagasi. In addition to the role as a transmitter of diseases, Ctenocephalides felis felis provokes allergic dermatitis and has been reported to produce anemia in dogs, cats, goats, cattle and sheep (Obasaju and Otisile 1980; Yeruham et al. 1989).

The blood-sucking arthropod Ctenocephalides felis has been confirmed as a vector for Bartonella henselae and is a suspected vector for Bartonella clarridgeiae, Bartonella quintana and Bartonella koehlerae in Bartonella transmission to mammals. (Bouhsira E, Ferrandez Y, et al., 2013).