3.0 Review of Literature

This review of literature deals with tropics pertaining to spider distribution, diversity, taxonomy, guild structure, predatory potential, fauna, and flora.

3.1 Diversity of Spiders

Spiders play many important roles in the ecosystem as predators and source of food as prey for other animals. Spiders are one of the very diverse groups of animals, which have attained Seventh Rank in global diversity (Sebastian and Peter, 2009). They have attracted the attention of naturalists from early times (Linnaeus, 1758; Loksa, 1969; Fabricius, 1793) and later in India (Stoliczka, 1869; Karsch, 1873; Herman, 1879; Simon, 1887; Pocock, 1900; Sherriffs, 1919; Gravely, 1921; Dyal, 1935), and enormous amount of literature has been accumulated.

Compared to various other animal groups in India, limited work has been carried out and about spiders, in recent years the considerable study was made by scientists and researchers namely Denis (1958), Tikader (1963), Brady (1964), Andreeva and Tyschchenko (1970), Patel (1973), Gajbe (1979), Barrion and Litsinger (1981a), Biswas (1984), Sterghiou (1985), Proszynski (1987), Dondale and Render (1990), Ganeshkumar and Mohanasundaram (1998), Jose and Sebastian (2001), Ghavami (2008) Sugumaran (2010), Siliwal et al., (2011) and Platnick (2013).

3.1.1 Spider diversity at the global level

Dondale (1979) had recorded that 12,000 species of spiders approximately occur in the world out of which only one fourth of the total fauna has been recorded. Platnick (2006) launched “World Spider Catalogue” a website and described the spiders with a total of 110 families representing 3,618 genera and 39,112 species. The goblin spider (Oonopidae) under genus *Gamasomorpha* currently contains 56 species with a wide distribution found in United States of America, Panama, South America, China, Africa, Indonesia and

### 3.1.1.1 Diversity of spiders in Africa

An attempt was made by Alderweireldt and Jocque (1993) to analyze the status of the diversity of the spider (Araneae) known to occur in Africa and an estimate of nearly 6,000 species had been recorded. Whitemore et al., (2002) described 4,832 numbers of spiders including 268 species belonging to 38 families in Savanna reserve of South Africa.

Warui (2004) described a total of 10,487 numbers of spiders including 132 species belonging to 30 families in Mpala Research Center of central Kenya. Haddad and Russel-Smith (2009) documented 493 spider species (54 families) from Mkomazi Game Reserve and a total of 431 species (46 families) have been recorded from Ndumo Game Reserve in two Savannah habitats along the eastern coastal plain of Africa. Haddad et al., (2009) carried out a study to enumerated a total of 2,808 spiders belonging to 36 families, 144 genera and 251 species in sand forest, Maputaland, South Africa.

Zongo et al., (2009) described 12 families and 24 genera of spiders in two different plants of Burkina Faso in West Africa. The most frequently encountered families are Thomisidae, Salticidae, Araneidae and Theridiidae in pure Sorghum plant. The Predominant families are Linyphiidae, Pisauridae and Theridiidae in pure Cowpea plant. Mukherjee et al., (2010) studied a total of 260 spiders belonging to 10 families and recorded in Robben Island, South Africa.

The distribution of spider species in the South African Savanna Biome represented 1,230 species belonging to 62 families and 381 genera were studied by Foord et al., (2011). Sallam (2012) investigated one male and one female of Hersilia caudata Savigny (Araneae: Hersiliidae) that were re-described from the orange orchards of Egypt. Dippenaar-Schoeman et al., (2013) documented 51 families with 238 genera and 413 species of spiders were recorded from crops in South Africa. A total of 43 spider families under 60 genera were recorded from Motane grassland management practices in South Africa by Jansen et al., (2013).
3.1.1.2 Diversity of spiders in North America

The spider genus *Agroeca* is reported to be in North America with four species namely *Agroeca pratensis* (Emerton), *A. ornata* (Banks), *A. brunnea* (Blackwall) and *A. minuta* (Banks) (Kaston, 1938) and Kagon (1943) prepared a list of spider fauna and observed that the population density of spiders was about 3,374 in number per acre in the cotton fields of Central Texas. Bishop (1949) had reported 11 species of spiders belonging to five families in Nueltin Lake, Keewatin, Canada. Dondale (1956) documented a total of 80 species of spiders from the apple trees in Nova Scotia.

Agrew *et al.*, (1985) reported a total of 134 spider species comprising 79 genera and 18 families in the peanut fields of Erath and Comanche Countries in the Texas west cross-Timber region. The most frequently encountered families are Araneidae, Clubionidae, Dictynidae, Gnaphosidae, Linyphiidae, Lycosidae, Philodromidae, Theridiidae and Thomisidae.

Oraze *et al.*, (1988) classified 30,000 spider specimens representing 11 families, 22 genera and species in the flooded rice fields of Northern California. Thirty-three species of spiders were recorded on the Belcher Islands of Canada of which 23 belonged to the family Linyphiidae, six to the Linyphiinae and 17 to the Erigoninae of two sub families. Four species of Lycosidae and one each of Gnaphosidae, Clubionidae, Dictynidae, Theridiidae, Thomisidae and Philodromidae were studied by Koponen (1992).

Muzika and Twery (1997) documented 24 families of spiders by adopting pit fall traps in an oak-mixed hardwood forest in North Central West Virginia, North America. Buddle (2001) reported 10,000 spiders representing 100 species from downed woody material in a deciduous forest in Central Alberta, Canada. Brierton *et al.*, (2003) investigated about 712 specimens consisting of 12 families, 27 genera and 40 species. Among them the most abundant species, *Pelegrina proterva* (Walckenaer) was recorded from Northern and Central New York.
Pinkus-Rendon et al., (2006a) determined 2261 individual spiders, representing 20 families, 56 genera and 97 species in coffee plantations of different managements in Southeast Mexico. Pinkus-Rendon et al., (2006b) recorded 115 spider species during dry and rainy seasons in Chiapas, Mexico. Paquin et al., (2008) reported five families representing eight species of spiders namely Araneus guttulatus (Walckenaer), Eustala cepina (Walckenaer), Mastophora hutchinsoni (Gertsch), Disembolus sacerdotalis (Crosby and Bishop), Admestina wheeleri (Peckham and Peckham), Leucauge venusta (Walckenaer), Dipoena appalachia (Levi) and Keijia alabamensis (Gertsch and Archer) for the first time in Quebec, Canada. Miliczky et al., (2008) obtained details about 690 specimens belonging to 12 families in 28 genera and 43 species of spiders from apple and pear orchards in South-Central Washington.

Petillon and Garbutt (2008) discussed a total of 291 adult spiders belonging to seven families and 27 species that were caught in natural and restored sites in 2005. Among them Arctosa fulvolineata (Lycosid) and Enoplogntha mordax (Theridiid) are considered as rarely encountered species. The genus Tinus is currently represented by seven species in the western hemisphere and found ranging from the Southwestern USA to Panama and one is located in Cuba and Hispaniola (Carico, 2008).

Bradley et al., (2008) described a total of 1,541 spiders representing 94 species captured from Marion Campus in Ohio. Richman (2008) presented nine species of genus Sassacus in North America. The most frequently encountered species are Sassacus papenhoei (Peckham and Peckham), Sassacus paiutus (Gertsch), Sassacus samalayucae (Richman), Sassacus cyaneus (Hentz), Sassacus alboguttatus (Pickard), Sassacus aztecus (Richman), Sassacus barbipes (Peckham and Peckham) and Sassacus lirios (Richman).

Platnick and Duperre (2008) observed details of a total of 23 species that are placed in the goblin spider genus Scaphiella and two of those species are S. maculata (Biraben) from Argentina and S. ula (Suman) from Hawaii Island. The goblin spiders (Oonopidae) are one of the target taxa because the distribution
range of the species tends to be small, and the group has the potential to provide amount of information on areas on endemism on a worldwide scale (Plantnick and Duperre, 2009). Snowman et al., (2010) reported around 1,000 obligate cave species, one terrestrial obligate cave species (Troglobites) and aquatic cave species (Stygobites) from the United States.

The spiders found in northwestern Louisiana during the last 40 years have resulted in the recognition of several new records of spiders for the state of Louisiana (34 species), northern Louisiana (14) and northwestern Louisiana (15). These species are discussed as the major additions to their geographic distributions by Hardy (2010). Pinzon et al., (2012) reported 9,288 ground dwelling spiders representing 15 families and 164 species in boreal forest from Canada. Kerzicnik et al., (2013) have described about 119 species of spider belonging to 19 families, recorded from Semiarid Eastern Colorado agroecosystem in United States.

3.1.1.3 Diversity of spiders in South America

Ferretti et al., (2010) documented a total of 402 individuals of the Mygalomorphae spiders belonging to four families namely Actinopus sp (Actinopodidae), Stenoterommata platensis (Nemesiidae), Xenonemesia platensis (Microstigmatidae) and Catumiri argentinense (Theraphosidae) recorded from Martin Garcia Island in Argentina. Platnick and Duperre (2010) observed 61 species of goblin spider genus Scaphiella in Latin America and the West Indies.

Melo et al., (2010) recorded 3,201 adult spiders belonging to 39 families, 143 genera and 170 species in Brazilian Atlantic forest, Brazil. Buckup et al., (2010) recorded 808 spiders of 51 families from the State of Rio Grande do Sul, Brazil. Rodrigues and Mendonca (2011) observed a total of 65 spider species from 20 genera collected from inventory of riparian forests in southern Brazil. Rodrigues et al., (2012) described 14 species and two species of the spider genus Sphecozone (Araneae: Linyphiidae) as reported was considered as the first time recorded in Brazil. They are Sphecozone rostrata and Sphecozone personata.
3.1.1.4 Diversity of spiders in Europe

Bultman and Uetz (1982) represented a total of 568 individuals belonging to 41 species and seven families of wandering spiders from three communities representing points on a successional gradient from western Michigan near the city of Holland. Heimer and Nentwig (1991) reported 1,100 species of spiders from Central Europe. Kula (1997) recorded 3,143 spiders representing 108 species from substitute birch stands in the Krusne hory Mountains and found in Northern Bohemia. Marc and Canard (1997) investigated and collected a total of 1,000 individuals of spiders and 39 species belonging to 14 families from apple orchards in the western part of France.

Chatzaki et al., (1998) carried out a study, in which a total of 1,845 specimens belonging to 21 families; 61 spider species had been recorded in seasonal activity of the ground spider fauna in a Mediterranean ecosystem, Mt. Youchtas, Greece. Downie et al., (1998) listed a total number of 33,123 individual adult spiders of 140 species from 16 families that were captured 1,996 from Scottish agricultural land, Scotland. Bell et al., (1999) discussed 7,529 individuals representing 147 species belonging to 17 families of spiders from wooden riparian zone of three rivers in the Western Europe.

Haughton et al., (1999) documented a total of 23,393 spiders and sampled the web-spinners representing more than 90% of the individual species in airable field margins, Loddington, England. Pekar (1999) observed 27 species of spiders that were found over winter on orchards tree trunks from Czech Republic. Moretti (2000) had determined about 143 spider species and 10,196 individuals. Of these, 64 species were represented by less than five individuals, and 39 species were observed from Canton Ticino in Southern Switzerland.

Galle and Urak (2001) observed 32 spider species of 11 families from Mures river Valley and recorded *Gnaphosa nigerima* (Koch) and *Centromerus laevitarsis* (Simon) as new ones from Romania. Koponen (2002) listed 17,360 ground living spiders in bogs from different Zones of Northern Europe.
The abundant typical species are *Pirata uliginosus*, *Pardosa sphagnicola*, *P. hyperborea*, *Hilaira nubigena* and *Pardosa atrata*.


Koponen (2005) investigated 91 species of ground-living spiders, 70 at the burned site and 59 at the unburned control site from Torronsuo National Park, Finland. Pekar (2005) carried out study of more than 1,600 individual spiders in sunflowers plant from Czech Republic. The majority of spiders (99%) described by Theridiids species are *Theridion impressum* (L.Koch) and *Neottiurea bimaculata* (Linnaeus).

Wang *et al.*, (2010) listed a total of seven species. The coelotine genus *Eurocoelotes* spider (Araneae: Amaurobiidae) species are *E. falciger* (Kulczynski), *E. anoplus* (Kulczynski), *E. gasperinii* (Simon), *E. brevispinus* (Deltshev and Dinitrov), *E. microlepidus* (de Blauwe), *E. paramicrolepidus* (de Blauwe) and *E. xinpingwangi* (Deltshev) from two regions of Croatia and Greece.


3.1.1.5 Diversity of spiders in Australia

Churchill (1998) observed a total of 8,625 spiders representing 130 species belonging to 33 families and 97 genera in Northern Territory, Australia. Pearce et al., (2004) obtained information from the study on 102 morphospecies spider belonging to 28 families in two summer seasons from soybean crops in south-east Queensland, Australia.

The effect of cultivation on spider diversity was assessed at three sites before and after cultivation in autumn from Waikato in New Zealand as reported by Clark et al., (2004). Richardson et al., (2006) listed a total of 4,140 localities for spider specimens belonging to 51 genera (Araneae: Salticidae) to be found at landscape regions across Australia. Cardosa et al., (2008) documented 10,808 adult spiders representing 204 species from Mediterranean Oak forest site estimated using semi-quantitative sampling method.

A total of 123 spider species recorded from Western Samoa was studied by Marples (2008). Harms and Harvey (2009) recorded five species and all belonging to the genus Australomimetus (Heimer) from Tasmania, Australia. Among them dominantly recorded species are Australomimetus maculosus (Rainbow), A. tasmaniensis (Hickman), A. aurioculatus (Hickman) A. audax (Hickman) and A. mendax (Hickman).
3.1.1.6 Diversity of spiders in Asia

Okuma (1968) investigated about 46 species of 13 families of spiders in Thailand and 77 species of 13 families from the paddy fields in Japan. Okuma et al., (1978) listed a total of 1,347 specimens, 12 families consisting 21 species of spiders distributed in paddy fields in Suweon from Korea.

Barrion and Litsinger (1981a) documented 32 spider species comprising 21 genera under nine families in rice agroecosystems (Dryland) from Philippine. The most dominant species were *Tetragnatha mandibulata* (Walckenaer), *T. javana* (Thorell) *Araneus inustus* (L.Koch) and *oxyopes javanus* (Thorell). Barrion and Litsinger (1981b) reported that *Hippasa holmerae* (Thorell) (Araneae: Lycosidae) inhabited rice-fields in the Philippines. Barrion and Litsinger (1984) investigated the spider fauna of rice fields in Philippines wetland ecosystem and recorded 51 spider species. Among these, there were orb weaving spiders like *Tetragnatha javana* (Thorell), *Tetragnatha japonica* (Bosenberg & Strand), *Leucauge decorata* (Blackwall), *Tetragnatha mandibulata* (Walckenaer), *Araneus inustus* (L.Koch), *Argiope catenulata* (Doleschall) and *Neoscona theis* (Walckenaer).

Kamal et al., (1990) described 12 species belonging to 10 genera under eight families in and around the Bangladesh rice research Institute farm. The more prevalent species are: *O. javanus, T. javana, L. pseudoannulata* and *Plexippus* sp. Twenty nine species of spiders belonging to 16 genera under 10 families were recorded from rice field of Shikerpur of Jhenidah district in Bangladesh by Kamal et al., (1992).

Russia; the recorded families were Theridiidae, Linyphiidae, Tetragnathidae, Araneidae, Lycosidae, Dictynidae, Titanoecidae, Clubionidae, Gnaphosidae, Zodariidae, Philodromidae, Thomisidae and Salticidae.

Bang et al., (1999) recorded a total of 121 species belonging to 77 families of spiders in the paddy fields of Korea. Song et al., (2002) documented a total of 310 species representing 39 families, 186 genera of spiders in Singapore. Sorensen (2004) determined a total of 5,233 adult spiders, representing 28 families and 149 species. Among them thirty-five species were singletones while 18 were doubletones from canopy of a Montane forest in Tanzania.

Lee et al., (2004) observed details on 189 female specimens of *Nephila pilipes* from 18 localities in Taiwan and nearby coastal Islands of two localities from the Ryukyu and 4 localities from South Western mainland China. Levy (2005) presented about two spider genera Singa and Hypsosinga (Araneae: Araneidae) from Israel. The most frequently encountered species are *Singa neta*, *Singa affinis* (O.P. Cambridge), *Singa attica* (Simon) and *Hypsosinga albovittata* (Westring).

Zhang et al., (2006) investigated seven spider species belonging to three genera (Araneae: Pholcidae) from Tibet, China and recorded four new species. They are *Pholcus medog*, *P. zham*, *Belisana gyirong* and *B. mainling*. Shuang-lin and Bo-Ping (2006) described a total of 2,164 specimens belonging to 43 species and 19 families in soil spider assemblages of three natural secondary forests of Ziwuling in Gansu, China.

spiders (Araneae: Salticidae) from the Bureinsky Nature Reserve and adjacent territories in the Far East Russia had been presented by Trilikauskas in 2007.

Ghavami et al., (2007) investigated a total of 45 species and 46 genera belonging to 18 families of spiders from Olive orchards in Northern part of Iran. Ghavami and Amooz (2008) reported a total of 1,310 specimens representing 34 species belonging to 32 genera and 13 families of spider fauna of Citrus Orchards in Northern part of Iran. Jung et al., (2008) estimated a total of 5,126 individuals of 103 species in Levee, 3,752 individuals of 124 species in Dike, 4,857 individuals of 121 species in Hillock and 3,710 individuals of 107 species in the streamside in four different sites from Korea.

Opatovsky et al., (2010) investigated a total of 1,377 adult, spiders in the samples representing 64 species in 17 families. Out of these, 21 species in eight families had activity- densities greater than 1% of the total number of adults from northwestern Negev desert, Israel. The genus *Ischnothyreus* is reported for the first time from Borneo with 17 new species of spiders viz., *I. balu*, *I. barus*, *I. danum*, *I. deelemana*, *I. elvis*, *I. falcifer*, *I. flabellifer*, *I. flippi*, *I. florifer*, *I. fobor*, *I. hooki*, *I. jojo*, *I. kalimantan*, *I. matang*, *I. mulumi*, *I. rex* and *I. serapi* (Kranz-Baltensperger, 2011).

Jager and Praxaysombath (2011) obtained 150 spider species from Southern Laos and recorded one new species called *Selenops muehlmannorum*. Ghaffar et al., (2011) investigated a total of 3817 and 3554 spiders belonging to 15 and 13 families, 36 and 35 genera under 81 and 80 species in citrus and guava trees from foliage spider fauna in the Province of Punjab of Pakistan. The spider fauna of Maldives is not rich when compared with many other tropical Islands. Sunil (2012) carried out 57 species of spiders belonging to 35 genera and 17 families from Maldives Islands in Indian Ocean.

3.1.2 Spider diversity in India

Tikader (1970) stated that 65 spider species in 33 genera were distributed in the families are Uloboridae, Homalonychidae, Theridiidae, Linyphiidae, Argiopidae, Thomisidae, Agelenidae, Hahniidae, Pisauridae, Lycosidae and
Oxyopidae to be found in Sikkim. Tikader (1977) presented 58 species under 41 genera of 20 families from the Andaman and Nicobar Islands in the Indian Ocean out of which 26 species were new to science. Gupta et al., (1986) obtained information about 15 species comprising 11 genera under 6 families of spiders from Ranga Reddy District in Andra Pradesh. Bharadwaj and Pawar (1987) documented a total of 432 species belonging to 131 genera under 27 families in the rice land of Madhya Pradesh.


Sebastian et al., (2005a) described a total of 1,130 individual spiders belonging to 92 species, 47 genera and 16 families in Central Kerala. The faunistic survey comprised 51 species belonging to 40 genera and 16 families of spiders in Mangalavanam, an ecosensitive mangrove forest in Cochin, Kerala as reported by (Sebastian et al., 2005b). Jose et al., (2008) investigated 147 species of spiders belonging to 82 genera and 22 families from Parambikulam Wildlife Sanctuary in the Western Ghats of Kerala.

Sen et al., (2009) recognized a total of 24 crab spider species belonging to 12 genera and after an analysis of the zoogeographical distribution of the recorded species revealed that the spider fauna was largely composed of oriental (100%), and Malayan (12.5%) elements from Reserve forest of Dooars in West Bengal. Sen et al., (2010) described 23 spider taxa belonging to 15 species and 18 genera from Senchal Wildlife Sanctuary and Neora Valley National Park in Darjeeling. Sharma et al., (2010) observed 117 specimens representing 44 species belonging to 12 families of spiders in Narmada River at Rajghat, Madhya Pradesh.
Quasin and Uniyal (2011) reported a total of 244 species of spiders belonging to 108 genera and 33 families in Nanda Devi Biosphere Reserve, Western Himalaya. Grismado et al., (2011) carried out investigation on five spider species from Southwestern India. Among them five species are *Aprusia strenuous* (Simon), *Ischnothyreus vestigator* (Simon), *Aprusia veddah* (Grismado and Deeleman), *Aprusia kataragama* (Grismado and Deeleman) and *Aprusia kerala* (Grismado and Deeleman).

Hippargi et al., (2011) discussed 19 spider species from Lonar Crater Sanctuary, 25 from Melghat Sanctuary and 31 from Southern tropical thorn forest. They were all recorded from three ecosystems of Maharashtra. Bhatkar (2011) listed 17 different families from Wan Sanctuary of Melghat tiger reserve, Maharashtra. The most frequently abundant families are Araneidae, Lycosidae, Salticidae, Thomisidae, Tetragnathidae, Nephilidae, Uloboridae and Eresidae. The survey of spiders from Toranmal Sanctuary in Maharashtra was carried out 117 spider species from 20 families and 55 genera are recorded (Archana, 2011).

The distribution of spider *Thelyphonus sepiaris* (Butler) was recorded for the first time in Madhya Pradesh by Talmale et al., (2012). Sachin (2012) documented a total of 117 spider species under 58 genera of 20 families which are recorded formally from the Jabalpur district of Madhya Pradesh. Chetia and Kalita (2012) described a total of 95 species representing 18 families and 56 genera from Gibbon wildlife Sanctuary, Assam. The updated spider checklist from India given by Keswani et al., (2012) shows that 1,685 species of spiders are recorded now from India. They belong to two infraorders, Mygalomorphae and Araneomorphae, 60 families and 438 genera.

### 3.1.3 Spider diversity in Tamil Nadu

Nirmala et al., (1991) listed 18 spider species under eight families of which 14 species were reported for the first time in the rice fields of Tamil Nadu. Shunmugavelu (1995) carried out the census of the spider *Crossopriza lyoni* (Blackwall) in the betelvine agroecosystem of Sholavandhan in Madurai district.
Sugumaran et al., (2007) reported a total of 265 spider individuals representing 38 species belonging to 13 families in horticultural crop of Yercaud Hills, near Salem. Premalatha (2007) observed details about a total of 984 specimens representing eight families, nine genera and 12 species of spiders in Ayyanar Hills Forest Reserve, in Rajapalayam, Tamil Nadu. The most frequently encountered species are Stegodypus tibialis (O.P.Cambridge), Nephila pilipes (Fabricius), Nephila clavata (L. Koch), Argiope catenulata (Doleschall), Smeringopus elongatus (Vinson), Crossopriza lyoni (Blackwall), Hersilia savignyi (Lucas), Hippasa pantherina (Pocock), Peucetia viridana (Stoliczka), Heteropoda sexpunctata, Heteropoda leprosa (Simon) and Heteropoda subtilis (Karsch).

Senthilkumar and Regupathy (2008) discovered 10 species of spiders belonging to seven families and eight genera in coffee plantation of Yercaud, Tamil Nadu. Among them, Telamonia dimitdiata (Simon) dominated throughout the season and it was co-dominated by Clubiona sp. and Linyphia sp. As part of this study, Shunmugavelu and Karthikeyani (2010a; 2010b) documented 12 species under seven families of spiders from Kumbakarai Falls, Theni district. Vinoth Kumar et al., (2010) stated that six species of spiders viz., Peucetia viridans (Hentz), Oxyopes sp., Argiope sp., Tetragnatha sp., Clubiona sp. and Thomisus sp. were found in the cotton ecosystem in Coimbatore. Sugumaran et al., (2010) reported 50 species belonging to 17 families in different places of the Shevaroy Hills, near Salem.

Umarani and Shunmugavelu (2010) documented 634 specimens in the Palani hills representing the family Araneidae which includes six genera and seven species of spiders. The most frequently encountered species are Araneus cucurbitinus (Simon), Argiope pulchella (Thorell), Cyclosa bifida (Doleschall), Leucacge decorata (Blackwall), Neoscona theis (Walckenaer), Neoscana nautica (L.Koch) and Nephila pilipes (Fabricius). Ganesan and Shunmugavelu (2012) recorded a faunistic survey of 25 species of spiders belonging to 21 genera and 10 families recorded from Perumalmalai forest area, Kodaikanal hills, Tamil Nadu during December 2009-May 2012.
3.2 Taxonomy of spiders

Taxonomy is the only way of understanding the countless species diversity of life (Sorensen, 2004 and Ghavami et al., 2007).

3.2.1 Spider taxonomy at global level

3.2.1.1 Spider taxonomy in Africa

A new species of Archaeodictyna ulova (Araneae: Dictynidae) was found in the communal retreats of two species of group-living Eresid spiders, Stegodyphus mimosarum (Pavesi) and Stegodyphus dumicola (Pocock) in Natal and eastern Transvaal regions of South Africa as reported by Griswold and Meikle-Griswold (1987).

The new spider family (Araneae: Chummidae) from the Eastern Cape region in South Africa takes new genus Chumma and is represented by two species viz: C. inquieta sp. nov. and C. gastroperforata sp. nov. as reported by Jocque (2001). Cumming and Wesolowska (2004) secured 40 Salticid spider species, 18 genus belonging to 29 genera determined five new spider (Araneae: Linyphiidae) species i.e., Agnyphantes assemblage in suburban from Zimbabwe.

Kuntner and Coddington (2009) discovered a new spider of the giant Nephila (Orb weaver) species in South Africa and the Island of Madagascar. Wang and Li (2011) observed three new species of the family Telemidae from western Africa. They include Cangoderces christae sp. nov. and Seychellia jeremyi sp. nov. from Cote d’Ivoire; Cangoderces milani sp. nov. from Cameroon, Africa.

3.2.1.2 Spider taxonomy in North America

Valdez-Mondragon (2009) studied two new species of the spider genus (Araneae: Ochyrocera) from Mexico and the recorded species are *Ochyrocera chiapas* and *Ochyrocera arietina*. Larrivee and Borkent (2009) observed two species of spiders in Salticidae species namely *Pelegrina proterva* (Walckenaer) and *Eris militaris* (Hentz) in north temperate hardwood forest at the Morgan Arboretum, Quebec and Canada.

Nieto-Castaneda and Jimenez-Jimenez (2009) discussed that a morphological and ecological differentiation between two desert wandering spider (Araneae: Miturgidae) species in Sonoran desert, North America. The recorded species are *Syspira tigrina* (Simon) and *Syspira longipes* (Simon) Richman (2010) recorded a new species, *Hentzia fimbriata* (F.O. Pickard-cambridge) and *Hentzia palmarum* (Hentz) from the United States. Sanchez-Ruiz *et al.*, (2010) reported 9 new species and all belong to the new genus of the spider family Caponiidae (Araneae: Haplogynae) from the West Indies. The recorded species are *C. bimini*, *C. andersoni*, *C. armasi*, *C. alayoni*, *C. juragua*, *C. granpiedra*, *C. terueli*, *C. tortuguilla* and *C. vega*.

### 3.2.1.3 Spider taxonomy in South America

A new spider species of *Loxosceles puortoi* (Araneae: Sicariidae) described from Palmas in Brazil was reported by Martins *et al.*, (2002). Two new genera in the spider family Trechaleidae, Trechaleoides and Paratrechalea as found in South America were described by Carico (2005). Polotow and Brescovit (2009) investigated a new genus *Toca* and proposed to include two new species like *T. bossanova* from Rio de Janeiro, Brazil and *T. samba* from Parana and Minas Gerais, Brazil.

Carico and Silva (2010) discovered one new spider species and that is *Trechalea rothi* (Araneae: Trechaleidae) found in Colombia in South America. A new spider genus, *Birabenella* (Araneae: Oonopidae) found in Argentina and Chile has been recorded. The four new species are *B. homonota*, *B. elqui*, *B. pizarroi* and *B. argentina*. They were described by Grismado and Cristian (2010).
Three new species from Northeastern Brazil are described and included in the newly proposed genus *Macutula* (Araneae: Salticidae). The type species *M. aracoiaba* and *M. caruaru* are described from the state of Pernambuco, while *M. santana* from the state of Bahia by Ruiz (2011). Ott and Rodrigues (2011) investigated for the first time the female spider of *Eilica pomposa* (Araneae: Gnaphosidae) and presented notes on its natural history and distribution in Brazil. Silva and Lise (2011a) stated that two new species of spider *Dossenus* (Araneae: Trechaleidae) *D. marginatus* and *D. guapore* were recorded from Northern Brazil.

Silva and Lise (2011b) listed seven new species of the spider genus *Dossenus* (Araneae: Trechaleidae) from Central and South America. The described species are *Enna carinata*, *E. triste*, *E. caricoi*, *E. venezuelana*, *E. silvae*, *E. frijoles*, and *E. zurqui*. Piacentini (2011) described three new species of Wolf spider (Araneae: Lycosidae) *Hippasella alhue* from the temperate Andean forest in the Argentinean Provinces, *Aglaoctenus yacytata* from the rain forests in Misiones Province and *A. puyen* from the temperate Andean forest in Rio Negro province in Argentina.

The haplogyne spider genus *Nopsides* (Araneae: Caponiidae) as recorded from the Mexican Mainland as well as the Baja Peninsula and Peru is reported by (Jimenez et al., 2011). Platnick and Duperre (2011) documented 17 new species representing Andean goblin spiders of the new genus *Scaphidysderina* from Peru. A new Theraphosinae spider genus *Catanduba* (Araneae: Theraphosidae) from Central Brazil in Cerrado areas with five new spider species viz., *C. tuskae*, *C. araguaia*, *C. piauiensis*, *C. canabrava* and *C. peruacu* were recorded by Yamamoto et al., (2012).

### 3.2.1.4 Spider taxonomy in Europe

Chickering (1943) documented 21 new species of spiders and all belong to the genus *Dipoena* (Araneae: Theridiidae) from Panama. Szita et al., (2002) listed a total of 180 spider species from Hungary. Among them five new species are *Cnephalocotes obscurus* (Blackwall), *Gongylidiellum vivum*
(O.P. Cambridge), *Larinia bonetti* (Spassky), *Zora armillata* (Simon) and *Synageles lepidus* (Kulczynski). Bosselaers and Henderickx (2002) discovered one new spider species and that is *Savignia naniplopi* sp. nov. found out in two adjacent limestone caves in Crete, Greece. Kostanjsek and Miller (2004) observed four spider species, *Gongylidium rufipes*, *Hylyphantes nigritus*, *Oedothorax apicatus* and *Panamomops mengei* from Slovenia.


### 3.2.1.5 Spider taxonomy in Australia


Baehr et al., (2010) described 19 new species in goblin spider of the new genus *Cavisternum* (Araneae: Oonopidae) from tropical northern Australia. The recorded new species are *C. bagleyae*, *C.barthorum*, *C. bertmaini*, *C. carae*, *C. clavatum*, *C. digweedi*, *C. ewani*, *C. foxae*, *C. gatangel*, *C. heywoodi*, *C. hughesi*, *C. ledereri*, *C. maxnoormanni*, *C. mayorum*, *C. michael bellomoi*, *C. noelashepherdiae*, *C. rochesterae*, *C. toadshow* and *C. wallockae*.

Framenau (2011) discussed a new orb-weaving spider species representing the first record of *Novaranea courti* from Southeastern parts of
Australia. The genera *Phlegra* (Simon), *Phintella* (Strand) and *Yamangalea* (Maddison) are newly recorded from Australia, and each genus describes one new species namely, *Phlegra proszynskii*, *Phintella monteithi* and *Yamangalea lubinae* by Zabka (2012).

### 3.2.1.6 Spider taxonomy in Asia

The dynamics of two communal species *Cترمْحِرَة moluccensis* (Doleschall) (Araneidae) in Papua, New Guinea *Philoponella republicana* (Simon) (Uloboridae) in Panama Canal Zone were studied by Lubin (1980). The taxonomy of 625 species and 188 genera reported before 1993 from an area covering entire Siberia with adjacent Urals, Cisuralia, northern and eastern Kazakhstan and Russia was discussed by Eskov (1994). Ori et al., (1996) discovered new brown widow spider *Latrodectus geometricus* and redback spiders *Latrodectus hasselti* were recorded from Yokohama, Tokyo, Nagoya, Osaka and Okinawa in Japan. Jager and Ono (2000) described four new species of spiders (Araneae: Sparassidae) from Japan and the recorded species are *Olios japonicus*, *Heteropoda simplex* sp. nov., *Sinopoda okinawana* and *S. tanikawai*.

Haupt and Shimojana (2001) recorded the genus *Latouchia* (Araneae: Ctenizidae) in Southern Japan and Taiwan and presented new species like *L. formosensis hyla* and subspecies like *L. swinhoei: L. s. kume, L. s. tonaki, L. s. kerama, L. s. izena, L. s. xena, L. s. crypta, L. s. typica* and *L. parameleomene*. Two new species of Araneid spiders, known as *Cyclosa punjabiensis* sp. nov and *Nephila pakistaniensis* sp. nov were described by Ghafoor and Beg (2002) after a survey carried out by them in Pakistan.

Levy (2009) reported two new spider species (Araneae: Sparassidae) from Israel and they are *Cerbalus psammodus* and *Cerbalus negebensis*. Kranz-Baltensperger *et al.* (2009) discovered a new spider genus and species, *Iraponia scutata* new species (Araneae: Haplogynae) belonging to the family Caponiidae found in Iran. Wang and Ono (2010) investigated on two new Coelotine spider (Araneae: Agelenidae) species namely *C. akakinaensis* (Shimojana) and *C. iheyaensis* (Shimojana) found in Japan. Seo (2010) documented a new species, *Neospintharus baekamensis* and two more species new to Korea (Araneae: Theridiidae). The recorded species are *Cryptachaea riparia* and *Lasaeola yoshidai*. Wang *et al.*, (2010) found a three new species of the spider genus (Araneae: Amaurobiidae) from China and recorded details about the species as *Taira qiuae*, *T. sichuanensis* and *T. zhui*.

The spider taxonomy of China was studied by many workers during 2011. Zhang *et al.*, (2011) determined a total of seven species. They are *Alistra annulata*, *A. hippocampa*, *Hahnia saccata*, *H. submaginii*, and *H. senaria* two known species, *Hahnia flagellifera* (Zhu, Chen and Sha) and *H. himalayaensis* (Hu and Zhang). They are recorded for the first time from Yunnan Province, China. Three new species of the spider genus *Mallinella* are reported from Hainan Island in China. They are *M. digitata*, *M. rectangulata* and *M. obtusa* was studied by (Zhang *et al.*, 2011).

Zhang and Peng (2011) listed eleven new species of the spider genus *Belisana* (Araneae: Pholcidae) from south China. The described species are *Belisana galeiformis*, *B. bawangenisis*, *B. chaoanensis*, *B. diaoluoensis*, *B. longinqua*, *B. parallelica*, *B. erromena*, *B. lata*, *B. colubrina*, *B. tianlinesis* and *B. yangi*. Two new species in the spider family Corinnidae, *Otacilia hengshan* and *O. foveata* as found in China have been described by Hu and Zhang (2011).

Selden *et al.*, (2011) discovered the largest known fossil spider, *Nephila jurassica* from Middle Jurrassica of China. Four new troglobilous species of the genus *Pholcus* Walckenaer (Araneae: Pholcidae) from Guizhou Province in China are presented as new species. They are *Pholcus anlong*, *P. ceheng*,
*P. xingren* and *P. xingyi* as reported by Chen *et al.*, (2011). The genus *Trilacuna* (Aranaeae: Oonopidae), comprising only two species from China is supplemented by seven new species as collected in Thailand, Malaysia and Sumatra. The recorded spider species are *T. merapi*, *T. bilingua*, *T. clarissa*, *T. werni*, *T. alces*, *T. kropfi* and *T. diabolica*. These were recorded by Eichenberger and Kranz- Baltensperger (2011).


Dankittipakul and Singtripop (2011) documented seven new species of *Systaria* from different regions of Southeast Asia. The recorded species are *S. decidua* and *S. lanna* from northern Thailand; *S. insolita* from northeastern Thailand; *S. bifida* from southern Thailand and Myanmar; *S. acuminate* from southern Thailand and Indonesia; *S. convolutiva* from Indonesia; *S. deelemanae* from the Philippines.

Moradmand and Jager (2011) carried out a study on the huntsman spider genus *Sparioleus* (Simon) in Iran and described four new species as *S. aratta* from Jebal Barez Mountains in Kerman Province, *S. iranomaximus* from Khofash cave in Ilam Province, *S. manesht* from Manesht mountain in Ilam and *S. zagros* from Knesht Cave, Kermanshah Province, Iran.

Eichenberger *et al.*, (2012) discovered 14 new species of the spider genera *Gamasomorpha* and *Xestaspis* (Aranaeae: Oonopidae) from Indonesia. The described species are *G. asterobothros*, *G. keri*, *G. petoteca*, *G. insominia*, *G. ophiria*, *G. squalens*, *G. coniacris*, *G. raya*, *G. fricki*, *G. schmilingi*, *X. kandy*, *X. paulina*, *X. semengoh* and *X. bifloccin*. They are very diverse and differ only by the shape of the booklung covers.
Kranz-Baltensperger (2012) recorded the genus Ischnothyreus (Aranee: Oonopidae) from Tioman Island in Malaysia and presented three new species like I. tioman, I. tetek and I. namo. The genus Clubiona (Latreille) is the biggest genus of Clubionidae and the only genus reported from China till now. A new spider species of Clubiona brachyptera (Araneae: Clubionidae) described from Hainan Island in China was made by Zhu et al., (2012). Dankittipakul and Deeleman-Reinhold (2013) have documented five new spider species are described from South East Asia. The recorded species are Sesieutes minuatus and Sesieutes aberrans from Thailand, Sesieutes abruptus and Sesieutes befidus from Malaysia and Sesieutes apiculatus from Indonesia.

3.2.2 Taxonomy of spiders in India

Pocock (1901) described 39 new species of spider belonging to six families from British India. The most frequently encountered families are Argiopidae, Oxyopidae, Lycosidae, Heteropodidae, Thomisidae and Cryptothelidae. Narayan (1915) investigated six new ant-like spiders (Araneae: Attidae) from Indian Museum. The recorded new species are viz., Harmochirus lloydii, Myrmarachne himalayensis, M. ramunni, M. uniseriatus, M. paivae and M. satarensis. Gravely (1921) listed seven new spiders of subfamily Tetragnathinae species and they are Tetragnatha mackenziei, T. moulmeinensis, T. fletcheri, T. cochinensis, T. listeri, T. sutherlandi and Orsinome listeri.

Tikader (1975) described three new species of spiders (Araneae: Argiopidae) of the genera Araneus and Chorizopes from India. A new spider species of Eilica platnicki (Araneae: Gnaphosidae) from India is reported by Tikader and Gajbe (1976a). Tikader and Gajbe (1976b) discovered a new species of spider of the genus Plator himalayaensis (Araneae: Platoridae) from Almora, Uttrakhand. Two new species namely Lyssomanes karnatkaensis and L. bengalensis belonging to the family Lyssomanidae were described from India (Tikader and Biswas, 1978).
Tikader (1980) reviewed the general taxonomic characters of spiders of India with special reference to Thomisidae. His review comprised of two sub-families belonging to 25 genera and of the 115 species of these, 23 species were new to science. Tikader and Malhotra (1980) reillustrated 65 known species and added 16 new species (81 sp.) under nine genera of the family Lycosidae from India. Tikader (1982a) redescribed 95 known species and added six new species (101 sp.) under 21 genera of the family Araneidae recorded in India. Tikader (1982b) discussed 89 species under 21 genera out of which 14 species were new to science of the family Gnaphosidae from India.

Gajbe (1987) observed one new spider species, *Scopodes tikaderi* (Araneae: Gnaphosidae) found in India. Gajbe (1992) reported a new species of spider, *Mimetus tikaderi* (Araneae: Mimetidae) found in India. A new spider species of the genus *Sosticus* (Chamberlin) belonging to the family Gnaphosidae is described as *Sosticus pawani* from India by Gajbe (1993). Patel (2003) recorded a total of 91 species of spiders belonging to 53 genera distributed in 22 families as found in four sites of Parambikulam wildlife Sanctuary, Kerala. Out of these, *Achaearanea globosa* of Theridiidae, *Neoscona parambikulamensis* of Araneidae and *Strigoplus moluri* of Thomisidae are described and illustrated as new to science.


Jose and Sebastian (2007) presented a new species of *Thelcticopis* (Araneae: Sparassidae) from India. The recorded species are *Thomisus meenae*, *T. dhananjayi*, *T. pritiae*, *T. manjuae*, *T. manishae*, *T. ashishi*, *Xysticus viveki*,

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and X. yogeshi. A new spider species of *Misumena ritucae* (Araneae: Thomisidae) discovered from Jabalpur in Madhya Pradesh was studied by Gajbe (2008a).

The genus *Conothele* of the trapdoor family *Ctenizidae* is reported for the first time from India with the description of two new species *Conothele varvarti* from Similipal Tiger Reserve in Orissa, eastern India and *C. vali* from Tawang district in Arunachal Pradesh, Northeastern India (Siliwal *et al.*, 2009). Two new species of the genus *Diplothele* (Araneae: Barychelidae) from Orissa were reported by Siliwal *et al.*, (2009). A new Brush-footed trapdoor spider (Araneae: Barychelidae) *Sipalolasma arthropophysis* (Gravely) was recorded from Andhra Pradesh by Javed *et al.*, (2010).


### 3.2.3 Taxonomy of spiders in Tamil Nadu

Sugumaran *et al.*, (2005) recorded six new species from different forest ecosystems of the Western Ghats of Tamil Nadu in Nilgris, Coimbatore, Erode, Virudhunagar and Tirunelveli Districts. The first occurrence of the genus *Tigidia* is reported with the description of two new species from the Western Ghats in Tamil Nadu, *T. nilgiriensis* from Kotagiri, Nilgiri District and *T. rutilofronis* from Maruthamalai, Coimbatore District, and described by Siliwal *et al.*, (2011). Two new trapdoor spider species, *Scalidognathus nigriaraneus* sp. nov. and *Scalidognathus tigerinus* sp.nov. recorded from South Western Ghats of Tamil Nadu were made by Sanap and Mirza (2011).
3.3 Study on guild structure and composition of spiders

The definition and interpretation of guild structure in ecological communities of spiders are reported by Adams (1985). Marc and Canard (1997) discussed several functional groups of spiders from western part of France. Sudhikumar et al., (2005) discussed a composition of guild structure of spiders from Mannavan Shola forest in Kerala. The guild structure of spiders on analysis revealed seven feeding guilds and they are: Orb web weavers (33%), Stalkers (29%), Foliage hunters (12%), Ground runners (8%), Scattered line Weavers (8%), Ambushers (8%) and Sheet web builders (2%) as found in Mangalavanam urban forest from Cochin during 2005. All were described by Sebastian et al., (2005b).

The spider assemblages in three natural secondary forests in Ziwuling were divided into five guild structure as reported by Shuang-lin and Bo-ping (2006). Otto and Floren (2007) listed a three guild composition of spiders and they are: Orb weavers (26%), Ambushers (11.1%) and Agile hunters (14.9%) from tree canopies in Bialowieza forest near Poland. Faria and Lima (2008) discussed the composition of guilds and body size distribution of spiders in South-Pantanal, Brazil.

Pinzon and Spence (2008) reported cursorial spiders from tree trunks of guild structural features in Canada. Pinzon et al., (2011) investigated a spider assemblages and feeding guild composition in overstory, understory and ground layers of managed stands in the western boreal mixed wood forest of Canada. The spider guild composition of different environments in East Asian subtropical plantation forest in Central Taiwan has been discussed by Huang et al., (2011). Stenchly et al., (2011) surveyed the spider web guilds in tree, plot and landscape scale management from Cacao agro forest in Indonesia.

Foord et al., (2011) carried out a guild structure and composition of spiders from Savanna Biome in South Africa. They are classified as follows: a total of 928 species (75%) are free-living spiders with 571 species living on the soil surface, including those living in the burrows (73 spp). The plant wanderers
sampled from the grass and tree layers are represented by 357 species. The web dwellers are represented by 302 species with the largest number making orb-webs (123spp) followed by the retreat-web spiders (61spp) and the sheet-web spiders (39spp).

Bambaradeniya and Edirisinghe (2011) described the guild structure and species richness of spiders in rice fields of Sri Lanka. Cardosa (2012) reported functional groups of epigean versus troglobiont spiders in the Iberian Peninsula. Kerzicnik et al., (2013) have discussed the hunting spider guild represented 89% of the spider fauna with the families of Gnaphosidae and Lycosidae found in eastern Colorado agroecosystems, United States.

3.4 Study on predatory potential of spiders

Experimental evidences suggest that spiders are generalist predators. Spiders as predators of lepidopterous larvae on apples in Canada are reported by Dondale (1956). Turnbull (1960) pointed out that Linyphid triangularis consumed a wide range of species of prey and its prey preference varied from place to place depending upon density of particular species at a particular time and place. Spiders not only prey upon the larvae and adults of the pest insects, but also cause indirect mortality by disturbing effect.

Yamanaka et al., (1973) stated that predation by micryphantid spiders on the first instar larvae of the tobacco cutworm, Spodoptera litura, on taro (Colocasia spp) was on important mortality factor but they noted that greater mortality was caused by the disturbance of the larval aggregations. Nakasuji et al., (1973) investigated a relative importance of the disturbing effect of the spider Oedothorax insecticeps on the larval aggregations of Spodoptera litura on apple trees. They reported that 38% loss of larval populations was due to dispersal, whereas only 4% was due to actual predations.

As arachnids in general and spiders in particular are effective predators of insects they could be employed in many biocontrol programmes (Savory, 1977). Mansour et al., (1980) suggested that larval populations of the apple pest Spodoptera litroalis did not increase at pest level on trees occupied by spiders,
whereas significant damage was observed on trees from which they had been removed. These workers further reported that spiders’ activity (Predation and disturbance) was responsible for a 98% reduction in larval densities.

Spiders also form an abundant predator group in Orchids growing in forests and this was studied by Carrol (1980). Riechert and Gillespie (1986) considered spiders as ideal biological control agents because besides being generalist predators, they were capable of propagating their population rapidly. Salticid spiders are cursorial hunting habitat with acute vision. Jackson (1986) documented a prey and predatory behaviour of Salticid spider, *Myrrmarachne lupata* species feed on a variety of insects like Drosophilia, Moth and Housefly from Queensland. Peter and Biswas (1990) recorded numerous spiders and their predatory activities in cotton fields. Spiders also have a very significant role to play in the ecology by being exclusively predatory and thereby regulate and destroy vast number of insects controlling insect populations by Wise (1993).


biocontrol agent of winter vegetable pest like *Phyllostreta cruciferae* has been discussed by Shunmugavelu and Ganesan (2012).


Dippenaar-Schoeman *et al.*, (2013) discussed five agrobiont spider species that might play an important role as natural controlling agents of pests from crops in South Africa. The described species are *Ostearius melanopygius*, *Pardosa crassipalpis*, *Cheiracanthium furculatum*, *Heliophanus pistaciae* and *Misumenops rubrodecoratus*. 