CHAPTER I

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1.1. Introduction

Lizards were evolved on Earth 250 millions years ago (Ahmed et al., 2009). The inventory of lizards in India was started during British colonial period. Most of the reported lizards from Northeast India were described as new species. Most of the important expeditions were made by British herpetologists and employees of British Empire in Khasi Hills and Dafla Hills. The species studied were mostly from Khasi Hills and Dafla Hills. Thomas Jerdon (1811 -1872) made an important expedition in Khasi Hills which led to the discovery of Calotes jerdoni which was named after him. The species Calotes maria, Oriocalotes paulus, Cyrtodactylus khasiensis, Takydromus khasiensis, Daposia gracilis and Japalura planidorsata were described from Khasi Hills, Japalura andesoniana and Pseudocalotes austeniana were described from Dafla Hills and Draco norvillii, Takydromus haughtonianus, Sphenomorphus maculatus and Sphenomorphus courcyanum were described by British herpetologist from present day Assam. After the Independence of India, much attention was not given to the inventory of herpetofauna from Northeastern region of India. From 80’s onwards many workers from Zoological Survey of India (ZSI) and South India paid attention to the inventory of herpetofauna of Northeast India and made some significant discoveries. Das and Sengupta (2000) described a new species of lizard Cnemaspis assamensis from Assam. Pawar and Biswas (2001) first reported Ptychozoon lionotum from Mizoram which was a new addition to the lizard fauna of India. Das et al. (2009) recorded the occurrence of Calotes irawadi from Barail Hill range of Assam. Kunte and Manthey (2009) recorded Japalura sagittifera from Arunachal Pradesh. Mahony (2009) described a new species Japalura otai from Mizoram. Though, so many workers are working on the herpetofauna of Northeast India, still the fate of some species viz. Draco norvillii, Takydromus haughtonianus, Takydromus sexlineatus, Lygosoma bowringii, Pseudocalotes microlepis and Hemidactylus karenorum are still unknown.
Again, nobody initiated any ecological and taxonomical works on the lizards of Northeastern region.

According to Lewin (1986) tropical forests are the planet’s most biologically diverse ecosystems. Northeast India is one of the biodiversity hotspot areas that support tropical evergreen forests within India. In Assam, 59.4% of the total forest area is categorized as reserve forest (RF). Thus, it is convenient to concentrate the reserve forests as the study area for biodiversity in northeastern region of India (Sengupta et al., 2000). The Assam Valley Tropical Wet Evergreen Forest (Champion and Seth, 1968) of Jeypore is located in eastern Assam and among the last remaining lowland rain forests in northeastern India (Kakati, 2004). Faunal and floral characteristics of this reserve forests attracted biologists’ attentions since British colonial period to the recent times. Dendrelaphis biloreatus and Oligodon erythrorhachis were described from Namsang, Jeypore by British herpetologist Frank Wall (1908, 1910). Thereafter, no such investigation has been made by any herpetologist in this region (Islam and Saikia, 2013).

The inventory of highly rich lizard fauna in the sub-tropical forest of Assam are the result of few investigations and present day knowledge of the species are mainly based on the earlier studies (Gogoi et al., 2001). No detailed study has been carried out in Assam, although Purkayastha (2013) reported 32 species of lizards from Assam and 44 species of lizards were reported by Ahmed et al. (2009) from Northeast India (Islam and Saikia, 2013).

Again, the habitat selection is one of the most poorly understood ecological processes (Krebs, 2001) due to the complexity of factors involved on it (Fortin et al., 2008), that could influence the species assemblages. The suitability of a particular habitat is influenced by numerous variables operating at different spatial and temporal scales. Choice of habitat depends on factors such as temperature gradients, food and mate acquisition and self protection from the predators (Huey, 1991; Downes and Shine, 1998; Downes, 2001). In a habitat, these factors can be further specialized according to the needs of the animals through microhabitat selection (Huey et al., 1989; Kearney, 2001; Compton et al., 2002).
The identification of microhabitat preferences of the lizards is also important to understand the distributional status of lizards and their crucial situation to focus conservation efforts. Microhabitat may influence the use of refuge by lizards because, it affects both the thermal advantage provided by refuge relative to the environmental gradients of light and temperature (Thierry et al., 2009) and as well as food availability (Lettink and Seddon, 2007; Norbury et al., 2009). Habitat suitability of a species also changes over time in response to both natural and anthropogenic influences (George and Zack, 2001). Evaluating the effects of microhabitat variables on detection probabilities of animals is an important component for designing monitoring techniques (Lettink and Seddon, 2007).

Again, the Scincidae is the largest family of existing lizards and includes over 1578 species (Uetz et al., 2014), is thought to have originated in Africa and then diversified and spread through Asia and Australia to its current worldwide distribution (Greer, 1970). On the basis of morphological characters, Greer (1970) divided Scincidae family into four subfamilies viz. Scincinae, Acontinae, Feyliniinae, and Lygosominae. Of these, the Lygosominae contains over 600 species distributed mainly in temperate and tropical Asia, Australia, and central and southern Africa. It also occurs in Madagascar and the western Indian Oceanic Islands, Southeastern North America, and Central and South America, including the Caribbean islands (Greer, 1970; Matsui, 1992; Zug, 1993). Such a high species diversity and wide distribution make Lygosominae skinks attractive objects for phylogenetic, taxonomic and biogeographical studies (Greer, 1974; Ota et al., 1996).

Within Lygosominae skinks, three evolutionary lineages (i.e., Eugongylus, Mabuya, and Sphenomorphus groups) are recognized on morphological, karyological, and immunological point of view (King, 1973, 1990; Greer, 1979, 1989; Hardy, 1979; Baverstock and Donnellan, 1990; Donnellan, 1991a, b; Ota et al., 1988, 1991, 1995, 1996). Honda et al. (1999a, b) demonstrated the presence of three distinct lineages within the Mabuya group (i.e., Egernia, Lygosoma, and Mabuya sub-groups), although they failed to resolve the relationships among these subgroups in details. The Mabuya group is mainly distributed in temperate and tropical Asia, Central and Southern Africa, and Australia.
Mabuya, the largest genus of this group with broadest range, also occurs in Madagascar and South America including the West Indian Islands, but it is not distributed in Australia (Boulenger, 1887a; Matsui, 1992; Nussbaum and Raxworthy, 1994).

The genus Mabuya seems to have first emerged in South or Southeast Asia and then dispersed through Africa onto Madagascar and South America because, a few species from South and Southeast Asia exhibit most primitive states of characters among the existing Mabuya species (Greer, 1977). Although some authors (e.g., Greer, 1977) pointed out the possible non-monophyly of this genus due to its wide distribution and great morphological diversity and no such comprehensive phylogenetic analyses have ever been made for the genus and its relatives to verify the prediction (Honda et al., 1999b).

There have been a number of debates regarding the phylogenetic relationships and classification of Lygosominae skinks and most of relevant arguments have depended on morphological evidence (e.g., Mittleman, 1952; Greer, 1970, 1974, 1979; Horton, 1972, 1973). However, due to the scarcity of informative characters, it is not easy to formulate a sufficiently reliable phylogenetic hypothesis for this group solely on the morphological ground. Phylogenetic analyses on the basis of molecular data are, therefore, expected to contribute much to the solution of this problem (Honda et al., 1999b).

Until recently, the Mabuya skinks were the one of the largest genera of skinks with a wide distribution primarily in South America, Africa, and Asia. Mausfeld et al. (2002) analyzed the molecular data from mitochondrial 12S and 16S rRNA regions and recovering four monophyletic species groups within Mabuya, subsequently the genus splits into four corresponding genera based on the geographic distribution of each monophyletic clade. Asian species were placed in Eutropis, African and Malagasy species became Euprepis [and subsequently Trachylepis (Bauer, 2003)], the species from the Cape Verde islands were returned to Chioninia, while the South American species retained the same generic name as Mabuya (Whiting et al., 2006).
The present study mainly emphasized to evaluate the lizard diversity and natural history in Jeypore Reserve Forest of Assam for conservation. Knowledge of specific physical microhabitat characteristics are lacking for skink. A study on skink in Joypore Reserve Forest is necessary to understand the retreat sites. Skinks usually use leaflitters as a retreat site and this study will determines whether skinks select leaflitters nonrandomly at a microhabitat scale. The morphological study of skink is also lacking. Skink shows some variation among different geographical locations. The present studies will also covers the morphological characters of skink which will eventually help the future taxonomist to differentiate the different skink species and their morphological differences.

1.2. Objectives

The main objectives are as follows:-

i) To prepare the inventory and natural history notes of lizards in Jeypore Reserve Forest.

ii) To study the microhabitat used by each skink species in the study area and their community structure.

iii) To provide the taxonomic description of each skink species recorded in the study area.

1.3. Review of Literature

1.3.1. Inventory and Taxonomy

1.3.1a. History of lizard study in India

The knowledge on Sauria of India is satisfactory in terms of taxonomy but in case of ecology it is not satisfactory. The region receives herpetological attentions in the late 18th century. The earlier records of the saurian study in colonial India was by Patrick Russell (1796) from the costal Coromandal containing descriptions and drawings of the limbless
scincid, *Barkudia melanosticta* (Schneider, 1801) being the only lizard species. Later, Hardwicke in collaboration with Gray published illustrations to Indian Zoology which was based on the collections of Hardwick depicting 263 full length sketches with a number of close up drawings of heads and tails of the species, some having descriptions and counts.

E. Blyth had mainly worked on the reptiles of Andaman and Nicobar Islands and also visited some parts of Cherrapunji in Khasi Hills of Meghalaya (earlier Assam State) and published papers like (i) Notes on the fauna of Nicobar Island (Blyth, 1946) (ii) Notes on the collection of Mammalia, Birds and Reptiles procured at or near the station of Cherrapunji in the Khasia Hills, north of Sylhet (Blyth, 1851) and (iii) Notices and descriptions of various reptiles, new or little known (Blyth, 1853, 1854). T. C. Jerdon was an important contributor to herpetology of Eastern Himalayan region. He made collections from all over the India and the most important was the expeditions to the Himalayas and the Khasi Hills of Meghalaya. Jerdon’s important works include a series of papers that deal with his extensive collections from India describing many new species of amphibians and reptiles. He published papers like (i) Catalogue of reptiles inhibiting the Peninsular of India (Jerdon, 1853a, b) (ii) Notes on Indian herpetology (Jerdon, 1870). The major synthesis on reptiles, planned in collaboration with Albert Günther of the British Museum, where most of Jerdon’s specimens were deposited. Günther described new species from Jerdon’s last expedition.

F. Stoliczka mainly worked on the reptiles and amphibians of India, Malaya and Burma. He published papers and notes like (i) Notes on new or little known Indian lizards (Stoliczka, 1871) (ii) Notes on reptilian and amphibian fauna of Kachh (Stoliczka, 1872a) (iii) Notes on various new or little known Indian lizards (Stoliczka, 1872b) (iv) Notes on some new species of reptilian and amphibian, collected by Dr. W. Waagen in North-western Panjab (Stoliczka, 1872c) (v) Notes on some Andamanese and Nicobarese reptiles with description of three species of lizards (Stoliczka, 1973). The genus *Stoliczka* was named after him. R. H. Beddome published many papers on herpetofauna of South India, describing many new species, especially of uropeltids and lizards. He published papers like ‘Description of new reptiles from Madras Presidency (Beddome, 1870, 1940). He also
published note on some reptiles of South India (Beddome, 1962). W. Theobald offered his
service to John Anderson to compile a catalogue of the herpetological holdings of the
museum of Calcutta. He also made some radical changes in the higher level of
classification. Theobald (1868a, b) published catalogue of reptiles in the museum of the
Asiatic Society of Bengal. He also published catalogue on Reptiles of British India in the
Museum of Asiatic Society of Bengal (Theobald, 1876).

A. Günther mostly worked on the collections at the British museum comprising the
British Indian Reptiles mainly from the parts of Siam, Nepal, Bengal and Ceylon. Günther
(1864) published the first description on the reptilian fauna of India in his book titled “The
Reptiles of British India” describing as many as 140 species of lizards. He also published
second report on collections of Indian Reptiles obtained by the British Museum (Günther,
1875). Blanford published his works on the reptilian and amphibian from central India,
Kashmir and Ladakh, and Ellor and Dumaguden in the form of (i) Note on some Reptiles
and Amphibia from Central India (Günther, 1870) (ii) List of Reptiles and Amphibian
Collected by Stoliczka in Kashmir, Ladakh, Eastern Turkestan and Wakhan with
descriptions of new species (Günther, 1875a, “1875”b, 1876) (iii) Notes on reptilia from
the Himalayas and Assam (Günther, 1878) (iv) Notes on reptiles (Günther, 1879a, b).
Boulenger (1890) had provided the description of 226 species of lizards in his published
book “Fauna of British India” in the volume of Reptiles and Batrachians. Boulenger’s
detailed work on the reptilian fauna India, Nepal, Sind, Burma, Ceylon, Siam and Malay
Peninsula, contributed to the herpetofaunal knowledge of India. His work also includes (i)
An account of the reptilia obtained of Tenasserim, by M.L. Fea of the Genoa civic
Museum (Boulenger, 1887b) (ii) An account of the reptilia obtained in Burma, north of
Tenasserim, by M.L. Fea of the Genoa civic Museum (Boulenger, 1888) (iii) On new or
little known Indian and Malayan Reptiles and Batrachians (Boulenger, 1891) (iv) A list of
the Reptiles obtained by N.H. Stevens in Upper Assam and the Eastern Himalayas
(Boulenger, 1913).

Smith analysed the old records in the field of taxonomy for the Amphibians and the
Reptiles and came up with 4 volumes of books on herpetology as fauna of British India
series. The publication of M. A. Smith’s “Fauna of British India” (Smith, 1935a), was the landmark in the Indian Sauriology which is still considered as most comprehensive contribution on lizards of India and adjacent region. He provided detailed accounts on 297 species of lizards, of which 248 species occurring in Indian Empire. He also published many notes such as (i) Notes on Reptiles and Batrachians from Siam and Indo China (Smith, 1923) (ii) On collection of amphibians, reptiles from the upper reaches of Brahmaputra (Smith, 1929) (iii) The Amphibians and Reptiles obtained by Captain Kingdom Ward in Upper Burma, Assam and S.W. Tibet (Smith, 1935b) (iv) The herpetology of the Andaman and Nicobar Islands (Smith, 1941) (v) The history of herpetology in India (Smith, 1952). By all means the 2nd volume of the lizards in the form of “Fauna of British India” series is still standard and most popular sources of reference amongst the lizard taxonomist of South Asia.

Indraneil Das also made significant contribution to the present day herpetology of India by his diversified publications of national and international importance, particularly his book of “Biogeography of the reptiles of South Asia” (Das, 1996) and “A photographic guide to snakes and other reptiles of India” (Das, 2002) which is one of the most popular pictorial guide on the Reptiles of India. His papers like (i) The reptiles of South Asia: checklist and distributional summary (Das, 1994) (ii) Checklist of the reptiles of India with English common names (Das, 1997) and (iii) Growth of knowledge on the reptiles of India with introduction to systematics, taxonomy and nomenclature (Das, 2003) boosted the herpetological knowledge of India. Dutta et al. (2009) published a book on Amphians and Reptiles of Simlipal Biosphere Reserve and gave description of 20 lizard species. Venugopal (2010) reported 201 lizards as valid distribution in India among the 230 species reported by other authors based on publication reports.

1.3.1b. History of lizard study in Northeast India

Significant contributions on the sauriological studies were also available in Northeast India. The main collection of lizards was seen in the zoological museum at the Zoological Survey of India office in Shillong and in Kolkata branch, where the collections were made during British India periods. These museums harbour all zoological collections from the early parts of 19th Century. Shillong had been the winter capital of than British Rule and so all sort of collection made during different surveys were deposited at Shillong. Accordingly, Zoological Survey of India at Shillong has made valuable contribution in this field of lizards.

The History of herpetological exploration in Northeast India was begun as early as 1784 with the establishment of the Asiatic Society in Calcutta. Thomas Jerdon (1811-1872) collected many herpetological specimens and deposited to the Society and the most important works of Jerdon includes a series of two papers that deal with his expedition findings from Khasi Hills and other Himalayan Region. That led to the discovery of Calotes jerdoni an agamid from Khasi hills and named after him with many other new

1.3.2. Microhabitat and Community structure

The study on lizard microhabitats and community structure was done by so many workers. But in India it is evident that, lack of contribution to the habitat ecology of Indian lizards was done. E. Pianka was the pioneer in the field of microhabitat study and community structure. Pianka published papers like the structure of lizard communities (1973), niche overlap and diffuse competition (1974) and guild structure in desert lizards (1980). Menke (2003) published lizard community structure across a grassland- creosote bush ecotone in the Chihuahuan Desert. Howard *et al.* (2003) published a paper on structural aspects of microhabitat selection by the skink *Lampropholis delicata*. Pernetta *et
al. (2005) studied macro- and microhabitat use of Telfair's skink (*Leiolopisma telfairii*) on Round Island, Mauritius: implication for their translocations. Buckley and Jetz (2009) studied the lizard community structure along environmental gradients.

The herpetofaunal exploration in Northeast India is still considered as preliminary. This is evident from the literature that new species and new records of sightings are continuously been added to the lizards of Northeast India. Thus, a detail work on the systematics and ecology on the lizards is felt necessary. This work provides updated taxonomic study of each species found in the study area with habitat ecology data and that will contribute towards the understanding of the lizards of Northeast India.