INTRODUCTION

The diversity of life on earth is immense. Although taxonomists have so far recognised less than 2 million species, scientists believe that the total number of species on earth is between 10 million to 80 million (Stork, 1988; Wilson, 1988). Stork, N.E. (1993) estimated the global total number of organisms to be around 30 million species or more. To describe this immense variety and richness of life on this planet, the term ‘biodiversity’ was coined by Wilson (1988) as a contraction of ‘biological diversity’ and represents the diversity of life at all levels including genetic, species and ecosystem diversity. Biodiversity provides a variety of environmental services from its species and ecosystems that are essential at the global, regional and local levels.

Manipur, a small hilly state in North-east India with an area of 22,327 sq. km. lies in the Indo-Myanmar Hotspot region (Mittermeir et al., 2004). Manipur lies between 23°83'N and 25°68'N latitudes and between 93°03'E and 94°78'E longitudes. The hill ranges cover about 92% of the total geographical area and the remaining 8% constitutes the central plain covering about 1920 sq. km. The valley stands at an altitude of 790 meters above the mean sea level and the hills at an altitude ranging from 1500 – 3000 meters above the mean sea level. It is a general observation that most of the hotspots and areas of high biological diversity are concentrated in
mountainous regions that harbour diverse habitats, and habitat diversity varies with altitudinal variation (Mittermeir et al., 1999). Altitudinal variations are most likely to be associated with habitat diversity (Myers et al., 2000), which in turn, favour high species packing. Depending on the altitude of hill ranges, the climatic condition of Manipur varies from tropical to sub-alpine. The wet forests and the pine forests between 900 – 2700 meters above the mean sea level and together sustain a host of rare and endemic flora and fauna. The rainfall is more in the hills than in the valley and the average annual rainfall is about 2077 mm. The mean annual temperature is 25.8 ± 0.8°C.

Studies undertaken in any group ranging from invertebrates to vertebrates have revealed a very rich biodiversity in the state. Manipur alone harbours 30 species of amphibian (Bhanu, Y. 2000). It also has a rich ichthyofauna which occurs in varied habitats viz., fresh water lakes, rivers, hill streams and other water bodies. Among the diverse group of vertebrates the reptiles also constitute one of the important fauna of Manipur. Fishes, amphibians and reptiles together comprises cold-blooded vertebrates and are collectively termed as ‘poikilothermic’ vertebrates. In poikilothermic animals, their body temperature fluctuates according to the temperature of the environment which ranges below the temperature of 37°C and they have no internal metabolic mechanism for regulating their body temperature.
They hibernate in winter and undergo aestivation during long periods of drought or heat. They have constituted one of the most favourable animal types for a wide range of biological studies. Some cold-blooded vertebrates viz., fishes, frogs also constitute an important staple diet for different sections of the population of Manipur and thus form an economically important group of animals. Due to their diverse feeding habits, they are subjected to many parasitic infections thereby sustain a rich parasitic fauna. They also serve as paratenic host for some helminth parasites for the completion of their life cycle (Diengdoh, 1989).

All living animals are known to be parasitized by certain parasites at one time or the other. Parasite is an organism which depends on another organism known as the host for their existence, mainly for acquisition of food, shelter, transport (during their larval period) and completion of life cycle for a certain period of developmental phase of parasite in the host. The association is termed as “parasitism” where the parasites derives benefit and the host gets nothing in return but instead got various degrees of harm. Heavy infection of parasites kills the hosts or the host species definitely suffer varying degrees of injury which may be significant or temporary inconvenience to some sort of discomfort or diseases which may lead to the death of the host organism (Jairajpuri, M.S. 2002).
Among the parasites, nematodes are an important group of parasites which have a wide range of distribution in most of the cold-blooded vertebrates. The nematodes are one of the most successful group of animals showing great adaptive radiation; their representatives live in fresh or marine water, in soil and on plants as well as on animals. Parasitism has arisen many times and in many different ways in the nematodes. The nematodes can be divided, rather arbitrarily, into parasitic and free-living forms. The knowledge of nematodes has been mainly derived from parasitic forms. Parasitic nematodes are of great interests to biologists because they are plentiful, are frequently encountered as endoparasites and infect a large array of invertebrate hosts (Cheng, T.C. 1986).

Nematodes are pseudocoelomate invertebrates, generally elongate and cylindrical, tapering at both ends, colourless and triploblastic. Their sexes are usually separate but some forms are hermaphroditic. Males are readily distinguished externally from females by their smaller size, curvature of the posterior end, and presence of bursae, genital papillae, and other accessory copulatory structures such as spicules, gubernaculums, caudal alae, etc. The body surface of a parasitic nematode is covered with an elastic cuticle. It is generally smooth; however various structures such as spines, bristles, warts, punctations, papillae, striations and ridges may be present (Chitwood and Chitwood, 1950 and Maggenti, 1981). These specialised
cuticular structure may be classified as either ornamentation or sensory organs. Their presence, arrangement and position of such structures are also of taxonomic importance.

The anterior end of the nematode body forms the head. The mouth is terminal & associated often with various structures such as lips, pseudolabia, odontia, cephalic papillae, amphids, colarettes and cords. The tail of most females is very simple. The posterior end of males varies in structure. The shapes, sizes and number of copulatory spicules and their auxiliary structures in males like gubernaculums, telamon, etc. are of taxonomic importance (Cheng, T.C.1986).

Nematodes are commonly found parasitizing in the intestinal tract and body cavity of the cold- blooded vertebrates. The recovery of nematodes is less in winter or colder months where cold temperature act as a limiting factor. Variation in the nematode population occur according to seasons depending on the degree of host’s activity which in turn depends on factors like temperature, rainfall, etc. The study of distribution and infestation pattern of nematodes is of primary importance for the assessment of the nature of parasitism and for evolving planning and management strategies for pest control in the long run. It provides a basis of comparison between different species of parasites (Li and Hsu, 1951).
The first comprehensive account of nematodes from the Indian region was compiled by Baylis (1936 and 1939) in two volumes on Nematoda in the Fauna of British India series. Many workers also took up the study of the group like Karve (1927-1951), Mirza (1938), Agrawal (1930), Moorthy (1937), Biswas and Chakravarty (1963), Soota T.D. and Chaturvedi (1971), Sahay, U. (1966), etc. So far, very few workers have undertaken studies on helminth parasites of cold-blooded vertebrates from North-east region of India, viz., Tandon, V. (2003), Shomorendro (2003), Chinglenkhomba, A. (2007), Gyaneswori, I. (2007), Tarnita, Th. (2007), Zenith, Ng. (2009) and Lakshmipyari, W. (2012). However, a comprehensive account of nematodes found in this particular group of cold-blooded vertebrates of this region is still scanty.

Keeping in view that nematodes are important for species identification and of the rich wild-life of Manipur which might harbour numerous nematode species awaiting their discovery, the present work was undertaken to record and establish a systematic account of the nematode fauna of cold-blooded vertebrates of the state of Manipur. This would help in highlighting and understanding about the distribution range of these parasites in this typical group of animals.
The present work mainly focused on the taxonomy of the nematodes and the population dynamics due to seasonal variation of some selected nematode species. An attempt to prepare a host-parasite list was also made.

**The thesis comprises of two main chapters:**

The first chapter deals with the taxonomical studies of the nematodes found in different cold-blooded vertebrate hosts of Manipur. Morphological characteristics and dimensions of different nematode parasites found from diverse habitats and localities of Manipur are discussed under 14 families, 6 orders and 21 different genera. Detailed descriptions of the nematodes both known and new are provided with possible illustrations, photomicrographs, differential diagnosis of new species, details of the host and remarks.

The second chapter is divided into four sub-chapters. Sub-chapter (i), (ii) and (iii) deals with the population studies of parasitic nematodes infecting three common cold-blooded vertebrate hosts of Imphal valley, Manipur. Frequency of occurrence of both female and male parasitic nematodes were also analysed with a view to understand their prevalence and intensity in relation to environmental factors like temperature, rainfall, etc. and thereby the probable reasons are discussed.
The sub-chapter (iv) is a checklist of host-parasite list showing comprehensive report of the nematodes found in the cold-blooded vertebrates of Manipur.