SPATIAL DISTRIBUTION PATTERNS OF FAUNA IN WESTERN GHATS

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ABSTRACT

Western Ghats (WG) is a mountain range running north–south parallel to the western coast of India traversing six states, Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu. About 40% of WG is under natural landscape (5000 species of flowering plants, 139 mammal species, 508 bird species and 179 amphibian species) and the rest of it under human-dominated land uses. The complex topography, geology, lithology coupled with climatic regime are responsible for diverse fauna and flora in this region. About 90% of the natural landscape is considered as an ecologically sensitive because of its high biological richness, home to 325 globally threatened endemic species and geological significance. It also includes Protected Areas (PAs), World Heritage Sites (WHSs) and Tiger and Elephant corridors. The WG faunal biodiversity has been analyzed by reviewing around 360 literature (Fishes: 56, Amphibians: 68, Reptiles: 60, Birds: 67, Mammals: 93 articles) and a detailed database has been created including location details, conservation and endemism status of each species. The database has covered 343 fish species, 248 amphibians, 197 species of reptiles, 529 species of birds and 161 species of mammals details. Amphibian group shows highest endemism in Western Ghats region, 62%, it is followed by Reptiles (52%), fishes, mammals, and birds. The Open layer plugin in Quantum GIS (QGIS) helped in the geo-visualization associating forest cover and species distribution. Spatial faunal distribution with latitudinal gradient highlights the significance of the region for conservation. Information pertaining to the endemic species including distribution helps the regional authorities in the effective conservation planning.

KEYWORDS

Western Ghats, Fauna, Endemism, Conservation status.

1. INTRODUCTION

The spatial distribution of an organism is determined by the combined effects of biological (Neudecker 1979; Sheppard 1979) and environmental factors that can affect the birth, growth, and death rates of individuals in the species populations (Glynn 1976; Adjeroud 1997; Hutchinson 1953). Characterizing and explaining the spatial variation of species abundance has an important role in ecology (Ives & Klopfer, 1997; Currie, 2007). The understanding of species distribution pattern in space and time has a significant role in the establishment of management and conservation plans (Fortin and Dale, 2005). Visualization of spatial data with attribute information aid in understanding the environmental and ecological factors responsible for spatial distributions and relations. Geographic information system (GIS) helps in the integration of spatial data from different kinds of sources, such as remote sensing, statistical databases, and recycled paper maps and it offers the ability to manipulate, analyze, and visualize the combined data.

1.1. Ecosystem: The ecosystem is the fundamental unit of ecology and it includes the multiple interactions between and within the biotope and biocenosis (Odum, 1980). The Earth could be considered a massive ecosystem consisting of biotic and abiotic communities occurring that are responsible for physical and chemical processes which sustain a community of interacting and non-interacting species. The biotic components may be producers, carnivores, omnivores etc., whereas the abiotic may be sunlight, temperature, precipitation, moisture etc. De Groot, 1992 defines ecosystem functions as the capacity of natural processes and components to provide goods and services that directly or indirectly satisfy human needs. Natural ecosystem plays a crucial role in the maintenance and regulation of ecological processes and life support systems in nature.

Each function is the result of the natural processes that takes place in nature. The most important processes of the ecosystem are the transformation of energy, conversion of solar energy to biomass (primary productivity), storage and transfer of energy and minerals in food chains (secondary productivity), biogeochemical cycles, mineralization of organic matter in soils and sediments and regulation of the physical climate system. These natural processes are the result of complex interactions between abiotic and biotic components of ecosystems through the universal driving forces of matter and energy.

1.2. Landscape: The landscape is defined as a region, where interactions between human and environment take place (Wiens & Milne, 1979). Landscape Ecology is defined as the study of patterns, processes and changes in the landscape (Fig. 1.1) at the scale of hectares to square kilometers (Forman & Godron, 1986; Turner, 1989). Landscape pattern is considered as the spatial relationship between patches or landscape elements. Landscape process is the interaction between spatial elements, and the landscape change is defined as the alteration in structure and function of the Landscape over time (Richard Hobbs, 1997). The changes include both natural and anthropogenic changes. Natural change occurs due to weather, earthquake, forest fire etc and anthropogenic changes take place due to human activities. These anthropogenic activities are one of the major drivers of landscape variations.

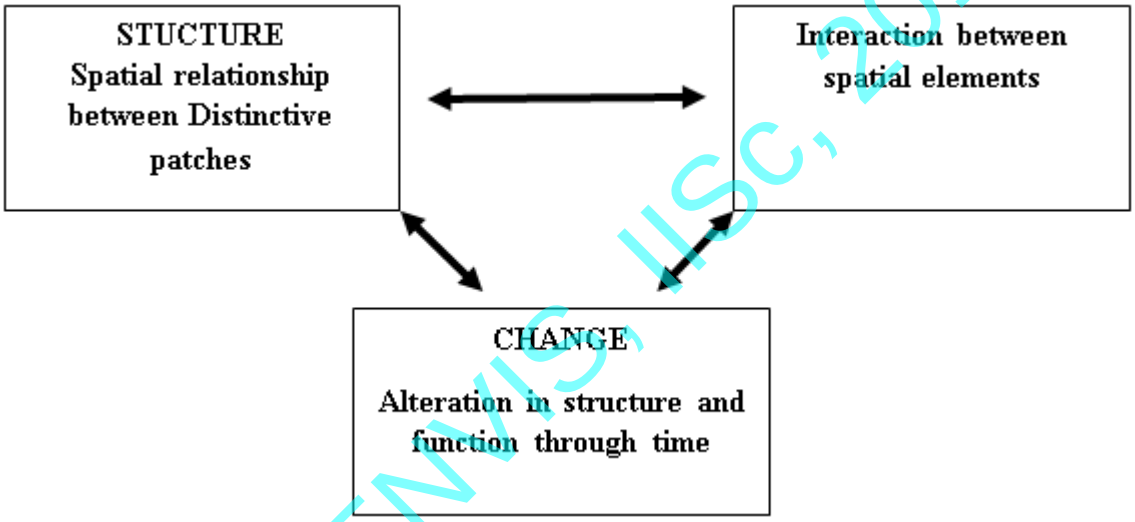


Fig. 1.1: Landscape structure and functions

Landscape complementation, supplementation, Source & sinks, and neighborhood effects are the 4 ecological processes which act at the landscape level (Dunning et al., 1992). Each process in nature depends upon the distribution of resources. Biota depends on these resource patches to meet their needs and it also supplements other patches with existing resources. The movement of biotic organisms from source to sinks helps in the maintenance of sink population and the neighborhood effects state that the movement of organisms between the landscape patches depends upon the permeability of boundaries neighboring patches. Landscape connectivity refers that the degree to which the landscape supports the movement of organisms between the patches (Taylor et al., 1993). Conserving Landscape connectivity is the key

strategy to protect biodiversity, maintain viable ecosystems and wildlife populations and facilitate adaptation for wildlife species to face the climatic changes (Meiklejohn et al., 2009).

1.3. Ecosystem Goods and Services: Ecosystem functions provide goods and services that directly or indirectly satisfy human needs. The domination of humans in the recent past has led to serious changes in the ecosystem, which has led to environmental degradation, loss of biodiversity, conflict over available resources etc. In order to continue the benefit from ecosystem functions, humans need to ensure the continued existence and integrity of natural ecosystems and processes. Nevertheless, these ecosystem goods and services are essential to the human existence on earth. The value of the ecosystem is classified into ecological value, socio-cultural value and economic value (Farber et al., 2002; Limburg et al., 2002: Howarth and Farber, 2002, Wilson & Howarth, 2002). The ecological value of an ecosystem can be determined by the integrity of regulations, habitat functions and other parameters of the ecosystem like complexity, diversity, and rarity (De Groot et al., 2000). The limits of sustainable use of ecosystem goods and services are defined by ecological criteria like integrity, resilience, and resistance (De Groot et al., 2000) (Fig. 1.2). Ecosystem functions are

(i) Production functions: Production functions include the production of ecosystem goods. Autotrophs are the producers which convert carbon dioxide, water, energy, and nutrients into a wide variety of carbohydrates through the process, photosynthesis. These carbohydrates are then used by organisms in the higher trophic level to generate a larger diversity of living biomass. This process of transfer of food energy within a group of organisms through a series of repeated eating and being eaten is known as food chain (Rastogi, 2004). These diverse carbohydrate groups not only provide ecosystem goods for humans but also serve as raw materials for energy resources and genetic material. Information functions of ecosystem help in the maintenance of human health by providing opportunities for reflection, spiritual enrichment, cognitive development, recreation and aesthetic experience.

(ii) Regulation functions: These functions regulate essential ecological processes and life-support systems through biogeochemical cycles and other biospheric processes. It helps in sustaining ecosystem health as wells as it provides direct or indirect benefits to humans in the form of clean water, air, and soil.

(iii) Habitat functions: help in the conservation of genetic and biological diversity by providing satisfactory habitats to flora and fauna.

(iv) Information functions: Socio-cultural value is other criteria that help in determining the relevance of natural ecosystems and their functions to the human society through social values and perceptions.

The Economic value of the goods and services of the ecosystem is determined by various methods depends upon the goods. Economic valuation methods encompass direct market valuation, indirect market valuation, contingent valuation and group valuation.

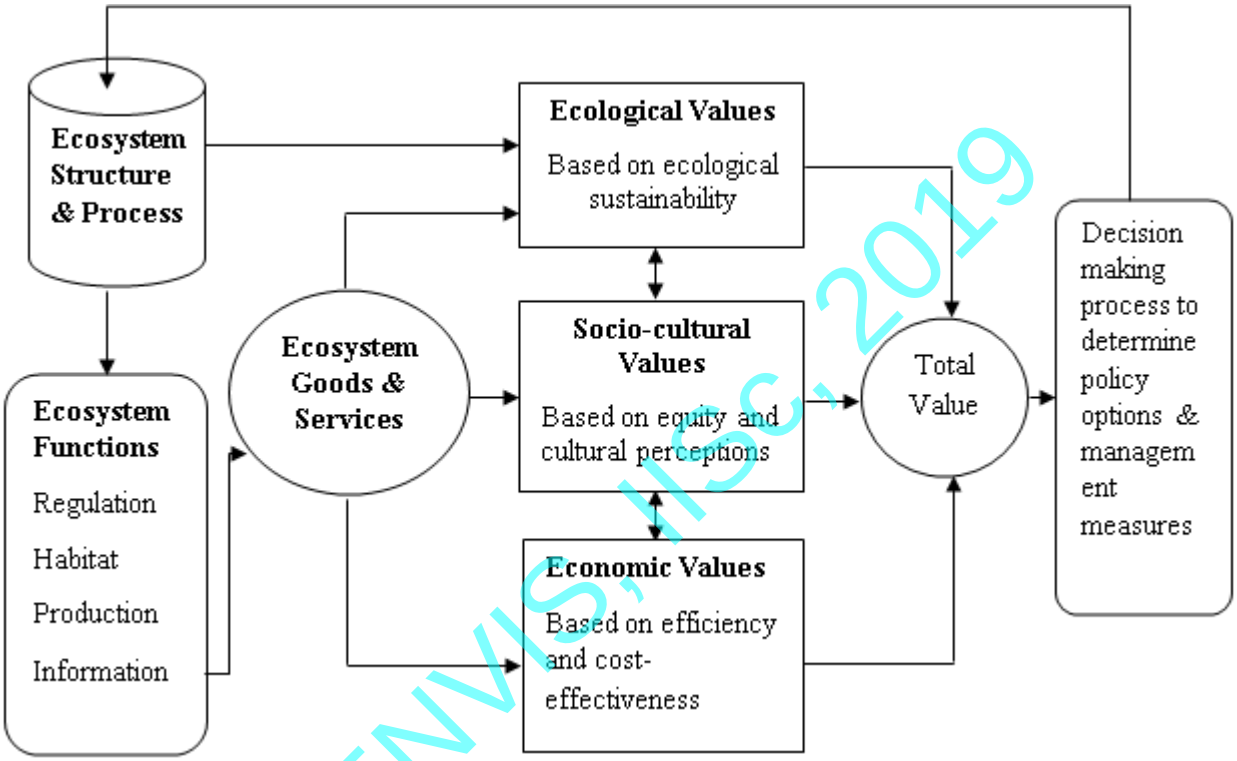


Fig. 1.2: Ecosystem goods and services.

1.4. Biodiversity: Biodiversity is the total variability of life on Earth (Heywood, 1995). Groombridge (2002) used the term biodiversity to describe the number, variety, and variability of living organisms in an ecosystem. All forms of life include plants, animals (including both invertebrates and vertebrates) as well as microorganisms such as fungi, bacteria and all levels of the organization. It is also defined as the variety at all levels of the organization includes the diversity in genetic level, species level, and ecosystem level. It is also defined as the richness, abundance, and variability of plants and animal species and communities and the ecological processes that link them with one another and with soil, air, and water (Hunter & Gibbs, 2007). Biodiversity has two functions; Ecological functions and Evolutionary functions. The interactions between the species through ecological processes like competition, parasitism, mutualism, predation and the interactions of species with its environment through the processes

like photosynthesis, biogeochemical cycling causes diversity in ecological processes. The diversity of evolutionary functions includes all the ecological processes which cause natural selection and other processes which cause mutations at the genetic level of the organisms (Hunter & Gibbs, 2007).

1.5. Forests: Forests are a large uncultivated tract of land covered with trees and underwood, woody grooves and pasture. Forests influence climate through physical, chemical and biological processes. Forests are providing ecological, economic, social and aesthetic services to both natural systems and life forms. It also helps in water retention, controls runoffs, provides a shield against floods, and helps in protecting the area from droughts. Forest also provides us with some valuable services such as conservation of ecosystem, prevents erosions, maintains the quality of water, produces oxygen for all living beings and reduces global warming by sequestering carbon from atmosphere. More than 1 billion people living in extreme poverty depends on the forest for their livelihood (Ghazoul, 2015).

1.6. Fauna: Living things are classified into two kingdoms, Plantae and Animalia (Fig. 1.3). The kingdom Animalia is generally classified into two groups, Non-chordates, and Chordates. The chordates include organisms having a notochord, a dorsal tubular nerve cord, and pharyngeal gill silts. These are the characteristic features of organisms belongs to the chordate phylum. Evolutionary theories show that chordates were originated from non-chordate groups (Jordan and Verma, 2013). Phylum chordata is a heterogeneous assemblage of organisms which widely differ from one another, and are classified into two groups- Protochordata and Euchordata. Protochordata members are relatively small, marine organisms without a vertebral column. This group is also known as invertebrate chordates or non-vertebrates.

The members of the phylum Chordata which possess vertebrae are included in the subdivision Euchordata. The notochord of vertebrates is supplemented by a vertebral column consisting of overlapping vertebrae. These organisms are usually dioecious and the body can be divisible into head, neck, trunk, and tail. It is the largest subphylum with 64,000 species (Noriyuki Satoh, 2016). The subphylum Vertebrata is again classified into two divisions: Agnatha, Jawless fish-like vertebrates without paired limbs and true jaws and Gnathostomata, Jawed vertebrates with paired limbs and true jaws. Gnathostomata has been further divided into two superclasses- Pisces which includes fishes and fish-like aquatic gnathostomes and Tetrapoda comprises of terrestrial four-footed gnathostomes. The superclass Tetrapodais comprised of 4 classes: Class Amphibia, Class Reptilia, Class Aves (Birds) and Class Mammalia.

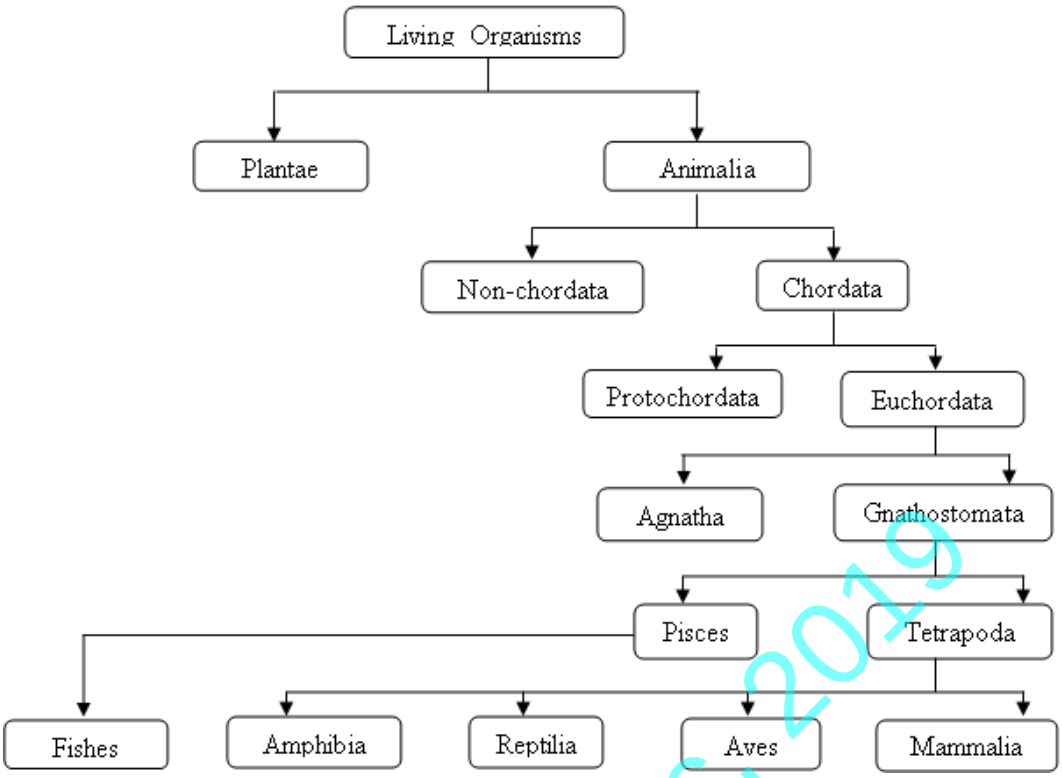


Fig. 1.3: Classification of living organisms.

Globally there are about 1.4 to 1.7 million species which has been described till now and also estimates that the total number of species on Earth ranges from 5 to 100 million. India is one of ecologically, biologically and culturally rich countries in the world. It is one of the richest countries among the twelve major countries with abounding biodiversity. There are 1,26,188 species have been reported from India till now. The faunal diversity of India includes 2546 freshwater fishes, 342 species of amphibians (Dinesh et al, 2012), 428 species of reptiles, 1228 species of aves and 372 species of mammals (Sreedharan, 2004). India shows rich diversity in almost all categories and subsidizes almost 6 percent to the total species richness of the world. Even hundreds of unidentified species still remain in the ecosystems in India.

1.7. Western Ghats

The Western Ghats is a continuous mountain chain running north–south parallel to the western coast of India traversing six states, Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu. It is one of the Gondwanaland breakup landmasses in the early Jurassic period seen towards the mainland Eurasia. The Gondwanaland included India, Australia, South Africa, South America and Antarctica as one single land mass (UNESCO). It is older than Himalaya Mountains with unique biophysical and ecological processes (Ray et al., 2016). The Western Ghats is one of the world's most heavily populated "Biodiversity Hotspot", supporting 400

million people. It provides sustain livelihoods by implementing sufficient necessities like water for drinking, transport, irrigation and food (Molur et al., 2011).

According to Gadgil report (2011), 142 taluks in the Western Ghats are considered to be ecologically sensitive zones and Kasturirangan report (2013) states that almost 60% of the Western Ghats region is under cultural landscape. It includes human-dominated land use areas like settlements, agriculture, and plantations other than forest plantations and 41% of the land area is currently classified as the natural landscape (ecologically sensitive). Of the natural landscape, almost 37% is considered as the biologically rich area, it covers an area of 60,000 sq. km. This report also shows that 90% of natural landscape has high biological richness, low fragmentation, and low population density. This natural landscape contains Protected Areas (PAs), World Heritage Sites (WHSs) and Tiger and Elephant corridors and these are considered as an ecologically sensitive area.

The complex topography and climatic conditions of Western Ghats have made certain parts inaccessible and have helped the region to retain its heritage. It also exhibits a great variety of vegetation comprising scrub jungles, grassland, dry and moist deciduous forests, and semi-evergreen and evergreen forests (Srinivasan et al, 2014). This helps in the presence of an abundance of fauna and flora in this region. The Western Ghats montane rain forest is also a home for a large number of endemic biota. It includes 5000 species of flowering plants, 139 mammal species, 508 bird species and 179 amphibian species. Myers et al, 2000 reported that at least 325 globally threatened species are present in the Western Ghats region and many species of plants and animals remain to be discovered from the Western Ghats. The unplanned developmental activities and abrupt land use changes (Ramachandra et al., 2016a; Ramachandra et al., 2018a) are threatening the forest cover, increase in fragmentation, loss of diversity and habitats, which necessitate the demarcation of ecological sensitive regions and conservation of them (Ramachandra et al., 2016b; Ramachandra et al., 2018b).

2.0 Biodiversity

Biodiversity is heterogeneously distribution of species across the Earth. Some areas like moist tropical forests and coral reefs are rich in biological variations and some areas are virtually devoid of life (some deserts and polar regions). This phenomenon is called latitudinal species richness gradient which means the number of organisms generally increases from polar to temperate to tropical areas (Gaston, 2000). Species are the group of actually or potentially

interbreeding natural populations, which are reproductively isolated from other such groups (Mayr, 1942). The global estimations show there are 1.7 million taxonomically described species present on the Earth (Hammond, 1995). The total number of species on Earth is estimated between 5 and 100 million (Sreedharan, 2004). Ecosystems with rich in biodiversity support the lives of thousands of species. About 75 percent of biodiversity exists in the territories like tropical rain forests, tropical dry deciduous forests and mangrove swamps.

Extinction is an occasional natural event and always anthropogenic, as many species lost through extinction every year. The average rate of extinction over past 200 million years is 1-2 species per year known as background extinction and 3-4 families per million years. In the modern era, due to anthropogenic activities, species and ecosystems are in the threatened condition. Massive human–induced extinction rates are estimated as 1000 to 10000 times higher than the expected (Brooks et al., 2006). Currently, 24% of mammals and 12% of birds are at risk of extinction (Rosser & Mainka, 2002). The number of threatened species is expected to increase 7% by 2020 and 14% by 2050, due to the increase in human population (Mckee et al., 2004). Each species in the ecosystem are interdependent, the loss of one species may lead to the disappearance of many other dependent species. Thousands of species worldwide are under threat from overuse, loss of habitat and environmental pollution. Hence the value of maintaining biodiversity is crucial across the world for a healthy ecosystem. Global biodiversity monitoring and management programs are providing information of the number and distribution of species, enabling governments to protect areas which containing rare and threatened species and high levels of biodiversity (Sreedharan, 2004).

2.1. Fishes: Freshwater fishes are considered a 'mega-diverse' group of vertebrates and it is the prime indicator of ecosystem status (Karr et al., 1986). Riverine fauna shows a high degree of endemism and the most endemic fish species are seen at the headwater streams (Groombridge, 1992; Kottelat & Whitten, 1997). Out of 24,618 species of fishes in the World, nearly 8.60% (2,118 species) were reported from India (Nelson, 1994). Freshwater biodiversity remains among the most endangered and poorly protected resources on Earth (Dudgeon 2011; Cooke et al., 2012) and it shows that, almost 1 in 3 freshwater species facing a high risk of extinction (Collen et al., 2014).

Dahanukar et al (2004), from the study 'Distribution, endemism and threat status of freshwater fishes in the Western Ghats', 288 species of freshwater fishes were reported. The study area

includes entire WG region. The study states that WG has 288 freshwater fishes belonging to 12 orders, 41 families, and 109 genera.

Johnson & Arunachalam (2009) studied the diversity, distribution and assemblage structure of fishes in streams of southern WG and reported 60 freshwater fishes belongs to four orders, 13 families, and 27 genera. It also shows that Cyprinidae is the largest fish family and its members *Danio aequipinnatus*, *Garra mullya* and *Rasbora daniconius* were reported from all the study streams in southern WG.

Shahnawaz et al (2010) reported 56 fish species from the Bhadra River in the WG region of Karnataka. *Puntius chola*, *Puntius sophore*, *Hypselobarbus kolus*, *Cirrhinus fulungee*, *Cirrhinus reba*, and *Osteobrama neilli* were the most common and uniformly distributed fishes in the Bhadra River. *Mystus krishnensis*, *Mystus armatus*, *Ompok pabo*, *Wallago attu*, and *Gagata itchkea* were the fish species reported as comparatively rare and confined to lower reaches of the river.

In addition to the number of freshwater fishes present in WG, many new species were discovered. Dahanukar et al., (2015) reported a new percomorph fish, *Badis britzi* from the Nagodi tributary of Sharavati River (Latitude: $13^0$54’58’’N; Longitude: $74^0$53’21’’E; Altitude: 594m asl) in Karnataka. Percomorph fishes are the species belongs to the family Badidae and it consists of two genera; Badis and Dario. Raghavan et al (2008) reported five exotic fish species from the Chalakudy River (Latitude: $10^0$10’ & $10^0$33’30’’N; Longitude: $76^0$17’ & $77^0$4’E) Kerala. *Oreochromis mossambicus*, *Gambusia affinis*, *Osphronemus goramy*, *Xiphophorus maculatus* and *Poecilia reticulata* are the exotic species reported. Katwate et al (2013) reported an endemic Barb, *Pethia setnai* from the WG region of Goa.

Jayaram (2009) reported that 197 species of catfish were present in India. Kumbar et al (2014) conducted a study on diversity, threats, and conservation of catfish fauna of Krishna River and reported that 13 catfish species are present in Krishna River in Sangli district, Maharashtra. *Mystus seengtee*, *Mystus bleekeri*, *Mystus malabaricus*, *Rita gogra*, *Rita kuturnee*, *Sperata seenghala*, *Ompok bimaculatus*, *Wallago attu*, *Proeutropiichthys taakree*, *Neotropius khavalchor*, *Heteropneustes fossilis*, *Clarias gariepinus* and *Glyptothorax poonaensis* are the catfish species.

2.2. Amphibians: The diversified topography, geographic locations, humidity and high rainfall supports the survival of numerous amphibian species in Western Ghats (Andrews et al., 2005).

It is estimated that 4522 amphibian species are present in the world. Among that 4.4% is reported from India (Sreedharan, 2004).

Krishnamurthy and Shakuntala (2013) reported 35 amphibian species from Sringeri Taluk. Sringeri is a small Taluk (434 sq km) situated on the Western Ghats region of Chickamagalur District (Latitude: $13^0$15' – $13^0$36'N; Longitude: $75^0$04' – $75^0$12'E, Altitude: 624-1458m msl), through field survey in agricultural fields, semi-evergreen forests, low and high-elevation evergreen forests. Various species reported are from the genus Rana, Philautus, Ichthyophis, Bufo, Polypedatus, Nyctibatrachus and *Ramanella montana, Microhyla ornata, Uraeoryphlus narayani, Rhacophorus malabaricus*.

Andrews et al (2005), surveyed for amphibian fauna in Kerala and highlights as the region has 70 amphibian species belongs to 20 genera, 7 families and 2 orders. The study was conducted in the time period between August 1999 and August 2002. Wayanad district (41 species) has the highest number of amphibians and Kozhikode has lowest with 11 species. *Minervarya syhadrensis* and *Rana limnocharis* are the two species reported from Kerala region for the first time. The highest number of amphibian species (48 species) were found between 500 and 1000m altitude and lowest number of species (7 species) above 1500m and 39 species were reported from 1000 and 1500m. *Indirana beddomii, Nyctibatrachus major* and *Rana temporalis* were reported from all the altitude. The study reported that highest number of amphibians (41) was found in agricultural fields and plantations and least number of species (9) were found in grasslands. Evergreen and semi-evergreen vegetation has 39 species of amphibians followed by deciduous forest (28) and shoals (18 species).

Indirana is the only genus of the endemic amphibian family Ranixalidae present in the Western Ghats, *Indirana gundia* is classified as a critically endangered frog species as per the IUCN Red List of Threatened Species. This species was discovered in 1986 in the forests of Kemphole and Sakleshpur (Latitude: $12^0$49.50'N; Longitude: $75^0$35.50'E), Karnataka, India, by Dubois (1986) and is known to occur only in the type locality (Gundya) at an altitude of 200 m asl (Ramachandra et al., 2010). Jesmina and George (2015) reported new distribution records for *Indirana gundia* from Kerala part of Western Ghats through visual encounter survey Method, *I. gundia* species were located from three locations, Konnakkad (Latitude: 12°22'1"N; Longitude: 75°22'21"E), Kanamvayal (Latitude: 12°17'41.2"N; Longitude: 75°28'38.0"E) and Aralam (Latitude: 11°52'43.7"N; Longitude: 75°53'19.0"E) in the northern part of Kerala.

Many new amphibian species were reported from the Western Ghats region in the past few decades. Biju (2003) discovers a new amphibian family as Nasikabatrachidae, includes only one frog species, *Nasikabatrachus sahyadrensis*. Padhye et. al., (2014) reported a new species of leaping frog, *Indirana chiravasi* belongs to the family Ranixalidae from the Amboli (Latitude: 15.956^{0}N; Longitude: 73.997^{0}E; Altitude: 744m) region of Sindhudurg District, Maharashtra. Zachariah et al (2011) reported a new Polypedates species, *Polypedates bijui* from the tea plantations of Kadalar tea estate (Latitude: 10°07'N; Longitude: 77°01'E, Altitude: 1393m asl) Idukki district Kerala. Zachariah et al (2011) reported nine new species of frogs of the Raorchestes genus from southern Western Ghats region. In this study, they conduct Field surveys in active and non active period (pre-monsoon, monsoon and post-monsoon seasons) in the Western Ghats. The species include, *Raorchestes agasthyaensis, Raorchestes johnceei, Raorchestes manohari* and *Raorchestes crustai* are reported from the Bonacaud estate (Latitude: 8°40'N; Longitude: 77°11'E; Altitude: 600m.asl), Thiruvananthapuram district, Kerala. *Raorchestes kadalarensis* and *Raorchestes heuerkaufi* are reported from Kadalar tea estate (Latitude: 10°07'N; Longitude: 77°01'E: Altitude: 1393m. asl) Idduki district, Kerala. *Raorchestes ravii* is reported from Naduvattam (Latitude: 11°23'N; Longitude: 76°34'E; Altitude: 1890m.asl) Nilgiri district, Tamil Nadu. *Raorchestes thodai* is reported from Ooty (Latitude: 11°24'N; Longitude: 76°40'E; Altitude: 1980 m.asl), Nilgiri district, Tamil Nadu. *Raorchestes uthamani* is reported from cardamom plantation (Latitude: 09°26'N; Longitude: 77°09'E; Altitude: 1000m. asl) Pathanamthitta district, Kerala. Priti et al (2016) reported a new crypyic species of bush frog, *Raorchestes honnametti* from shola forests in Honnametti (Latitude: 11.8987°N; Longitude: 77.1741°E; Altitude: 1659m amsl) and Dodda Sampige (Latitude: 11.9473°N, Longitude: 77.1836°E; Altitude: 1142m amsl) within Biligiri Rangaswamy Temple Tiger Reserve.

Gower et al (2011) conducted a study on the molecular systematics of caeciliid caecilians of the Western Ghats, India and reported *Indotyphlus battersbyi, Indotyphlus maharashtraensis, Gegeneophis danieli, Gegeneophis cf. danieli, Gegeneophis cf. mhadeiensis, Gegeneophis mhadeiensis, Gegeneophis goaensis, Gegeneophis seshachari, Gegeneophis madhavai, Gegeneophis krishni, Gegeneophis sp., Gegeneophis carnosus* and *Gegeneophis ramaswamii* Van Bocxlaer et al (2012) conducted the study on Mountain-associated clade endemism in an ancient frog family (Nyctibatrachidae) on the Indian subcontinent. Night frogs (Nyctibatrachidae) form a family endemic to the Western Ghats. This study includes 119 Nyctibatrachus taxa sampled across the Western Ghats over a period of 15 years. They includes

Nyctibatrachus petraeus, N. humayuni, N.danieli, N. sp, N. vrijeuni, N. shiradi, N. karnatakakaensis, N. dattatreyaensis, N. indraneli, N. grandis, N. sylvaticus, N. acanthodermis, N. gavi, N. minor, N. kempholeyensis, N. major, N. minimus, N. poocha, N. devein, N. periyar, N. pillaii, N. aliciae, N. vasanthi, N. deccanensis, N. anamallaiensis and *N. beddomii.*

2.3. Reptiles: Reptiles are widely distributed class of Kingdom Animalia. It is present in the entire states of Western Ghats. Palot (2015) reported the reptiles present in the Western Ghats region of Kerala. In this study 173 species were reported, of which 87 are endemic to Western Ghats. Sayyed (2016) assessed the faunal diversity in Satara district in Maharashtra and reported 74 reptilian species (25 are Western Ghats endemic) from 15 families were reported from the Satara district. Vansda National Park is consisting of 41 reptilian species from 31 genera and 11 families (Vyas, 2004).

Radhakrishnan (1999) reported 32 reptilian species of 19 genera and 8 families in the four conservation areas in the Idukki district, Kerala. Periyar Tiger Reserve, Idukki and Chinnar Wildlife sanctuaries and the Eravikulam National Park. Gekkonidae, Agamidae, Scincidae, Typhlopidae, Colubridae, Uropeltidae, Elapidae, and Viperidae are the reptilian families present in the conservation areas of Idukki district.

Ganesh et al (2013) reported 71 reptilian species (47% are WG endemic) from the Agumbe Plateau of Central Western Ghats. Chandramouli and Ganesh (2011) reported 46 species of reptiles belongs to 27 genera and 9 families from the Cardamom Hills, Theni and Virudunagar districts, Tamil Nadu state (Latitude: 09°25'– 09°38'N; Longitude: 77°21'–77°34'E; Altitude: 500–1600m asl) and Ponmudi Hills, Thiruvananthapuram district, Kerala state (Latitude: $8^0$45'N; Longitude: $77^0$08'E; Altitude: 100–1090m asl).

It is estimated that 484 species of reptiles are in India (Kumar et al., 1998). Colubridae is one of the largest snake families in the class reptiles. Vogel & Roiijen (2012) reported a new dendrelaphis species, *Dendrelaphis girii* from Castle Rock, District Belgaum, Karnataka. Das (1991) reported a Mabuya species, *Mabuya gansi* from Kalakkad Tiger Reserve, (Latitude: 8º25' to 8º53'N; Longitude: 77º10' to 77º35'E) Tirunelveli district of Tamil Nadu State. *Dasia johnsinghi* is the new species reported from the study conducted by Harikrishnan et al., (2012) from collected from Servalar, KaniKudi (Latitude: 8.65354°N; Longitude: 77.31387°E) in a riverine forest habitat, Mundanthurai plateau, Tamil Nadu.

2.4. Birds: Birds are one of the best indicators of environmental quality of the ecosystem and perform various roles such as Scavenger, Pollinator, and Predators of insect pests (Chavan Nilesh, 2015). There are more than 9000 bird species in the world out of that around 1300 species are present in the Indian subcontinent (Grimmett et al., 1999). There are 508 species reported from the WG region and 28 species were endemic to the region (Rasmussen & Anderton 2005).

Birds are the widely distributed fauna present in the Western Ghats. Raman et al (2005) conducted the study on Tropical rainforest bird community structure in relation to altitude, trees species composition, and null models in the Western Ghats and reported that, 278 bird species from Kalakad-Mudanthurai tiger reserve. The fixed-radius point count method was used to survey bird populations in the study areas, Kannikatti (Latitude: 8°37′N; Longitude: 77°16′E; Altitude: 740m), Sengaltheri (Latitude: 8°31′N and Longitude: 77°26′ E; Altitude: 1040m), and Kakachi (Latitude: 8°33′N; Longitude: 77°24′E, Altitude: 1220m) in KMTR.

Ramchandra (2013) conducted a study to estimate the bird diversity and richness in Chandoli national park and reported that 151 bird species from 15 orders and 45 families are present in the Chandoli national park. Passeriformes are the highest order of birds. Among the 151 birds in Chandoli, 63 species belong to the order Passeriformes and 39 species belongs to the order Ciconiiformes.

Bird diversity in Sharavathy landscape by Barve & Warrier, (2013) shows 215 species of birds were reported from the Karnataka region of central WG, among that 15 species were endemic to the region. This study was conducted in the time period of December 2008 and March 2010 and survey method was used to encounter the birds present in the area.

Praveen (2015) reported 500 species of the birds present in Kerala region, among that 17 are endemic to WG. 25 species were under various threatened categories of IUCN and 32 near threatened species were also recorded.

A number of threatened and rare species of birds were reported from the WG region. According to the literature, there are two species of vultures present in India, the Indian White-backed Vulture *Gyps bengalensis* and the Long-billed Vulture *Gyps indicus*. The population rate of these species is declining by more than 90% throughout India (Green et al., 2004; Shultz et al., 2004). Pande et al (2011) reported this critically endangered Indian White-backed Vulture *Gyps bengalensis* from the Shrigonda Taluk (Latitude: $18^0$61'N; Longitude: $74^0$69'E), Pune District,

Maharashtra, India. Karuthedathu et al (2014) reported the sighting of Common Swift *Apus apus* from the Kanyakumari district in Tamilnadu and Kasargod district in Kerala. Narayanan et al (2006) reported a globally vulnerable species of bird, *Pycnonotus xantholaemus* commonly known as Yellow-throated bulbul is reported from the Anuvavi Subramaniar temple (Latitude: 11°03.5'N; Longitude: 76°50.9'E; Altitude: 690m asl), Coimbatore district of Tamilnadu.

2.5. Mammals: Mammals are the highly developed vertebrates, it is estimated that there are 4629 species of mammals present across the globe and 372 mammals were reported from India. Almost 8% of the global mammalian population is reported in India (Sreedharan, 2004). Large mammals are particularly prone to extinction due to their greater body mass and associated life history traits (Cardillo et al., 2004). Cardillo et al (2005) states that the extinction risk for mammals increases sharply above a body mass threshold of 3 kg.

According to Bapureddy et al (2014), primates are the major group of animals contributing to the mammal biomass in the evergreen forests of the Western Ghats, and they also play a major role in seed dispersal and regeneration of the forests. Lion-tailed macaque (*Macaca silenus*), bonnet macaque (*Macaca radiata*), Nilgiri langur (*Trachypithecus johnii*), southern plains gray langur (*Semnopithecus dussumieri*), black gray langur (*S. hypoleucos*), tufted gray langur (*S. priam*), and two subspecies of loris, Mysore slender loris (*Loris lydekkerianus lydekkerianus*) and Malabar slender loris (*L. lydekkerianus malabaricus*) are the primates present in the WG region. Lion-tailed Macaque (*Macaca silenus*) is an endangered species which is endemic to central and southern WG. Molur *et al*. (2003) projected a total lion-tailed macaque population of about 3,500 individuals in 49 subpopulations in eight locations in the WG. Karanth (1985) reported about 3,000 individuals in 123 groups in 19 locations in Karnataka from the northernmost Kumta range to southern Brahmagiri Wildlife Sanctuary.

Chiroptera is the second most diverse order of mammals and perform ecosystem services like seed dispersal, pollination and insect control. A variety of ecologically and commercially important plants rely on bats to some degree as pollinators or seed dispersers (Kunz *et al.*, 2011). According to Mistry (2001), India has 11.6% of world's bat population. According to Raghuram et al, (2014) about 43% of the reported 117 bat species present in India are found in the WG region Korad et al (2007) reported that 52 species of bats from the WG through the diversity and distribution of bats in Western Ghats. Among the 52 species, 6 species belong to

the suborder Megachiroptera and the remaining 46 species comes under the suborder Microchiroptera.

Hemitragus hylocrius, commonly known as Nilgiri Tahr is an endemic species present in the WG and it is categorized under endangered category by IUCN red data list. Abraham et al (2006) reported that Kerala has 998 individuals and 11 groups of Nilgiri Tahr and report the presence of largest population in the Eravikulam National Park with 696 individuals. Mudappa (2006) reported the sightings of *Paradoxurus jerdoni* (Brown palm civet) from Kalakad-Mundanthurai Tiger Reserve, Tamilnadu.

2.6. Spatial Distribution

Spatial distribution of species helps to find out their abundance, habitat requirements and associated threats which have a crucial role in planning effective conservation and management of biodiversity. Raghavan et al (2016) conducted the study 'Protected areas and imperiled endemic freshwater biodiversity in Western Ghats Hotspot' in the protected areas of Kerala. They collected the biodiversity details of the study region including geographical locations of species sightings. Threat status of each species was analyzed and spatially overlaid the distribution ranges with the shape file of protected areas. The result of this study shows that 130 endemic freshwater fauna including 57 fishes, 37 amphibians, 17 crabs, 16 shrimps, and 13 odonates were reported from the protected areas of Kerala. The spatial overlapping concluded that 54.6% of endemic fauna including one-third of threatened species and 71% of data deficient species were present outside the boundaries of protected area.

According to the study 'Small carnivores of Biligiri Rangasway Temple Tiger Reserve, Karnataka, India' conducted by Kumara et al (2014) in Karnataka region shows the relation between the distribution of species and their habitat preference. In this study, they classify the forest types of the study area into various groups, Evergreen, Moist and dry deciduous, Scrub forests and plantations. They collect the geographical details of species findings and overlaid above the map of study area and concluded that small carnivores were more in the dry deciduous forest (38.52%), followed by moist deciduous forests (28.68%), 27% in evergreen forests and the least distribution is seen in the scrub forest (5.74%).

3. OBJECTIVES

The main aim of the present study is to estimate the faunal diversity and distribution in the Western Ghats. This involved:

- Literature review - faunal species studies in WG.
- Fauna spatial distribution patterns analyses in WG based on the family, endemism and conservation status.
- Assess the spatial patterns in the distribution of endemic fauna along the latitudinal gradients of WG.

4. STUDY AREA

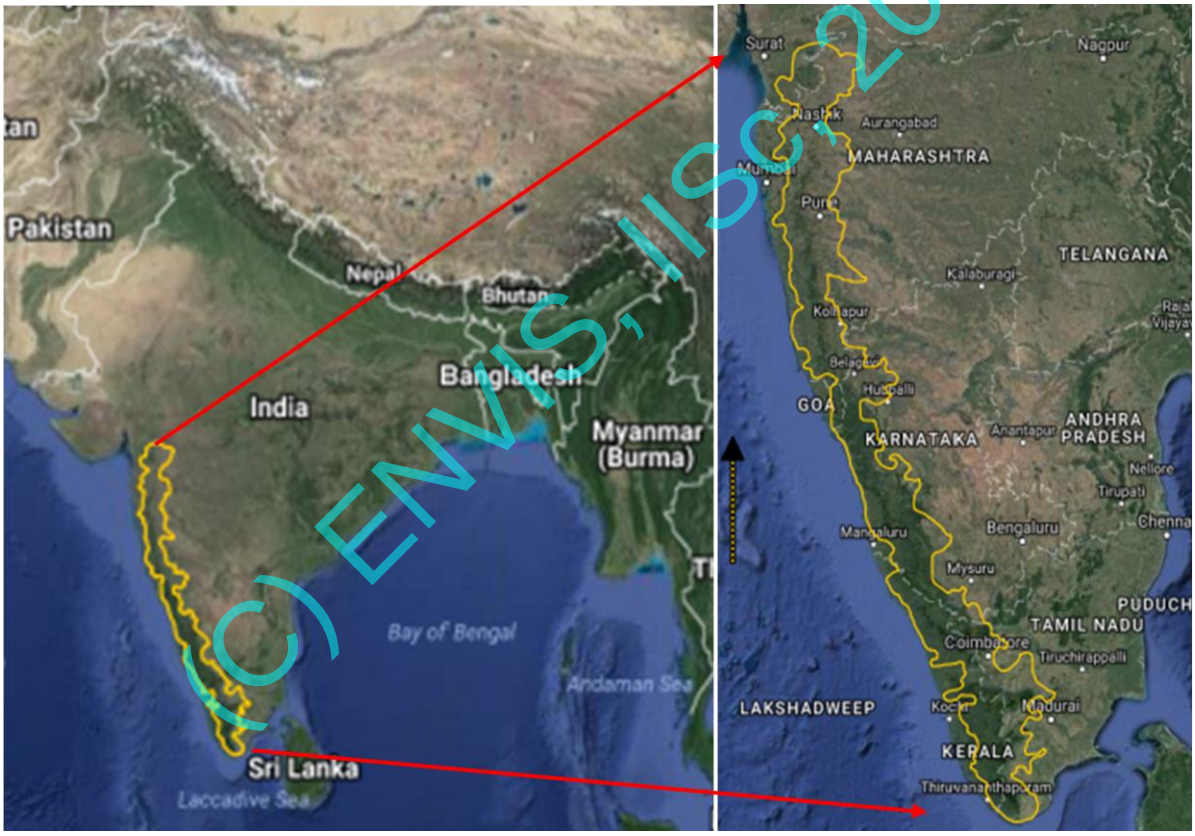


Fig. 4.1. Study Area – Western Ghats.

The Western Ghats is a mountain range of southwest India, considered as one of the 34 Global biodiversity hotspots and also one of the world's eight "Hottest of Biodiversity Hotspots" (Ranjit Daniels, 1992; Anjum Nasreen Rizvi, 2009). This mountain range runs continuously from north to south between 8º0' to 22º26'N latitude and 72º55' to 78º11'E, covering 6 states, Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamilnadu (Fig. 4.1). It covers a distance of

1500 km from Tapti River in the north to Kanyakumari to the south and an area of 1,64,280 sq.km. This continuous mountain range is being interrupted by the 30 km wide Palghat Gap at the latitude around 11˚N (Ranjit Daniels, 1992; Kasturirangan, 2013).

Altitude of Western Ghats ranges from 0 to 2674 m above sea level with the width ranging from 10km to 200km at the narrowest point to the widest point (Ranjit Daniels, 1992; Kasturirangan, 2013) (Fig. 4.2). The hills of greater height (1000-2000m) are seen between 8-13ºN and 18-19ºN. The peaks over 2000m are found only in the Nilgiris, Palanis and Anamalais. The Nilgiris and Palanis are spurred from the main hill chain which extends the Western Ghats eastwards to 78ºE. A narrow coastal strip separates the Western Ghats from the Arabian Sea. The width of the coastal strip varies from 30 to 60 km (Ranjit Daniels, 1992).

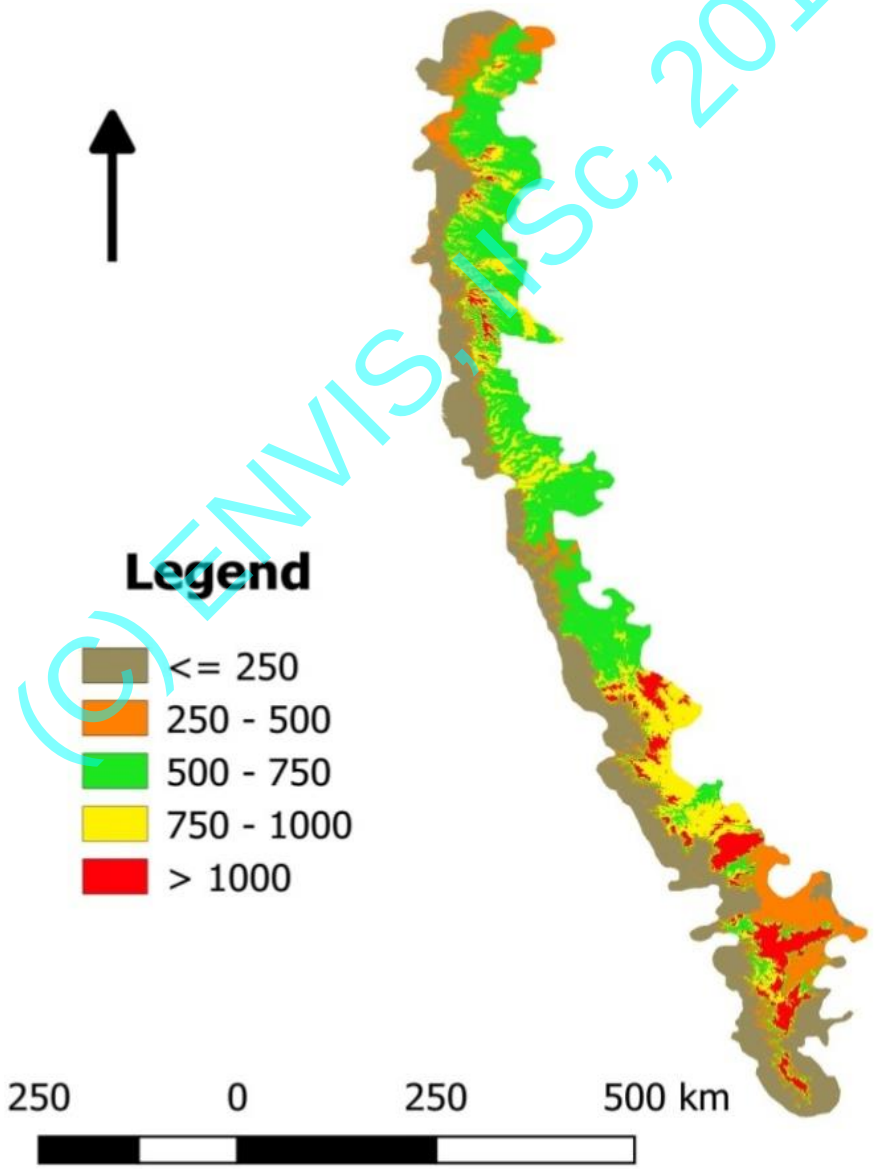


Fig. 4.2. Digital Elevation Model of Western Ghats.

Western Ghats region has an annual average rainfall of 2500 mm. Southwest monsoon brings rainfall in the Western Ghats region in the months of June and October. Hence it is the wettest season in the Western Ghats. Southern latitudes of Western Ghats experience prolonged rainy season due to pre-monsoon and winter showers. Thus the southern Western Ghats has a shortest dry period (2-5 months) and in the northern regions dry period varies from 5 to 8 months. Mean temperature of Western Ghats region ranges between 20 and 24°C. However, it shows fluctuations in according to seasons. In summer, temperature rises beyond 30°C and it falls to 0°C during winter in the higher hills.

The Western Ghats forms an important watershed for the peninsula with a large number of streams and rivers. Due to the prolonged rainy season and steeper hills in the southern region, torrential and perineal hill streams seem to be common. There are 38 east-flowing and 27 west-flowing major rivers originate from the Western Ghats. The west-flowing rivers drain into the Arabian Sea and the east-flowing rivers merge into one of the three major river systems, Cauvery, Krishna, Godavari, and then joins to Bay of Bengal (Dahanukar et al., 2004). These river mouths are acting as a rich habitat for diverse flora and fauna (Mesta et al., 2013).

Western Ghats has been classified into different ecological zones such as wet evergreen forests, dry evergreen climax forests and deciduous climax forests (Ramesh, 2001). It includes different vegetation types like tropical wet evergreen forest, montane stunted evergreen forest (Shola) and grassland, lateritic plateaus, moist and dry deciduous forests, dry thorn forests and grasslands (Raghavan et al., 2012). The vegetation becomes drier from west to east across the hills. Lower elevations on the eastern side contain tropical dry deciduous and thorn forest due to the less availability of rain (<1200m). While tropical moist deciduous forests are more in well-watered areas. With increasing elevation, tropical wet evergreen rainforest appears along the higher slopes and ridges. The western aspect of the hills tends to have mostly tropical moist deciduous and wet evergreen forest types at lower elevations (Champion & Seth, 1968).

Western Ghats is the natural habitat for endemic flora and fauna. 5000 species of flowering plants were reported from the Western Ghats region, among that *Artocarpus hirsutus, Artocarpus heterophyllus, Acacia nilotica, Acacia catechu, Pinanga dicksonii, Vateria indica* are some of the dominant tree species. 139 mammal species, 508 bird species, 179 amphibians, 290 species of freshwater fishes, 174 species of Odonates, 269 Land snails, and 331 butterfly species have been recorded from the Western Ghats region. Out of which at least 325 globally threatened species occur in this region (Myers et al., 2000).

Western Ghats is not only the abode for some of the world's unique fauna, flora and fungi, but also has highest human population. It is more than 300 humans per sq.km, which is higher than that of other hotspots, posing serious challenges to conservation endeavour in the Western Ghats (Molur 2009). It includes 2 Biosphere Reserves, 13 National Parks, and several Wildlife Sanctuaries. Nilgiri Biosphere Reserve is spread over 5,500km² covering the evergreen forests of Nagarahole, deciduous forests of Bandipur National Park and Nuguin Karnataka and adjoining regions of Wayanad, Mudumalai National Park and Mukurthi National Park of Kerala and Tamilnadu forming the largest contiguous protected area (Myers et al., 2000).

5. MATERIALS AND METHODS

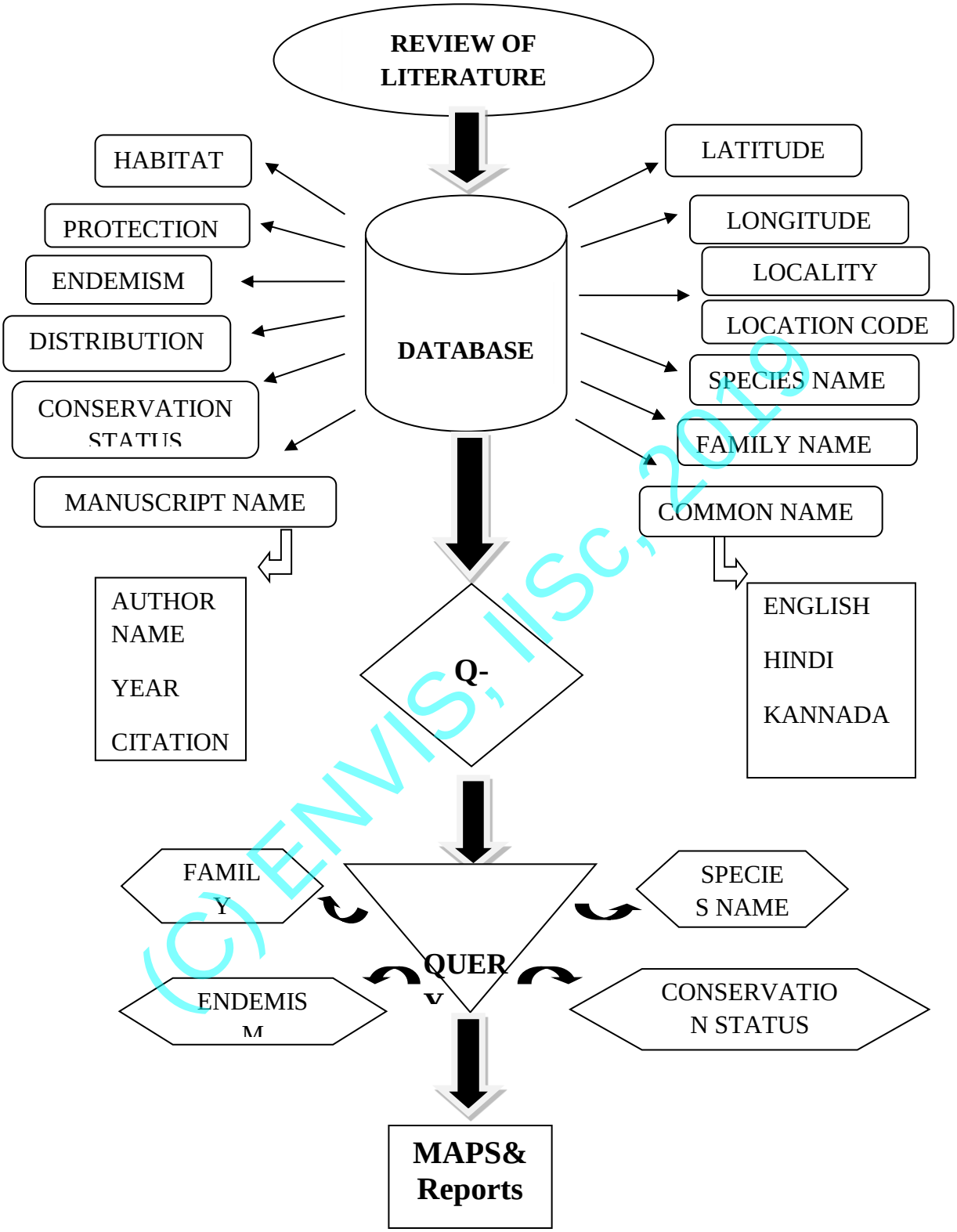


Fig. 5.1. Method followed

Literatures were reviewed and data was compiled covering select fauna - Fishes, Amphibians, Reptiles, Birds and Mammals (Fig. 5.1). Data mining was done from online portals Science

Direct (http://sciencedirect.com) and from Google Scholar (https://www.scholar.google.com/). The authenticity of the articles was reviewed before taking the information such as checking a number of citations, journal impact factor, etc. Some of the prime publications, checklists and management plans of protected areas are also collected from authentic sources such as regulatory agencies's reports. Location details including the geographical coordinates of species sightings were collected from the reviewed articles itself. Google Earth (http://earth.google.com) was used to find out the geographical coordinates of species occurrence locations. Other relevant information such as conservation status, endemism, legal protection, habitat details and taxonomical details of each species were collected from IUCN Red List (http://www.iucnredlist.org), ENVIS Sahyadri: Western Ghats Biodiversity Information System and India Biodiversity Portal (http://wgbis.ces.iisc.ernet.in/biodiversity).

According to the retrieved data, the database was created for each group (Table. 5.1). Location details of species sightings, scientific name, and common names in English, Hindi, Kannada languages, conservation status, endemism, legal protection details, Habitat preference and taxonomical details of each species were included in the database. Manuscript details of the literature from which the species details were retrieved also included in the database. It includes the article name, authors name and year of publication. GIS analysis was used to create distribution maps. This was performed in Q-GIS 2.16.3. To understand the distribution of various species in Western Ghats region, distribution ranges of each species group were overlaid with the shape file of Western Ghats Boundary. Querying function is implemented to retrieve data from each file. Querying includes displaying based on respective species name, family name, conservation status, and endemism. Distribution maps for various groups were created according to the families present in each group. Spatial overlay of Western Ghats boundary and conservation status of each group was done to estimate the distribution of species according to IUCN conservation in the Western Ghats region. Extinct, critically endangered, endangered, vulnerable, near threatened, least concern, data deficient and not evaluated are the categories included in the conservation status. Similarly, spatial overlap of Western Ghats boundary and species which are endemic to Western Ghats from each group were done to estimate the distribution of endemic species in Western Ghats.

Sl No.	Latitude	Longitude	Location	Species Name	Family Name	Conservation Status	Endemism	Common Name	Habitat	Elevation	Protection	Distribution	Author	Year

Table. 5.1: Sample Database Table

6. RESULTS

6.1. Faunal species in Western Ghats

The review covered 360 articles from national and international journals and action plans. As per the mined data, Western Ghats has 335 species of fishes, 248 species of amphibians, 197 species of reptiles, 529 bird species and 161 mammalian species. WG is the abode for many endemic species, amphibians show higher endemism (62%) followed by reptiles (52%), fishes (26%), mammals (6%) and birds (5%). The literature also revealed that many numbers of threatened species are present in the WG region. *Philautus leucorhinus, Philautus temporalis, Philautus nasutus* and *Philautus variabilis* are the extinct amphibian species present in WG region. Many critically endangered species such as *Gonoproktopterus thomassi, Horalabiosa arunachalami, Fejervarya murthii, Philautus kaikatti, Ardeotis nigriceps, Gyps indicus, Millardia kondana, Viverra civettina* are also present in the regions of WG.

Fishes: Western Ghats has 335 species of Fishes across 133 locations, as per the reviewed literature. The study sites include Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamilnadu state portions of Western Ghats (WG) region (Fig. 6.1.1). The review highlights studies have identified 336 species up to species level and 7 has up to genera level. WG region has 52 families of fishes. Cyprinidae is the largest fish family present in the WG which consists of 148 species and many small families with one species are present in the WG regions. Fish families are widely distributed across the WG region. As per the review, Bagridae, Cyprinidae, Mastacembelidae and Siluridae are reported from all states of WG. Ambassidae, Aplocheilidae, Balitoridae, Belonidae, Blenniidae, Channidae, Cichlidae, Cobitidae, Gobiidae, Hemiramphidae, Mugilidae, Nandidae, Osphronemidae, Poeciliidae and Sisoridae families show wide distribution in all states except Gujarat region of WG. Other families are reported across the central and southern WG and also from Goa and Maharashtra regions. Among the 335 species of Fishes, 88 species were Endemic to WG. The analysis depicts about 26% of total population of fishes present are endemic to the WG region.

Amphibians: Western Ghats has 248 species of Amphibians across 383 locations, as per the reviewed literature. The study sites include Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamilnadu state portions of WG (Fig. 6.1.2). These studies have identified 215 species up to species level and 33 has up to genera level. WG region has 11 families of amphibians. The families such as Bufonidae, Dicroglossidae, Ichthyophiidae, Indotyphlidae, Micrixalidae, Microhylidae, Nasikabatrachidae, Nyctibatrachidae, Ranidae, Ranixalidae, and Rhacophoridae

are present in the WG. Rhacophoridae is the largest family consists of 82 species and Nasikabatrachidae is the smallest family consists of only one amphibian species, *Nasikabatrachus sahyadrensis*. Ranixalidae is widely distributed family, reported across all states of WG. Indotyphilidae is reported from all states except Gujarat. Dicroglossidae, Bufonidae, Ranidae, Rhacophoridae, Microhylidae and Nyctibatrachidae show the higher distribution in the WG portion of Maharashtra, Karnataka, Kerala, and Tamilnadu. Ichthyophiidae, Micrixalidae, and Nasikabatrachidae show the higher distribution in the Central and Southern WG region. Among the 248 species of Amphibians, 154 (62%) species were Endemic to WG.

Reptiles: Western Ghats has 197 species of Reptiles across 165 locations in Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamilnadu state portions of WG (Fig. 6.1.3). 186 species has been identified up to species level and 11 has identified only up to genera level.WG region has 19 families of reptiles. The families are Agamidae, Boidae, Chamaeleonidae, Colubridae, Crocodylidae, Elapidae, Gekkonidae, Geoemydidae, Gerrhopilidae, Lacertidae, Pythonidae, Scincidae, Testudinidae, Trionychidae, Typhlopidae, Uropeltidae, Varanidae, Viperidae, and Xenodermidae. Among these 19 reptilian families present in the WG, Colubridae is the largest family with 43 species. Chamaeleonidae, Crocodylidae, Pythonidae, and Varanidae are the smallest reptilian families present in the WG region. As per the review, Elapidae, Pythonidae, and Viperidae are the widely distributed families, reported from the WG regions of all the states. Agamidae, Boidae, Colubridae, Gekkonidae, Scincidae, Trionychidae, and Varanidae are reported from all states except Goa. Chamaeleonidae, Typhlopidae, Uropeltidae shows the higher distribution in Gujarat, Maharashtra, Kerala, and Tamilnadu region of WG. Geoemydidae and Gerrhopilidae show higher distribution in the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu. And the families, Crocodylidae, Lacertidae, Testudinidae, and Xenodermidae show the higher distribution in the Central and Southern WG region. Among the 197 species of Reptiles, 102 (52%) species are Endemic to WG.

Birds: Western Ghats has 529 species of Bird species across 119 locations. The study sites include Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamilnadu state portions of WG (Fig. 6.1.4). These studies have identified 528 species up to species level and one species, *Gallinago sp* has identified only up to genera level. WG region has 85 avian families. Among these, Accipitridae is the largest family consists of 43 species and has many small families which consist of only one species. Majority of the avian families are distributed across the WG

regions of Maharashtra, Karnataka, Kerala, and Tamilnadu. The families like Emberizidae, Glareolidae, Gruidae, Phoenicopteridae, Pteroclidae, and Rostratulidae are reported from the WG region of Maharashtra. Dromadidae and Stercorariidae are observed in the Karnataka region. Cathartidae and Pelecanidae are the avian families reported from the Kerala and Tamilnadu regions of WG respectively. Among the 529 species of Birds, 28 (5%) species were Endemic to WG.

Mammals: Western Ghats has 161 species of Mammals across 148 locations, as per the reviewed literature. The study sites include Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamilnadu state portions of WG (Fig. 6.1.5). These studies have identified 156 species up to species level and 5 species up to genera. WG region has 32 families of mammals. They are Bovidae, Canidae, Cercopithecidae, Cervidae, Elephantidae, Emballonuridae, Equidae, Erinaceidae, Felidae, Herpestidae, Hipposideridae, Hyaenidae, Hystricidae, Leporidae, Lorisidae, Megadermatidae, Molossidae, Muridae, Mustelidae, Pholidota, Platacanthomyidae, Pteropodidae, Rhinolophidae, Rhinopomatidae, Sciuridae, Soricidae, Suidae, Tragulidae, Tupaiidae, Ursidae, Vespertilionidae, and Viverridae. Vespertilionidae is the largest family consists of 25 species present in the WG. Elephantidae, Erinaceidae, Hyaenidae, Hystricidae, Leporidae, Pholidota, Platacanthomyidae, Suidae, Ursidae and Tupaiidae are the smallest families consist of only one species, *Elephas maximus*, *Hemiechinus nudiventris*, *Hyaena hyaena*, *Hystrix indica*, *Lepus nigricollis*, *Manis crassicaudata*, *Platacanthomys lasiurus*, *Sus scrofa*, *Melursus ursinus* and *Anathana ellioti* respectively. Cercopithecidae, Felidae, Hipposideridae, Hystricidae, Muridae, Rhinolophidae, Suidae, Ursidae and Vespertilionidae are widely distributed mammalian family, reported across the regions of WG. Families like Bovidae, Canidae, Leporidae, Pteropodidae, Sciuridae, Tragulidae and Viverridae shows the higher distribution in the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu. Elephantidae, Emballonuridae, Megadermatidae, Mustelidae, and Soricidae are the families show the higher distribution in Karnataka, Kerala and Tamilnadu regions of WG. Equidae, Molossidae and Platacanthomyidae has distributed across southern WG region. Erinaceidae, Rhinopomatidae and Tupaiidae reported from the WG region of Tamilnadu. Among the 161 species of Mammals, 10 species (6%) were Endemic to WG.

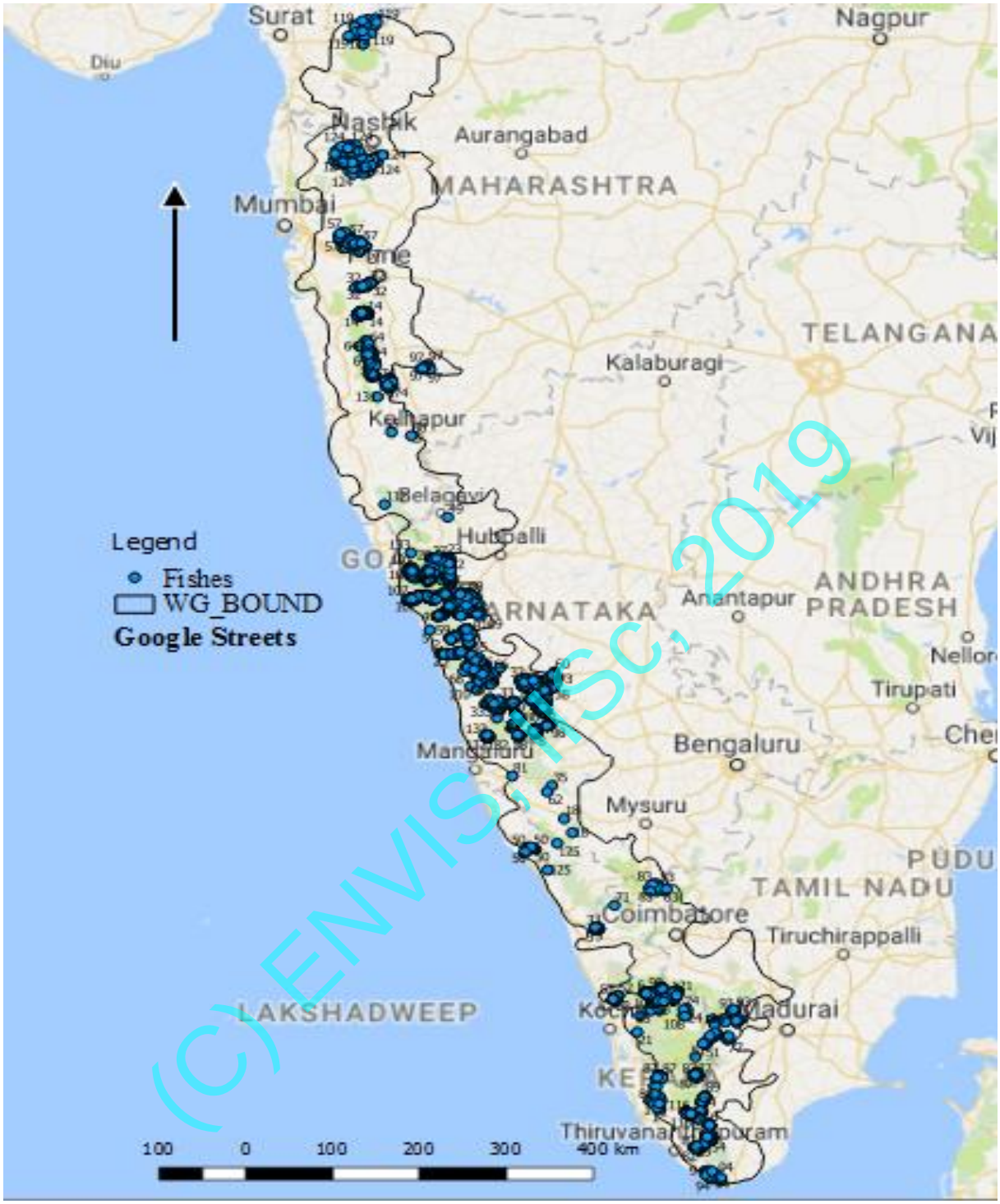


Fig. 6.1.1. Spatial distribution of Fishes in the WG.

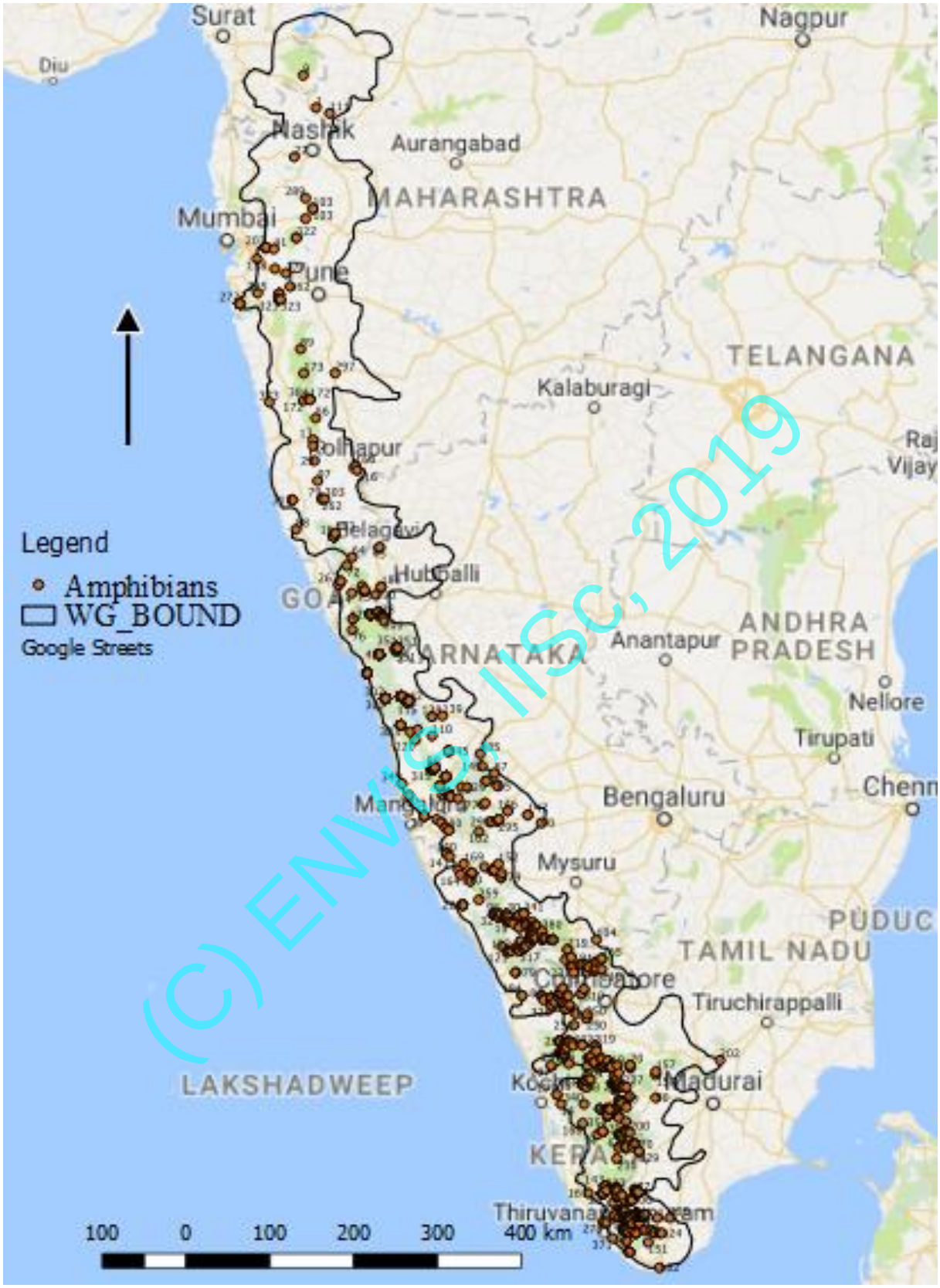


Fig. 6.1.2. Spatial distribution of Amphibians in the WG.

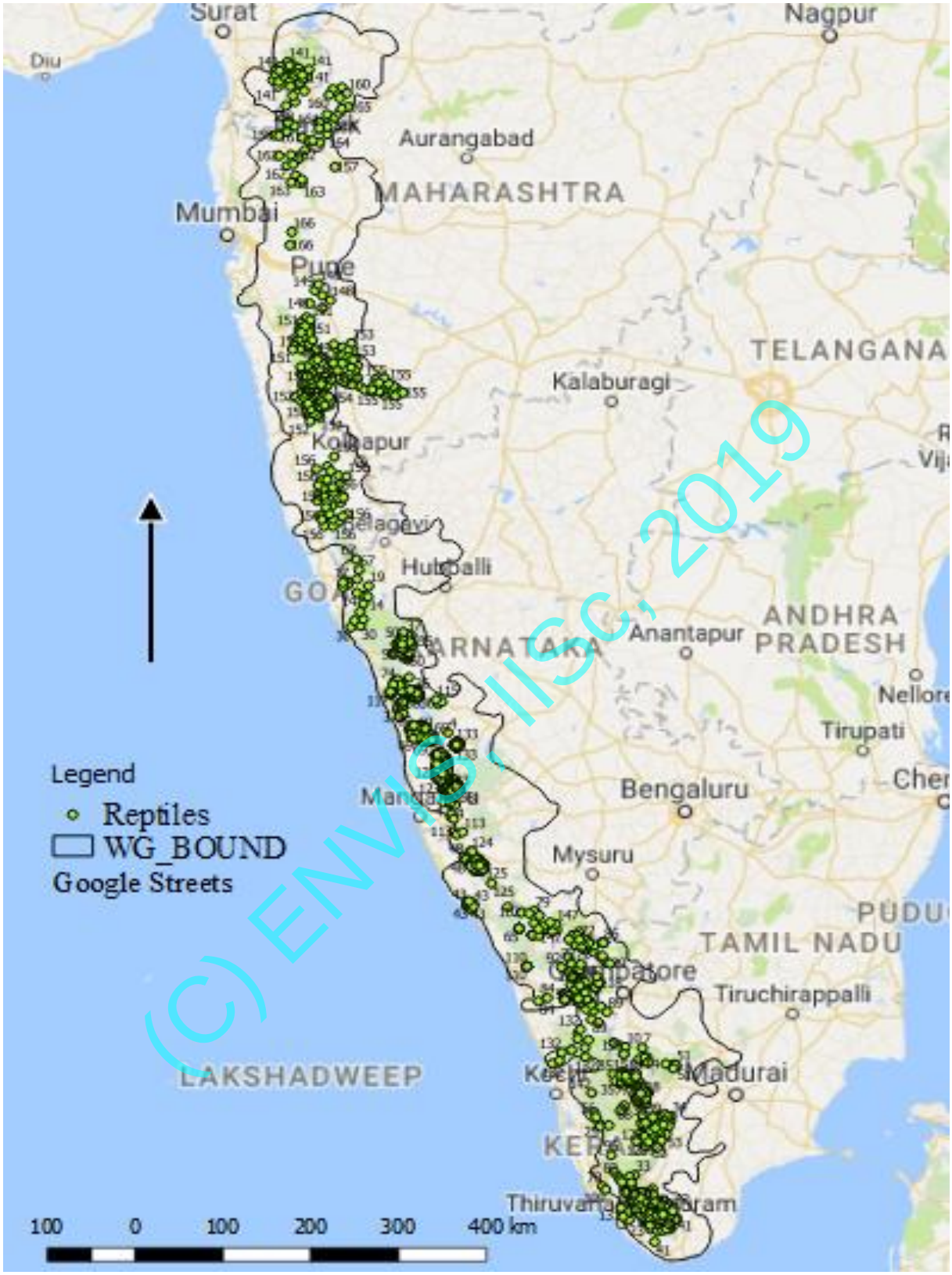


Fig. 6.1.3. Spatial distribution of Reptiles in the WG.

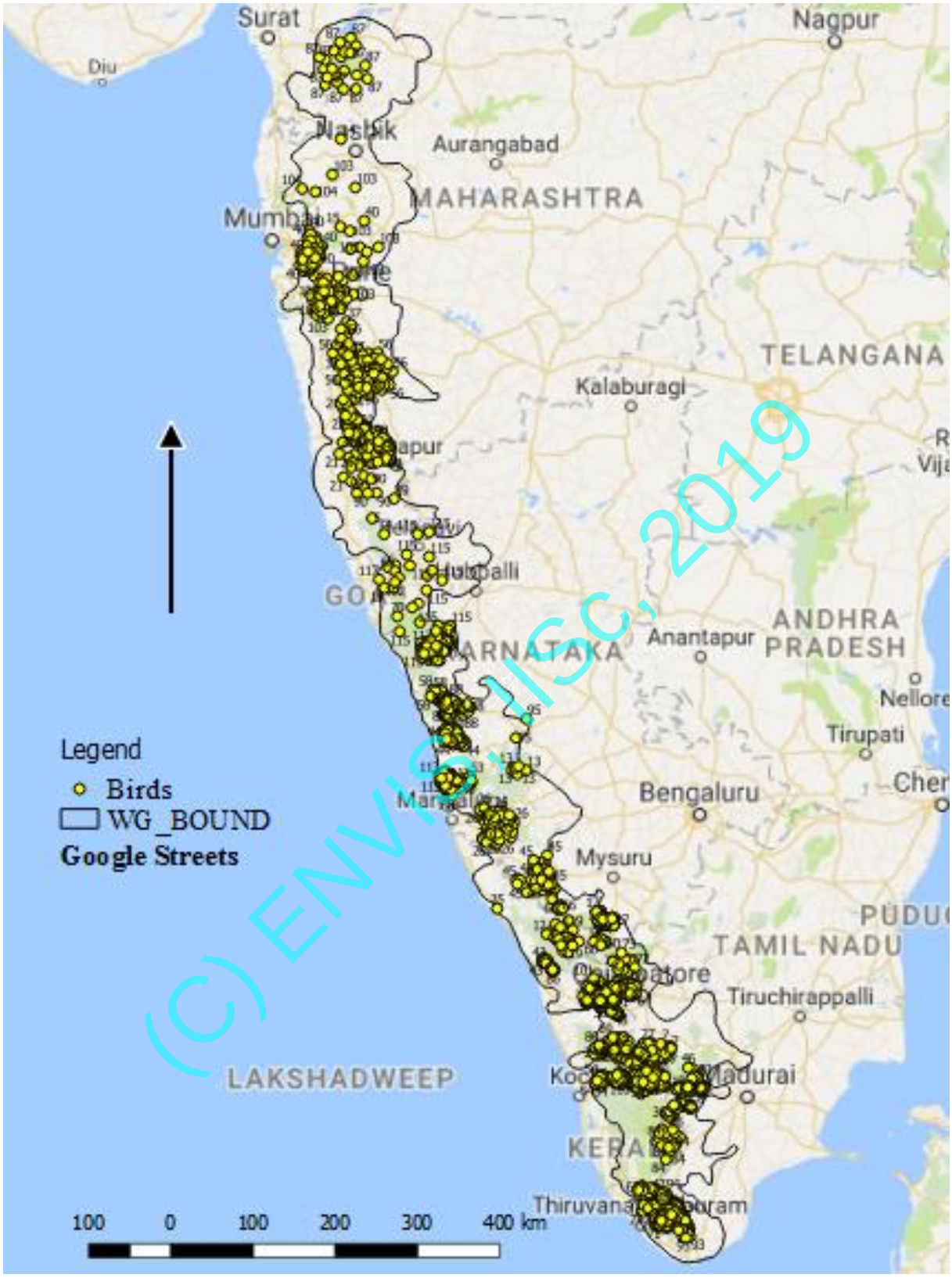


Fig. 6.1.4. Spatial distribution of Birds in the WG.

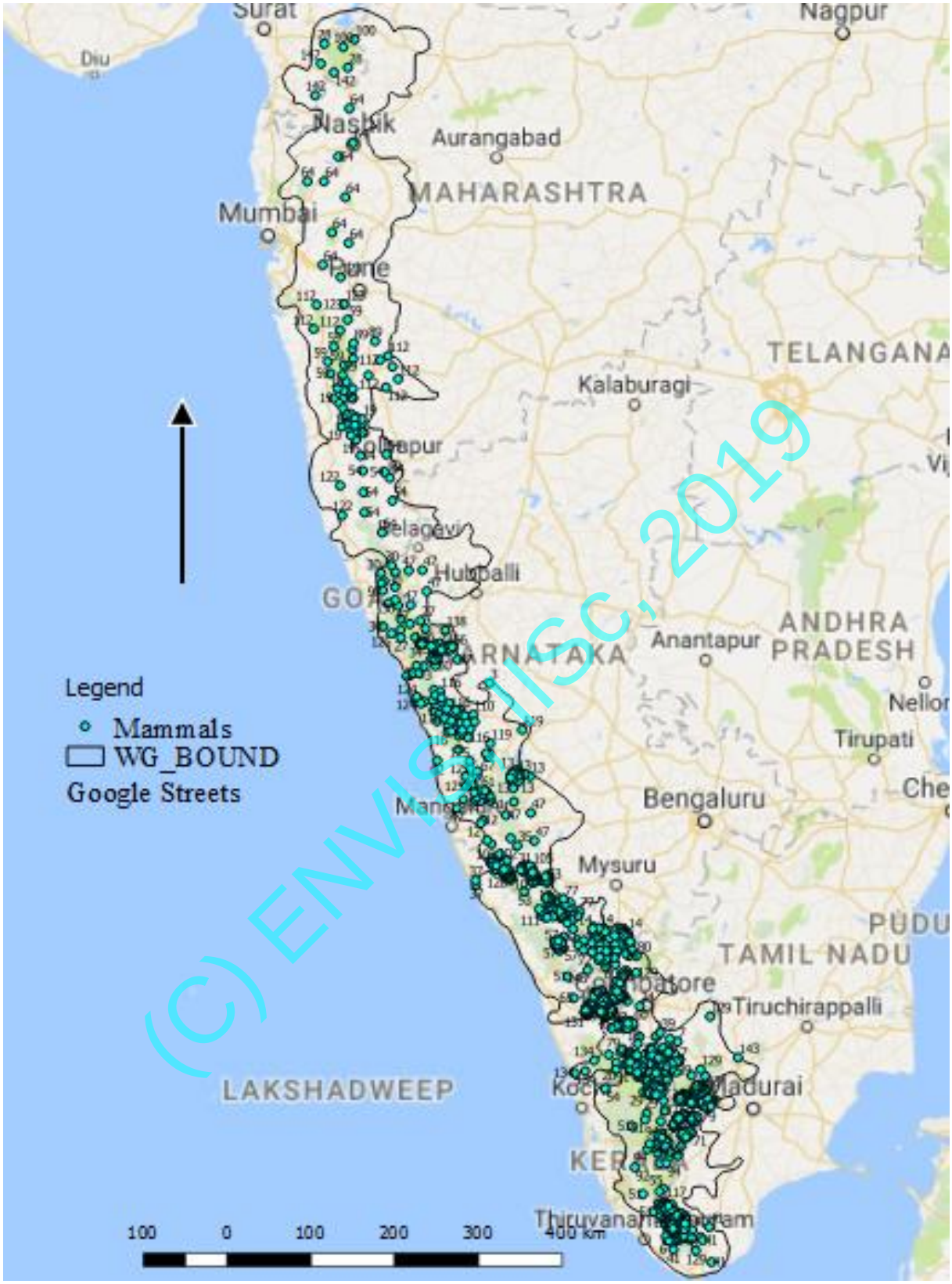


Fig. 6.1.5. Spatial distribution of Mammals in the WG.

6.2. FISHES

Fishes are aquatic animals belongs to the Kingdom Animalia, Phylum Chordata and subphylum Vertebrata. They are cold blooded animals and it poses paired gills, fins, post-anal tail and the elongated body is covered with scales. There are 27977 species of fishes from 515 familiies and 62 orders were described globally (Helfman et al., 2009).

Western Ghats has 335 species of Fishes across 133 locations, as per the reviewed literature. The study sites include Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamilnadu state portions of Western Ghats (WG) region (Fig. 6.2.1). The review highlights studies have identified 336 species up to species level and 7 has up to genera level. WG region has 52 families of fishes. Cyprinidae is the largest fish family present in the WG which consists of 148 species and many small families with one species are present in the WG regions (Fig. 6.2.2a & 6.2.2b). Fish families are widely distributed across the WG region. As per the review, Bagridae, Cyprinidae, Mastacembelidae and Siluridae are reported from all states of WG. Ambassidae, Aplocheilidae, Balitoridae, Belonidae, Blenniidae, Channidae, Cichlidae, Cobitidae, Gobiidae, Hemiramphidae, Mugilidae, Nandidae, Osphronemidae, Poeciliidae, and Sisoridae families show wide distribution in all states except Gujarat region of WG. Other families are reported across the central and southern WG and also from Goa and Maharashtra regions.

Distribution based on the family

Adrianichthyidae is the fish family which includes ricefishes. Ricefishes are small ray-finned fishes found in freshwater and brackish waters. WG has two species of Adrianichthyidae family, *Oryzias melastigma*, and *Oryzias setnai*. As per the review, these species are distributed across the WG region of Karnataka and Maharashtra (Fig. 6.2.3). *Oryzias melastigma* and *Oryzias setnai* are commonly known as Estuarine ricefish and Indian ricefish respectively.

Ambassidae is the family of glassfishes. This family comes under the order Perciformes and it consists of both freshwater and marine fishes. *Ambassis gymnocephalus, Ambassis interrupta, Ambassis nalua, Chanda nama, Parambassis dayi, Parambassis ranga, Parambassis thomassi* and *Pseudambassis baculis* are the Ambassidae species present in WG. These species are reported from the WG region of Maharashtra, Goa, Karnataka, Kerala and Tamilnadu (Fig. 6.2.3). *Ambassis nalua, Parambassis dayi*, and *Parambassis thomassi* are the endemic species present in WG.

Anabantidae are a fish family that includes climbing gouramies or climbing perches. As per the review, it is one of the smallest and widely distributed fish family present in the WG region. *Anabas testudineus* is the only species reported from the WG region. It is commonly known as climbing perch and it is categorized as data deficient species by IUCN red data list. This species shows distribution across Maharashtra, Kerala and Tamilnadu regions of WG (Fig. 6.2.3).

Anguillidae are the family of ray-finned fishes, which includes freshwater eels. *Anguilla bengalensis, Anguilla bicolor* and *Channa marulius* are the species present in WG, across the regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.4). According to IUCN conservation status, *Anguilla bengalensis* and *Anguilla bicolor* are categorized as near threatened species and *Channa marulius* is grouped as least concern.

Family **Aplocheilidae** comes under the order Cyprinodontiformes. Aplocheilus is the only genera of this family present in WG. *Aplocheilus blockii, A. dayi, A. lineatus, A. panchax* and *A.parvus* are reported from Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.4). *Aplocheilus lineatus* is one of the widely distributed species in WG.

Ariidae is the family of catfishes. This family includes marine, freshwater, and brackish water species. *Arius dussumieri, Nemapteryx caelata* and an unidentified Ariidae species have reported from the Southern WG (Fig. 6.2.4). As per the report, *Arius dussumieri* is reported from the Kerala region of WG (Nair et al., 1988) and *Nemapteryx caelata* is reported from Tamilnadu regions of WG (Chellappandian et al., 2014).

Badidae is a small family of freshwater fishes. Members of this family are also known as Chameleonfishes. Out of two genera of this family, *Badis* is the only one genus is reported from the WG region. *Badis badis* and *Badis britzi* are the Badidae species reported from the WG regions of Goa, Karnataka, Kerala and Tamilnadu (Fig. 6.2.5). *Badis badis* is commonly known as Dwarf chameleon fish and it is grouped under least concern category by IUCN conservation status. Dahanukar et al (2015) reported the new species, *Badis britzi* from the Shimoga district of Karnataka.

Blenniidae is the largest family consists of blennies. *Entomacrodus vermiculatus, Omobranchus punctatus* and *Omobranchus zebra* are the Blenniidae species present in the WG region. These species show higher distribution in all states of WG except Gujarat region (Fig. 6.2.5). According to the IUCN conservation status, all the Blenniidae species reported from the WG are listed under the category least concern.

Belonidae family is a fish family consists of needlefishes. It is one of the widely distributed families present in the WG. *Xenentodon cancila* is the only species of the family Belonidae reported from the WG regions of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.5). *Xenentodon cancila* is a least concern species commonly known as Freshwater garfish.

WG region has only one species belongs to the family **Carangidae,** *Caranx sansun*. It is also known as Giant kingfish or yellowfin jack and it is reported from the WG region of Kerala (Nair et al., 1988) (Fig. 6.2.5).

Bagridae are one of the largest families of catfish, it includes more than 200 species. WG has 23 species; *Aorichthys sp, Batasio sharavatiensis, B. travancoria, Horabagrus brachysoma, H. nigricollaris, Mystus armatus, M. bleekeri, M. cavasius, M. gulio, M. keletius, M. krishnensis, M. malabaricus, M. menoda, M. montanus, M. oculatus, M. punctatus, M. vittatus, Rita gogra, R. kuturnee, R. pavimentatus, R. rita, Sperata aor,* and *S. seenghala*. This family is distributed across all states of WG (Fig. 6.2.6). Species *Batasio sharavatiensis* and *Horabagrus brachysoma* are widely distributed across the Karnataka region of WG (Bhat, 2003). *Mystus cavasius* and *Sperata seenghala* are the diverse species in the Bagridae family and it is reported from all states of WG. *Mystus krishnensis* and *Rita gogra* are reported from the Bhadra river of Karnataka (Ahmad et al., 2013; Shahnawaz et al., 2010). *Batasio travancoria* and *Horabagrus nigricollaris* have higher distribution in southern WG. *Mystus armatus, M. oculatus, M. punctatus* and *M. vittatus* are highly distributed in the central and southern regions of WG. *Rita rita* shows higher distribution in WG region Maharashtra (Dahanukar et al., 2004). Mystus is the largest genera present in the WG and its species shows endemism. *Batasio sharavatiensis, Mystus malabaricus, M. montanus, M. oculatus* and *M. punctatus* are the endemic Bagridae species present in the WG. According to the IUCN red data list, *Mystus punctatus* is considered as critically endangered, *Mystus vittatus, Horabagrus brachysoma* and *Batasio travancoria* are categorized as vulnerable species, *Horabagrus nigricollaris* and *Batasio sharavatiensis* are grouped into endangered species and *Mystus malabaricus* as near threatened species.

Balitoridae is the fish family which includes loaches. WG region has 28 species of Balitoridae species and has distributed across the regions of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.7). Loaches are commonly known as Murangi in Kannada. More than 60% of the Balitoridae species present in the WG region are endemic. *Balitora mysorensis, Bhavania australis, Clarias dayi, Homaloptera menoni, Homaloptera Montana, Homaloptera*

santhamparaiensis, Nemacheilus Anguilla, Nemacheilus keralensis, Nemacheilus monilis, Nemacheilus petrubanarescui, Nemacheilus pulchellus, Nemacheilus striatus, Nemachilichthys rueppelli, Schistura nagodiensis, Schistura sharavathiensis, Travancoria elongata, and *Travancoria jonesi* are the species endemic to WG. As per the literature, *Balitora brucei* is reported from Karnataka region of WG (Dahanukar et al., 2004). *Balitora mysorensis* and *Bhavania australis* show higher distribution in Karnataka region. *Clarias dayi, Homaloptera Montana, Homaloptera pillaii, Nemacheilus trinagularis, Homaloptera menoni* and *Travancoria elongata* is highly distributed in southern WG. Arunachalam, 2000 reported an endangered species *Homaloptera santhamparaiensis*, commonly known as Santhampara loach from the Kerala region of WG. *Schistura nagodiensis*, Nagodi loach and *Schistura sharavathiensis*, Sharavati loach are reported from the Karnataka region (Chandran et al., 2007). *Nemacheilus monilis, N.petrubanarescui, N.pulchellus, Schistura nilgiriensis* and *Schistura semiarmatus* show higher distribution in the central and southern WG. According to the IUCN conservation status, *Balitora mysorensis, Nemacheilus keralensis* and *Schistura sharavathiensis* are categorized as vulnerable species, *Homaloptera Montana, H. santhamparaiensis, Nemacheilus petrubanarescui, N. pulchellus, N. striatus, Schistura nagodiensis, Travancoria elongata* and *Travancoria jonesi* are listed under the Endangered category and *Balitora brucei* as near threatened species.

Channidae is the family of fishes commonly known as snakeheads. It has two genera i.e., Channa and Parachanna. Channa is the only genera present in WG. *Channa gachua, C. marulius, C. micropeltes, C. orientalis* and *C. punctatus* are the species distributed across the WG region of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.8). Sreedharan (2004) reported *Channa gachua* from the WG region of Kerala. *Channa marulius* is reported from the Tunga and Bhadra river of Karnataka (Ahmad et al., 2013).

Cichlidae is the family of fishes which includes Cichlids and comes under the order Perciformes. *Etroplus maculates, E. suratensis* and *Oreochromis mossambica* are the Cichlidae species present in the WG. These species are distributed across the Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.8).

Clariidae is the family consists of freshwater air-breathing catfishes. This family comprises of 15 genera and 116 species. Clarias and Horaglanis are the two genera of this family reported from the WG. *Clarias batrachus, C. dussumieri* and *Horaglanis krishnai* are species reported from the Goa, Karnataka, Kerala, and Tamilnadu regions of WG (Fig. 6.2.8). *Clarias*

dussumieri and *Horaglanis krishnai* are the endemic species in WG. IUCN red data list categorized the widely distributed species, *Clarias dussumieri* as near threatened species and *Horaglanis krishnai* in data deficient category.

Clupeidae is a family of ray-finned fishes. This family consists of 54 genera and 198 species. WG has 3 Clupeidae species, *Dayella malabarica, Hilsa kelee, Tenualosa ilisha* and are distributed across the region of Gujarat, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.9). As per the review, *Tenualosa ilisha* is the only Clupeidae species reported from the WG region of Gujarat (Bhakta et al., 2016; Dash et al., 2017).

Cobitidae is the family of true loaches, it consists of 29 genera and 257 species. WG has 5 Cobitidae species, *Acantophthalmus bashai, Botia striata, Lepidocephalus guntea, Lepidocephalus thermalis* and *Pangio goaensis* and has distributed across the regions of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.9). *Botia striata* and *Pangio goaensis* are the species endemic to WG region. *Botia striata* is categorized as an endangered species while all other comes under least concern category. As per the review, *Lepidocephalus guntea* and *Lepidocephalus thermalis* are the widely distributed Cobitidae species.

Cyprinodontidae is the family of pupfishes. It consists of 9 genera and 136 species. Only one species, *Aphanius dispar* is reported from the WG and the literature show it is distributed across the lower parts of rivers, streams and brackish waters of Karnataka and Goa (Fig. 6.2.9). It is a least concern species commonly known as Dispar topminnow or Arabian toothcarp.

Cyprinidae is the fish family which includes freshwater cyprinids and the common members are carps and minnows. It consists of 381 genera and 3072 species of fishes. It is the largest family present in the WG region with 28 genera and 148 species. These species are widely distributed across all states of WG (Fig. 6.2.10a, 6.2.10b & 6.2.10c). As per the reviewed literature, Cyprinidae shows highest distribution in Maharashtra and Karnataka region of WG. *Aspidoparia morar, Barilius evezardi, Chela cachius, Ctenopharyngodon idellus, Devario fraseri, Garra gotylagotyla, Labeo bata, Labeo sindensis, Osteobrama cotiocunma, Osteobrama vigorsii, Parapsilorhynchus discophorus, Parapsilorhynchus prateri, Parapsilorhynchus tentaculatus, Puntius arenatus, Puntius deccanensis, Puntius fraseri, Rasbora labiosa,* and *Salmostoma phulo* are reported from the WG region of Maharashtra. *Barilius vagra, Cyprinus carpio specularis, Labeo angra, Labeo boga, Labeo nigrescens, Puntius cauveriensis, Puntius pleurotaenia, Rasbora caverii, Rasbora rasbora* and *Salmostoma horai* are the species shows the distribution in Karnataka region. Central WG is

the abode of species, *Barilius canarensis, Chela dadyburjori, Pethia setnai, Puntius coorgensis, Puntius narayani, Puntius phutunio* and *Tor putitora.* Dahanukar et al (2004) reported, *Horadandia brittani, Horalabiosa arunachalami* and *Puntius sharmai* from the WG region of Kerala and *Esomus thermoicos, Garra lissorhynchus, Hypselobarbus dobsoni, Hypselobarbus kurali, Puntius aruliustambiraparniei, Puntius rohani* and *Tor khudree malabaricus* from the Tamilnadu region. *Amblypharyngodon microlepis, Crossocheilus periyarensis, Danio neilgherriensis, Garra hughi, Garra mcclellandi, Garra menoni, Garra surendranathinii, Horalabiosa joshuai, Labeo dussumieri, Lepidopygopsis typus, Osteochilichthys longidorsalis, Puntius burmanicus, Puntius chalakkudaiensis, Puntius denisonii,* and *Puntius ophicephalus* are the species which shows higher distribution in Southern WG. *Barilius bakeri, B. canarensis, B. gatensis, Crossocheilus periyarensis, Danio neilgherriensis, Devario fraseri, Garra bicornuta, G. hughi, G. mcclellandi, G. menoni, Gonoproktopterus dubius, Gonoproktopterus kolus, Gonoproktopterus lithopidos, Gonoproktopterus thomassi, Horalabiosa arunachalami, Horalabiosa joshuai, Hypselobarbus dobsoni, Hypselobarbus kurali, Hypselobarbus micropogon, Labeo kawrus, Labeo potail, Osteobrama bakeri, Osteobrama neilli, Osteochilichthys brevidorsalis, Osteochilichthys longidorsalis, Parapsilorhynchus discophorus, Parapsilorhynchus prateri, Pethia setnai, Puntius arenatus, P. carnaticus, P. cauveriensis, P. deccanensis, P. denisonii, P. dubius, P. fasciatus, P. fraseri, P. ophicephalus, P. rohani, P. sahyadriensis, P. saranaorphoides, P. wynaadensis, Rasbora labiosa, Rohtee ogilbii, Salmostoma boopis* and *Tor mussullah* are the 45 Cyprinidae species which are endemic to WG. According to the IUCN status, *Gonoproktopterus thomassi, Horalabiosa arunachalami, Puntius bovanicus, P. deccanensis* and *P. wynaadensis* are categorized as critically endangered species. *Barilius canarensis, Crossocheilus periyarensis, Gonoproktopterus dubius, Hypselobarbus curmuca, H. micropogon, Labeo potail, Lepidopygopsis typus, Osteobrama cotiopeninsularis, Osteochilichthys longidorsalis, O. thomasi, Puntius arulius, P. cauveriensis, P. denisonii, P. dubius, P. fraseri, P. melanostigma, P. ophicephalus, P. sharmai, Schismatorhynchos nukta, Tor khudree, T. khudree malabaricus, T. mussullah* and *T. putitora* are grouped as endangered species and *Chela fasciata, Cirrhinus cirrhosus, Cyprinus carpio, Devario fraseri, Garra menoni, Gonoproktopterus kolus, Parapsilorhynchus discophorus, Pethia setnai, Puntius arenatus, P. pleurotaenia, P. rohani, P. sarana sarana* and *Salmostoma horai* comes under the vulnerable category

Eleotridae is the fish family which includes medium sized fishes closely related to gobies. This family contains 134 genera and 179 species. Eleotridae is one of the smallest families present in WG region and it includes only one species *Eleotris fusca*. It is distributed across the regions of southern WG (Fig. 6.2.11). It is a least concern species commonly known as Brown spinecheek gudgeon, Dusky sleeper.

Elopidae is the family of ray-finned fishes consists of only one genus Elops. *Elops machnata* is the only Elopidae species reported from the southern WG region (Fig. 6.2.11). It is commonly known as ladyfish or Indo-pacific tarpon. According to IUCN conservation status, it is categorized as least concern species.

Gobiidae is the one of the largest fish family consists of more than 2000 species. Gobies are the fishes included in this family. WG has 8 species *Awaous grammepomus, Bathygobius fuscus, Brachygobius nunus, Glossogobius giuris, Periophthalmus variabilis, Sicyopterus fasciatus, Sicyopterus griseus* and *Stigmatogobius javanicus*. These species are distributed across Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu regions of WG (Fig. 6.2.11). As per the review, *Glossogobius giuris* is the widely distributed Gobiidae species in WG. *Awaous grammepomus, Bathygobius fuscus* and *Periophthalmus variabilis* show higher distribution in the WG region of Karnataka and Goa. Dahanukar et al (2004) reported *Brachygobius nunus* and *Stigmatogobius javanicus* from the Maharashtra regions of WG. *Sicyopterus fasciatus* and *Sicyopterus griseus* show higher distribution in southern WG.

Haemulidae family includes fishes which are commonly known as grunts. This family comprises 19 genera and 133 species. *Plectorhinchus gibbosus* and *Pomadasys argenteus* are the Haemulidae species present in the WG region and it is distributed across the regions of Karnataka, Goa and Kerala (Fig. 6.2.12). As per the review, *Plectorhinchus gibbosus* is reported from Kerala region of WG (Nair et al., 1988). *Pomadasys argenteus* is highly distributed in Karnataka and also reported from Goa regions of WG (Dahanukar et al., 2004).

Hemiramphidae is the family of fishes commonly known as halfbeaks. This family has 8 genera and 62 species. From the WG region, only two Hemiramphidae species are reported. They are *Hyporhamphus limbatus* and *Hyporhamphus xanthopterus* and has distributed across the region of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.12). *Hyporhamphus xanthopterus*, commonly known as Vembanad halfbeak is an endemic species categorized under the vulnerable category is reported from the southern WG regions.

Engraulidae is one of the smallest fish families present in WG region. It has 17 genera and 146 species. *Stolephorus commersonnii* is the only species reported from the Kerala region of WG (Sreedharan, 2004) (Fig. 6.2.12). It is commonly known as Devis's anchovy or white-bait.

Heteropneustidae is also one of the smallest fish families, it consists only one genus and 5 species. *Heteropneustes fossilis* is the only species present in the WG regions of Maharashtra, Karnataka, Kerala and Tamilnadu (Fig. 6.2.12). It is commonly known as stinging catfish and grouped in the least concern category.

Lutjanidae is the family belongs to the order perciform, the members of this family are commonly known as snappers. These are marine fishes but also seen in estuaries and freshwaters. It has 17 genera and 110 species. *Lutjanus johnii* is the only species reported from the WG. It shows distribution in the Karnataka and Goa regions (Fig. 6.2.13). According to IUCN status, it is categorized as least concern and it is commonly known as Golden snapper or John's snapper.

Mastacembelidae is the family of fishes generally known as Spiny Eels. It has 3 genera and 86 species. It is one of the widely distributed families in the WG and it includes 4 species, *Macrognathus guentheri, M. malabaricus, M. pancalus* and *Mastacembelus armatus*. These species shows wide distribution across all states of WG (Fig. 6.2.13). According to the review, *Mastacembelus armatus* shows wide distribution across all states of WG. Murugan et al (2015) reported *Macrognathus malabaricus* from the WG region of Tamilnadu. *Macrognathus guentheri* shows higher distribution in Southern WG. *Macrognathus pancalus* is highly distributed in Karnataka and Kerala regions of WG.

Nandidae family includes small freshwater fishes commonly known leaffishes. It has only 3 genera and 9 species and mostly observed in South Asia. *Nandus nandus, Pristolepis fasciata* and *Pristolepis marginata* are the Nandidae species present in WG and has distributed across the WG regions of Maharashtra, Goa, Karnataka, Kerala and Tamilnadu (Fig. 6.2.13). *Pristolepis fasciata* and *Pristolepis marginata* are the species which are endemic to WG region. All the Nandidae species are categorized as least concern by IUCN red data list.

Megalopidae are the family of tarpons, large air-breathing fishes. This family comprises of 1 genus and 2 species, one is native to Atlantic and other to Indo-Pacific regions. *Megalops cyprinoides* is the species present in the WG. It shows the distribution in the WG regions of

Karnataka, Goa, Kerala and Tamilnadu (Fig. 6.2.14). It is commonly known as Ox-eye tarpon or Indo-Pacific tarpon and it is categorized as a data deficient species.

Mugilidae is the family consists of 20 genera and 78 species. Members of this family are commonly known as Mullets. WG has 5 Mugilidae species, *Liza macrolepis*, *Liza parsia*, *Mugil cephalus*, *Rhinomugil corsula* and *Valamugil cunnesius*. Species of Mugalidae family are distributed across the WG region of Maharashtra, Goa, Karnataka, Kerala and Tamilnadu (Fig. 6.2.14). As per the literature, *Liza macrolepis* and *Mugil cephalus* show higher distribution in Karnataka and Goa regions of WG. *Valamugil cunnesius* is reported from the Kerala region of WG (Nair et al, 1988).

Nemacheilidae is the family of loaches comes under the order Cypriniforms. WG has 1 genus and 4 Nemacheilidae species out of total 46 genera and 650 species. *Nemacheilus evezardi*, *Nemacheilus guentheri*, *Nemacheilus sinuatus* and *Oreonectes keralensis* are distributed across the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.14). As per the review, *Nemacheilus evezardi* shows higher distribution in Karnataka and Maharashtra regions of WG. *Nemacheilus sinuatus* ie reported from the Nilgiri biosphere reserve (Daniels, 1993). A vulnerable species, *Oreonectes keralensis* is reported from the Kerala regions of WG (Radhakrishnan, 2002). *Nemacheilus guentheri* is the only Nemacheilidae species which is endemic to WG.

The members of **Notopteridae** family are commonly known as featherbacks or knifefishes. It consists of 4 genera and 10 species and commonly lives in freshwaters and brackish water. WG has 2 Notopteridae species; *Notopterus chitala* and *Notopterus notopterus* across the regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.15). The review shows that *Notopterus chitala* is distributed in the WG regions of Maharashtra (Dahanukar et al., 2004). Both the species as categorized as least concern by IUCN red data list.

Osphronemidae family comes under the order perciforms and includes freshwater fishes known as gourami. *Osphronemus goramy* and *Pseudosphromenus cupanus* are the Osphronemidae species present in the Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.15). According to IUCN conservation status, these species are grouped as least concern species.

Pangasiidae is the family of shark catfishes and it includes 4 genera and 28 species. WG has only one Pangasiidae species, *Pangasius pangasius*. It is commonly known as Pungas and distributed across the regions of southern WG (Fig. 6.2.15).

Poeciliidae are the family of freshwater fishes comes under order Cyprinodontiformes. *Gambusia affinis, Poecilia reticulata, Xiphophorus hellerii and Xiphophorus maculates* are the species of this family present in WG. These species are distributed across Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.16). As per the review, *Poecilia reticulata* is the widely distributed species and *Xiphophorus hellerii* is reported from the WG region of Maharashtra. *Xiphophorus maculatus* shows the higher distribution in the southern WG (Raghavan et al., 2008).

Psilorhynchidae is one of the smallest fish families present in the WG. Only one species, *Psilorhynchus tenura* is reported from the WG region of Karnataka (Ahmad et al., 2013). This species shows endemism in WG and it is categorized as critically endangered species by IUCN red data list (Fig. 6.2.16).

Salmonidae is the family of ray-finned fishes comes under the order Salmoniformes. Freshwater whitefishes, Salmons, trouts and graylings are the members of this family. As per the literature, from WG region, *Salmo gairdnerii gairdnerii* is the only one Salmonidae species is reported. It is reported from the Kerala region of WG (Radhakrishnan, 2002). This species is commonly known as Rainbow trout (Fig. 6.2.16).

Schilbeidae is the family of catfishes, the members are generally known as Schilbid catfishes. This family has 15 genera and 67 species. *Eutropiichthys goongwaree, Eutropiichthys vacha, Neotropius khavalchor, Proeutropiichthys taakree taakree, Pseudeutropius mitchelli* and *Silonia childreni* are species reported from the WG regions of Maharashtra, Karnataka, Kerala and Tamilnadu (Fig. 6.2.17). According to the reviewed literature, *Eutropiichthys goongwaree* and *Eutropiichthys vacha* commonly known as Goongwaree vacha and Batchwa vacha respectively, are reported from Maharashtra regions of WG (Dahanukar et al., 2004). *Neotropius khavalchor* and *Proeutropiichthys taakree taakree* show higher distribution in the WG region of Karnataka and Maharashtra. *Pseudeutropius mitchelli* and *Silonia childreni* are the two endangered and endemic species present in the WG.

Scatophagidae is the family of scats. *Scatophagus argus*, commonly known as spotted scat has reported from the WG regions of Karnataka, Goa, Kerala, and Tamilnadu (Fig. 6.2.17).

This species is categorized as least concern and commonly seen in Estuaries, Harbours, Mangrove Sloughs, Lower Reaches of Freshwater Streams, especially with High Mineral Concentrations.

Sciaenidae is the family of croakers. *Johnius belangerii* is the croaker commonly known as Belanger's croaker present in the WG region. This species shows the distribution in Karnataka and Goa regions of WG (Fig. 6.2.17).

Siluridae family includes catfishes and it has 12 genera and 120 species. *Ompok bimaculatus, O. pabo, Pterocryptis berdmorei, Silurus wynaadensis* and *Wallago attu* are the species present in the WG. These Siluridae species shows distribution in entire states of WG (Fig. 6.2.18). As per the review, *Ompok bimaculatus* (Indian butter-catfish) is the widely distributed species. Dahanukar et al, (2004) reported *Pterocryptis berdmorei* from the WG regions of Karnataka. *Silurus wynaadensis* is the endemic species present in the WG region. As per the IUCN status, *Silurus wynaadensis* is considered as endangered species and *Ompok bimaculatus, Ompok pabo* and *Wallago attu* as near threatened species.

Sillaginidae members are generally known as sand borers or Whitings. *Sillago sihama* is the Sillaginidae species present in the WG region. It is also known as Sand Whiting or Silver Sillago. *Sillago sihama* is a least concern species shows the higher distribution in the WG region of Kerala (Fig. 6.2.18).

Sisoridae is the family of catfishes. WG has 12 Sisoridae species*; Bagarius bagarius, Bagarius yarrelli, Gagata gagata, Glyptothorax anamalaiensis, G. annandalei, G. housei, G. lonah, G. madraspatnum, G. poonaensis, G. saisii* and *G. trewavasae*. These species are distributed across the region of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.19). As per the review, *Bagarius bagarius, Gagata gagata, Glyptothorax poonaensis* and *Glyptothorax saisii* shows higher distribution across the WG regions Karnataka. *Glyptothorax anamalaiensis* and *Glyptothorax housei* are highly distributed in the southern WG. *Glyptothorax anamalaiensis, G. housei, G. poonaensis* and *G. trewavasae* are the endemic species. According to IUCN conservation status, *Glyptothorax anamalaiensis, Glyptothorax housei* and *Glyptothorax poonaensis* are grouped as endangered species, *Gagata itchkeea, Glyptothorax madraspatnum, G. saisii* and *G. trewavasae* are categorized as vulnerable species and *Bagarius bagarius* and *Bagarius yarrelli* are categorized as near threatened species.

Soleidae is the family of flatfishes. It consists of 32 genera and 174 species. *Brachirus orientalis* is the only Soleidae species present in the WG region. It is commonly known as Oriental-sole or Sole and has distributed in the WG region of Kerala and Tamilnadu (Fig. 6.2.20).

Synbranchidae is the family of swamp eels and it consists of 4 genera and 23 species. WG has only one genus, Monopterus. *Monopterus eapeni*, *M. fossorius* and *M. indicus* are the species distributed across the WG regions of Maharashtra, Kerala and Tamilnadu (Fig. 6.2.20). According to the Reviewed literatures, *Monopterus indicus* has distributed across the WG region of Maharashtra (Dahanukar et al., 2004). *Monopterus indicus* is the Synbranchidae species which is endemic to WG. *Monopterus fossorius* is categorized under endangered species and *Monopterus indicus* is grouped as vulnerable species.

Syngnathidae is the family of pipefishes. WG has 2 species, *Ichthyocampus carce* and *Microphis cuncalus* have distributed across the WG region of Maharashtra, Goa and Karnataka (Fig. 6.2.20). *Ichthyocampus carce* and *Microphis cuncalus* are commonly known as Indian freshwater pipefish and Crocodile-tooth pipefish respectively.

Synodontidae is the fish family comprises of lizardfishes. It has 4 genera and 73 species. *Harpadon nehereus* (Bombay duck) is the Synodontidae species distributed across the WG region of Kerala (Vijayakumar et al., 2015) (Fig. 6.2.20).

Terapontidae is the family consists of tigerperches or grunters. *Terapon jarbua* is the Species reported from the WG region of Kerala (Nair et al., 1988). It is also known as Jarbua Terapon or Tiger-perch and it is categorized under the least concern category (Fig. 6.2.21).

Tetraodontidae family includes pufferfishes and it contains 29 genera and 200 species. *Arothron immaculatus*, *Carinotetraodon travancoricus* and *Chelonodon patoca* are the species which has distributed across the WG region of Karnataka, Goa, Kerala and Tamilnadu (Fig. 6.2.21). *Arothron immaculatus* and *Chelonodon patoca* are the species reported from the WG region of Kerala (Nair et al., 1988). *Carinotetraodon travancoricus* is the vulnerable species and it also shows endemism to WG region.

Trichluridae is a fish family generally includes cutlassfishes. WG has only one species of Trichluridae family out of 10 genera and 45 species. *Lepturacanthus savala* commonly known as Small-headed ribbonfish or ribbon fish is distributed across the WG region of Tamilnadu (Chellappandian et al., 2014) (Fig. 6.2.21).

Zenarchopteridae is the fish family comes under the order Beloniformes and the members of this family are known as halfbeaks. WG has only one Zenarchopteridae species, *Zenarchopterus striga*. It has distributed across the regions of Karnataka and Goa (Fig. 6.2.21). *Zenarchopterus striga* is commonly known as Hooghly halfbeak.

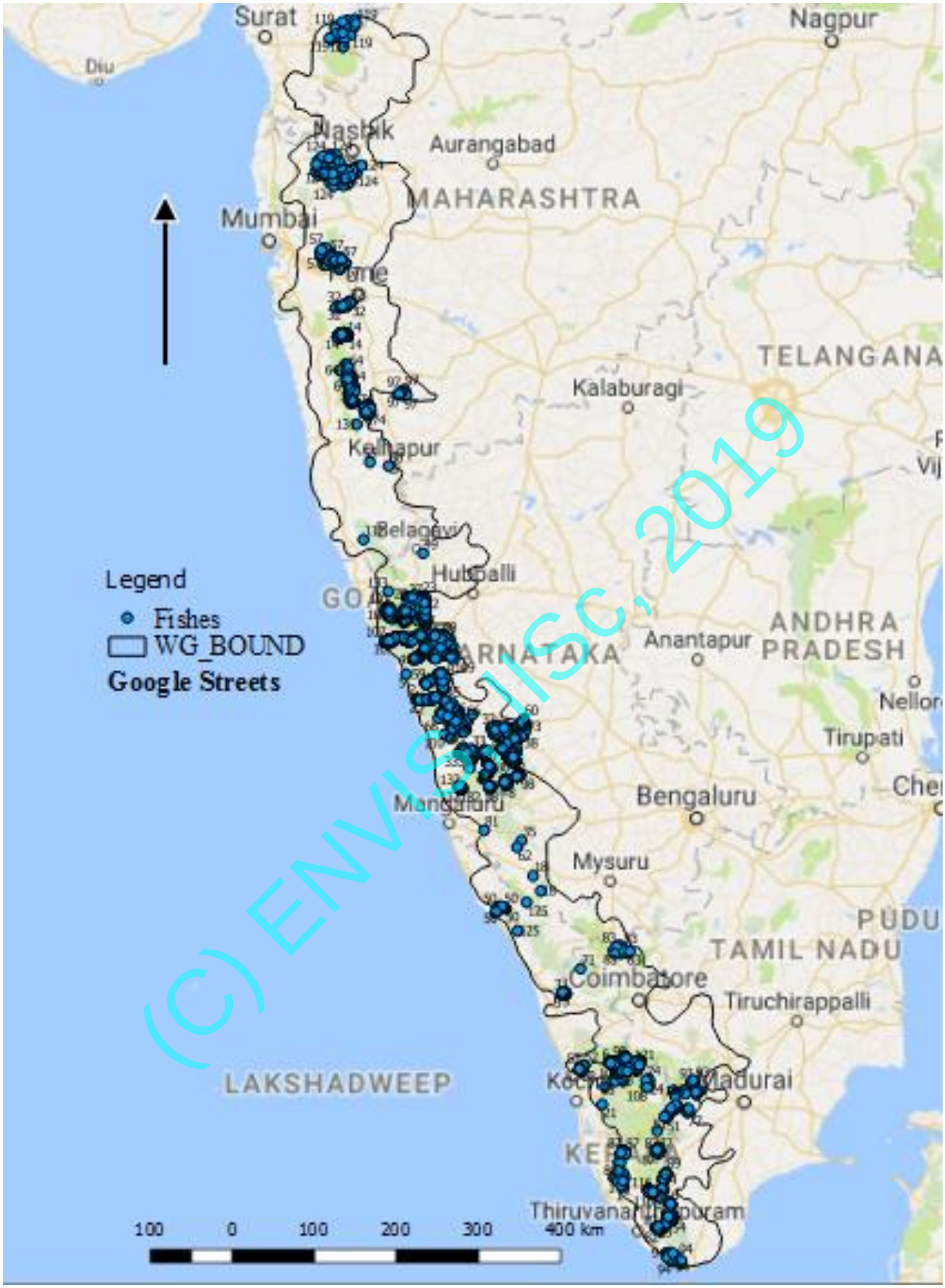


Fig. 6.2.1. Spatial Distribution of Fishes in the WG.

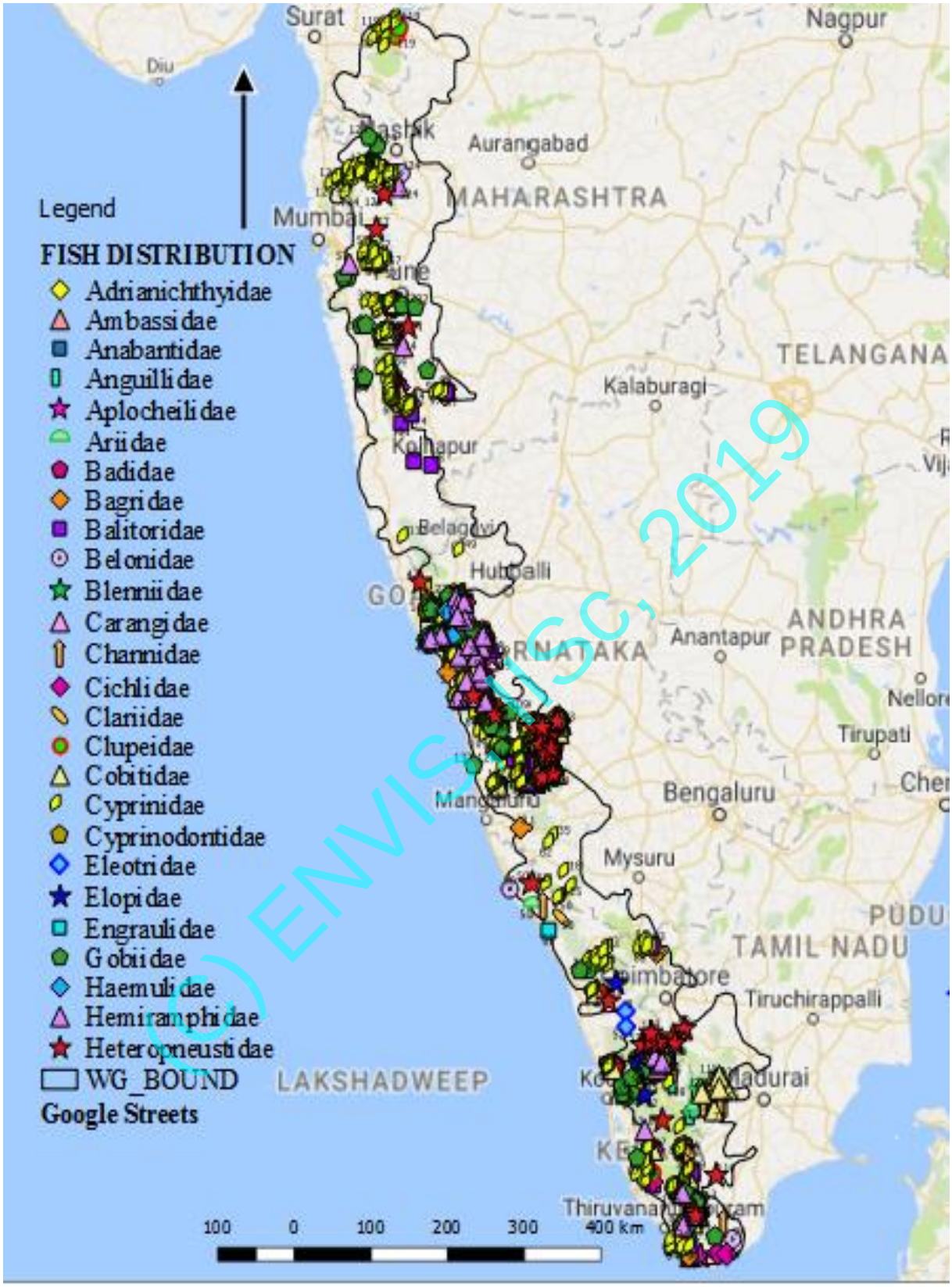


Fig. 6.2.2a. Spatial distribution of Fish families in WG.

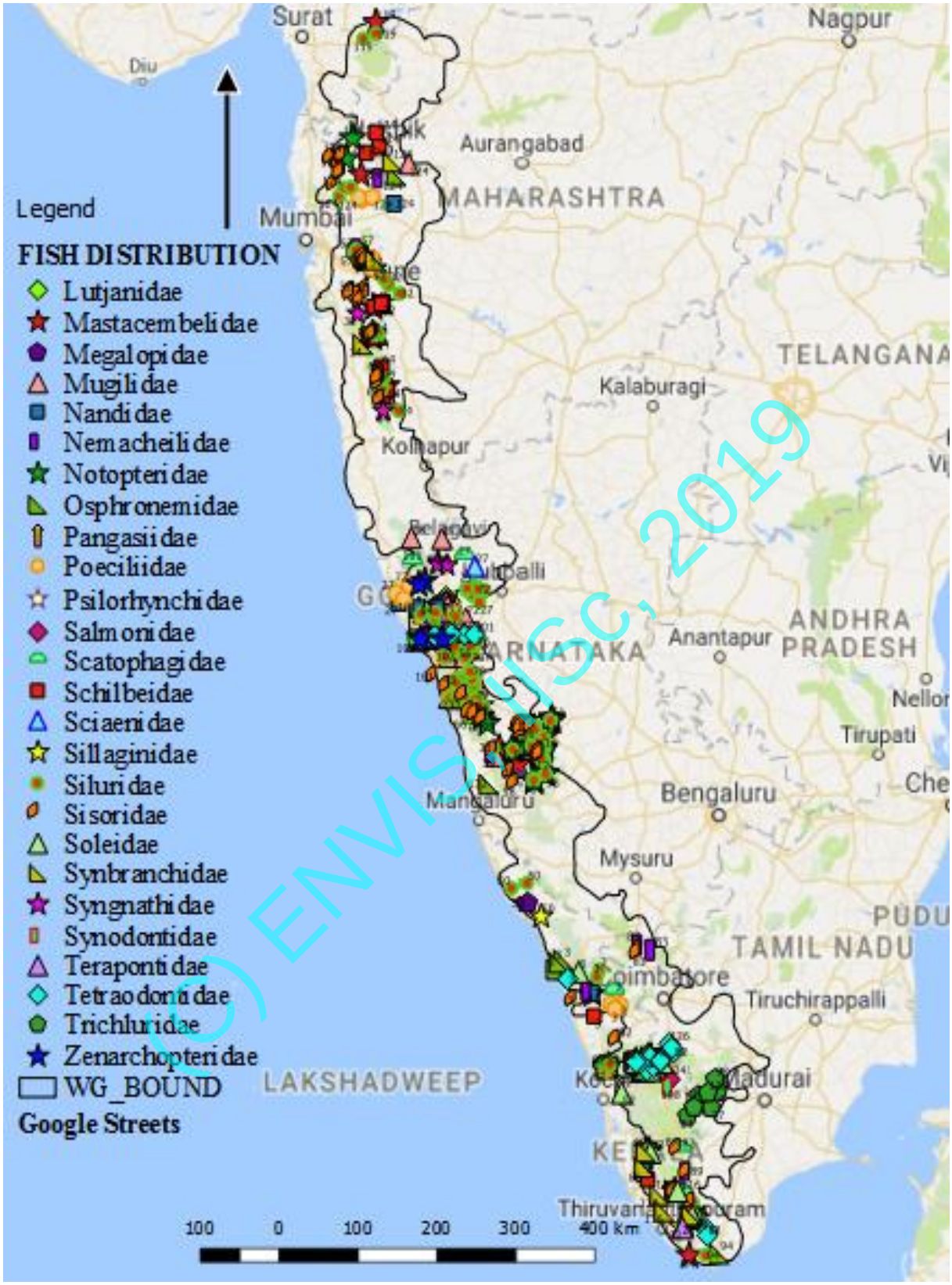


Fig. 6.2.2b. Spatial distribution of Fish families in WG.

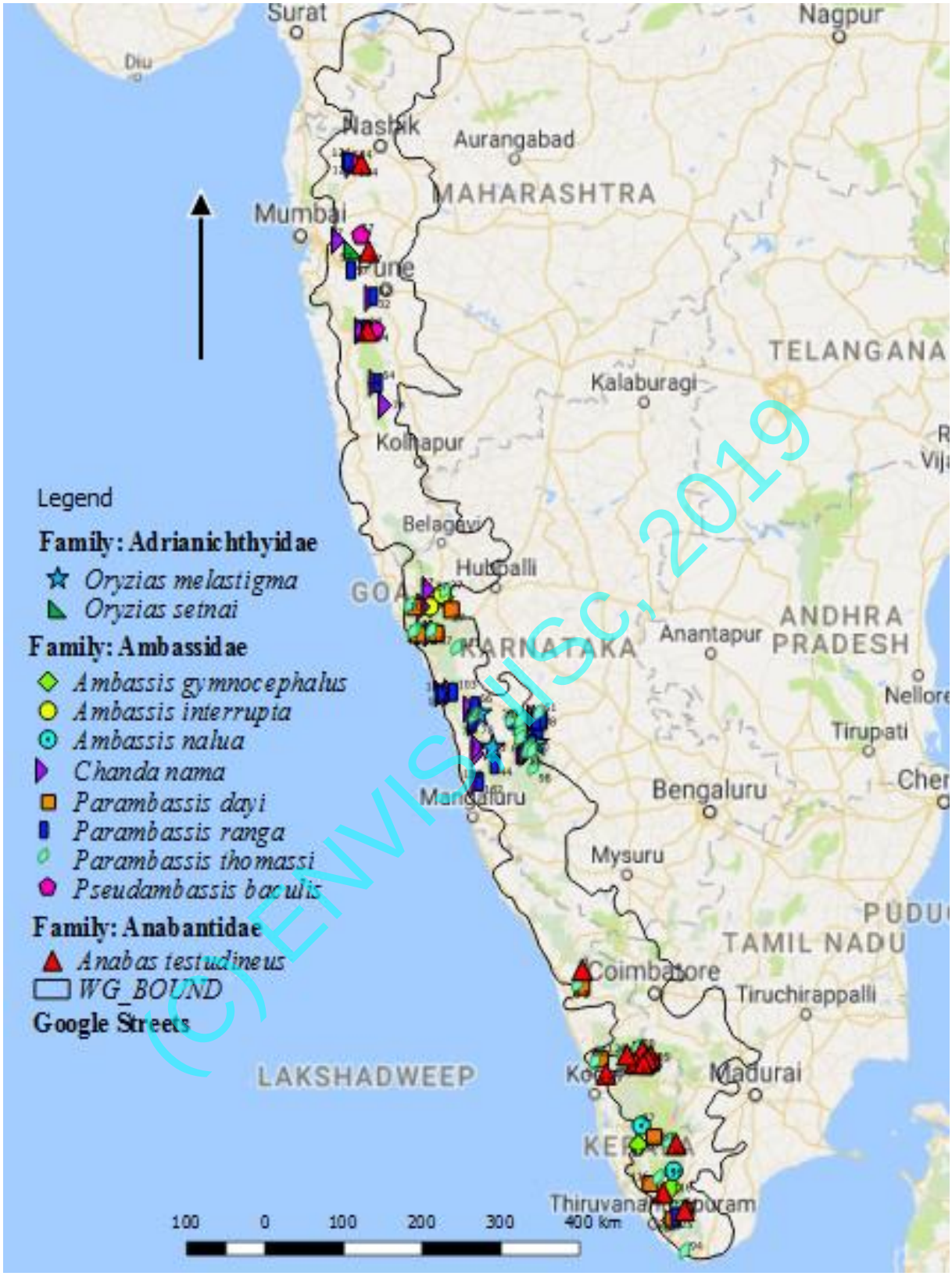


Fig. 6.2.3. Spatial distribution of the Adrianichthyidae, Ambassidae and Anabantidae families.

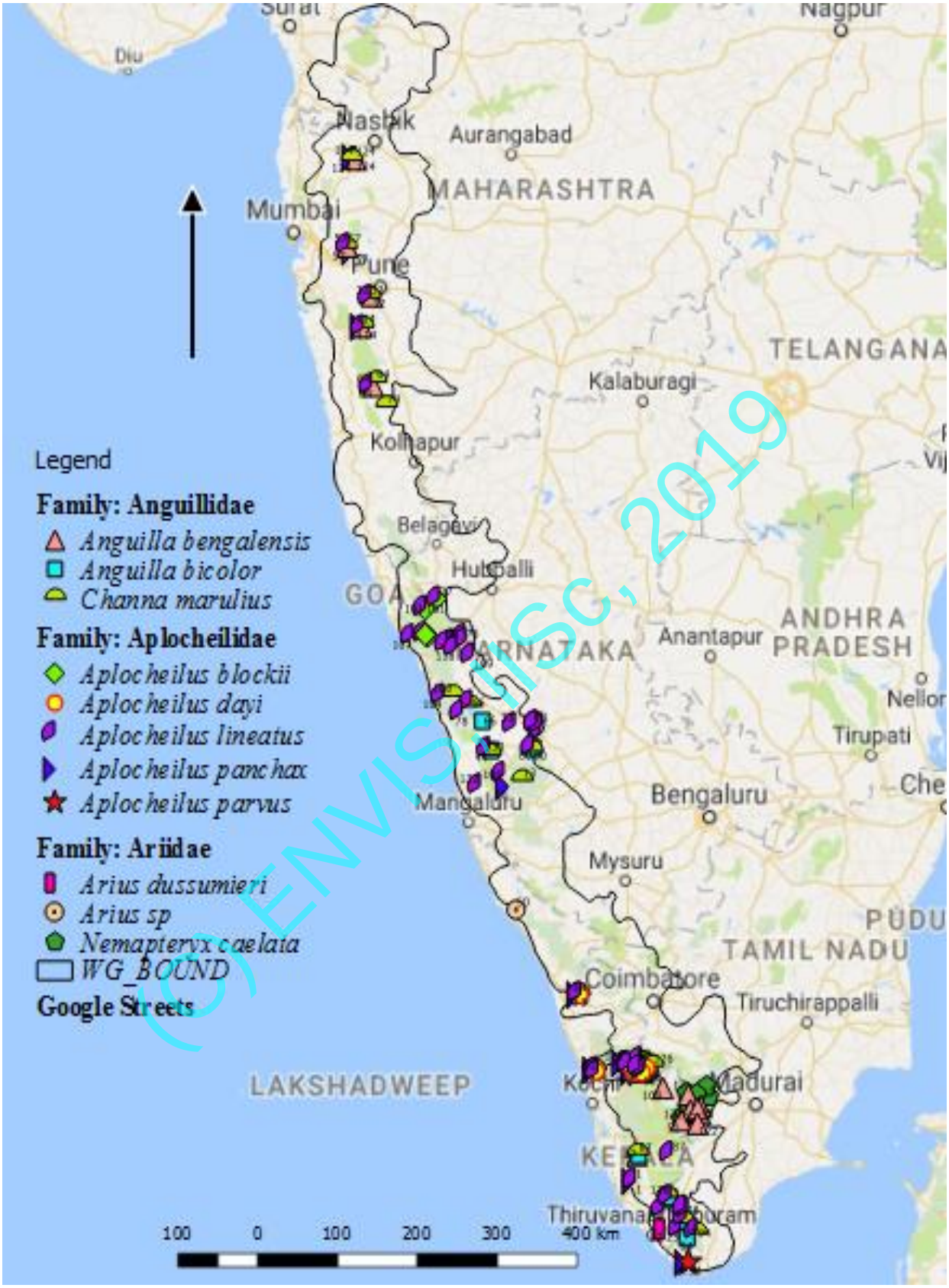


Fig. 6.2.4. Spatial distribution of the Anguillidae, Aplocheilidae and Ariidae families.

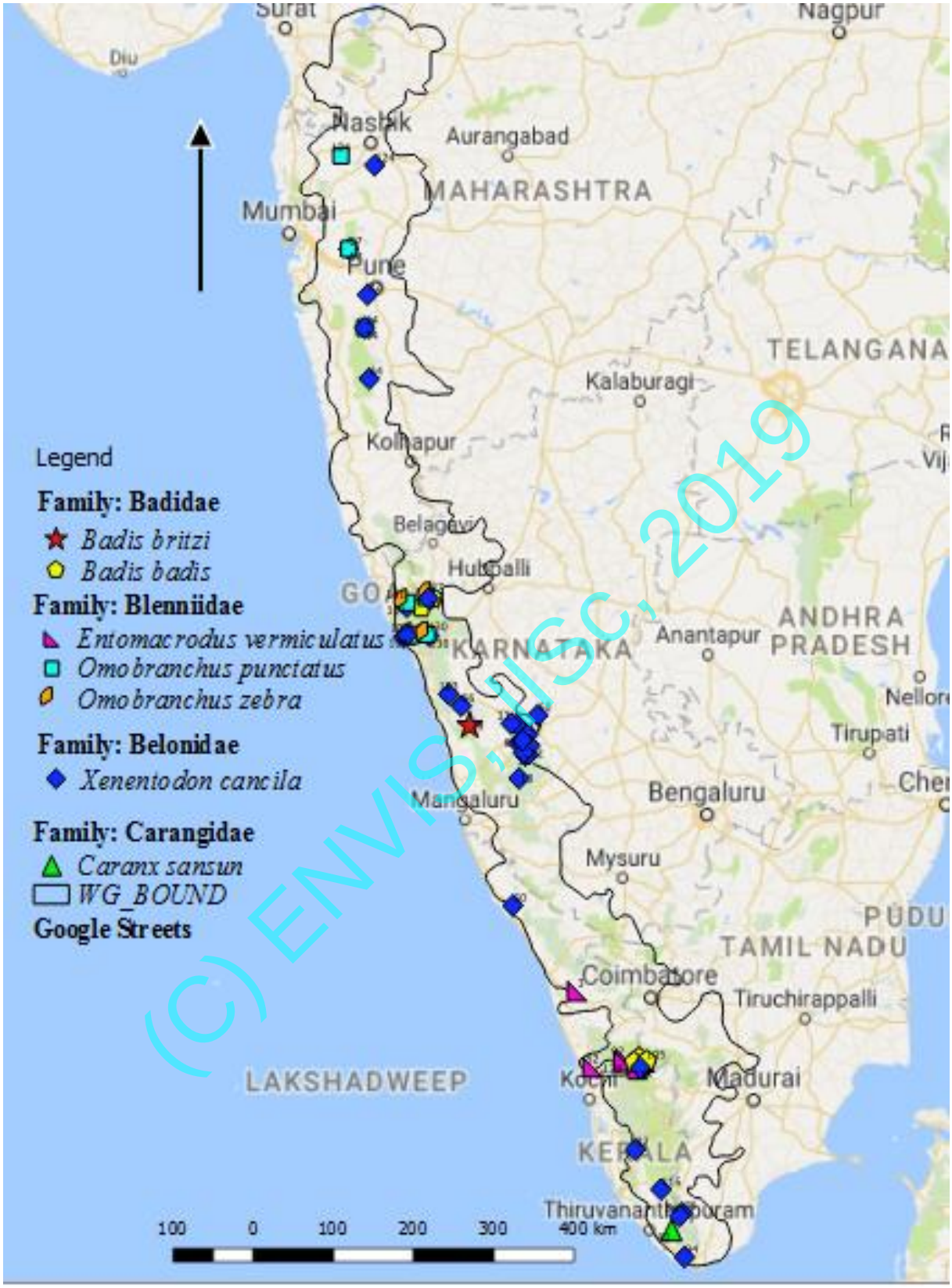


Fig. 6.2.5. Spatial distribution of the Badidae, Blenniidae, Belonidae and Carangidae families

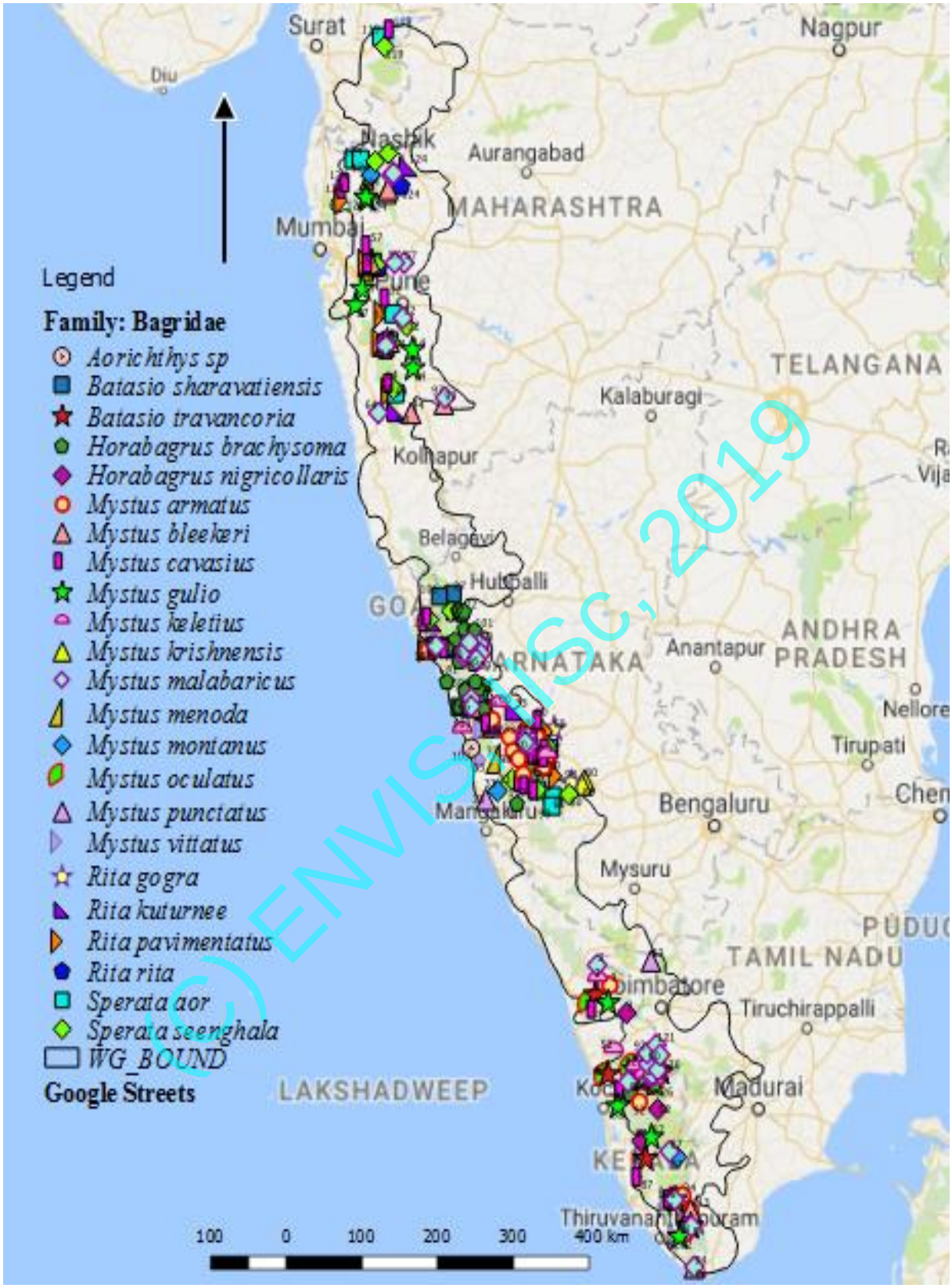


Fig. 6.2.6. Spatial distribution of the Bagridae family.

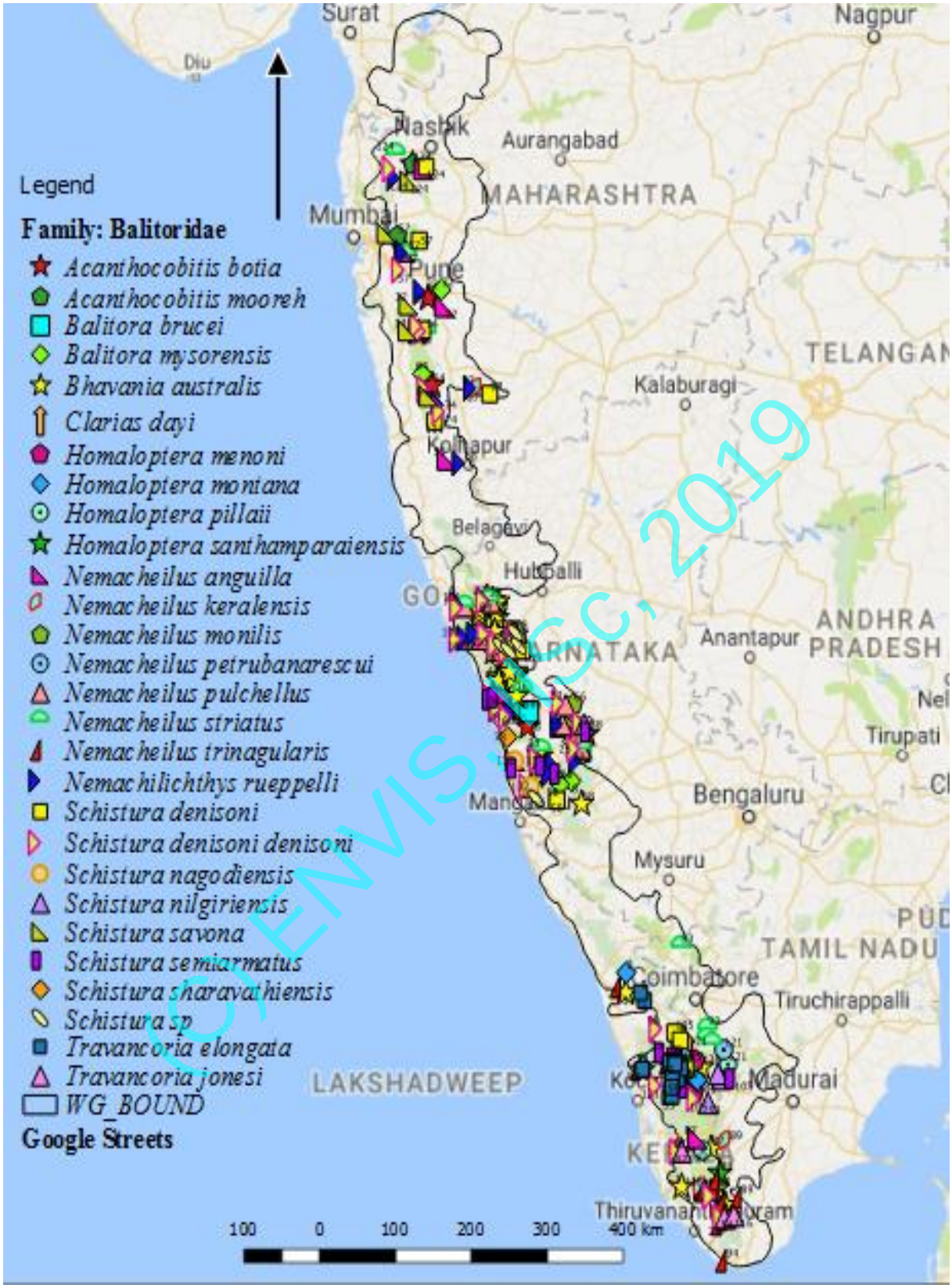


Fig. 6.2.7. Spatial distribution of the Balitoridae family.

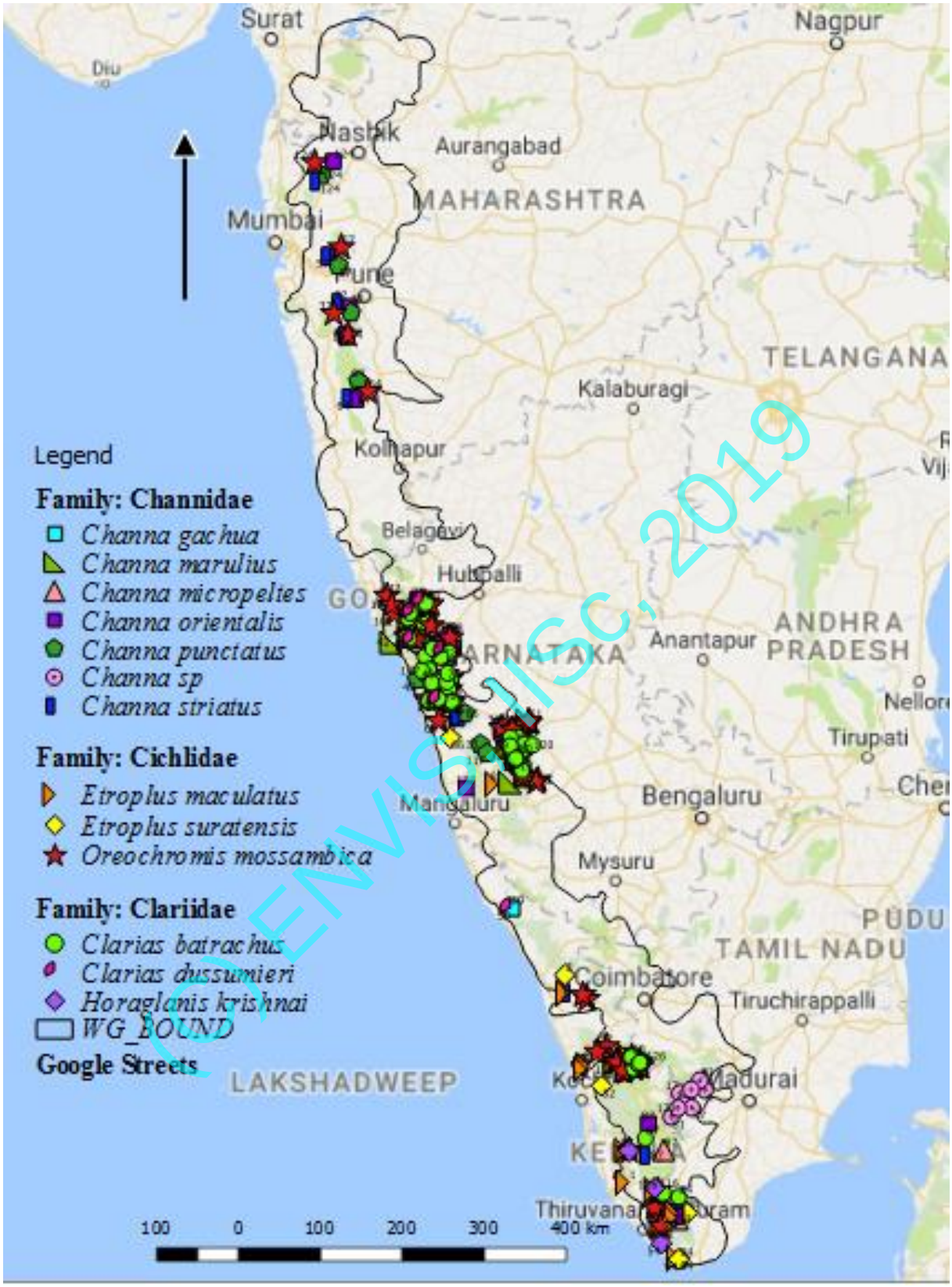


Fig. 6.2.8. Spatial distribution of the Channidae, Cichlidae and Clariidae families.

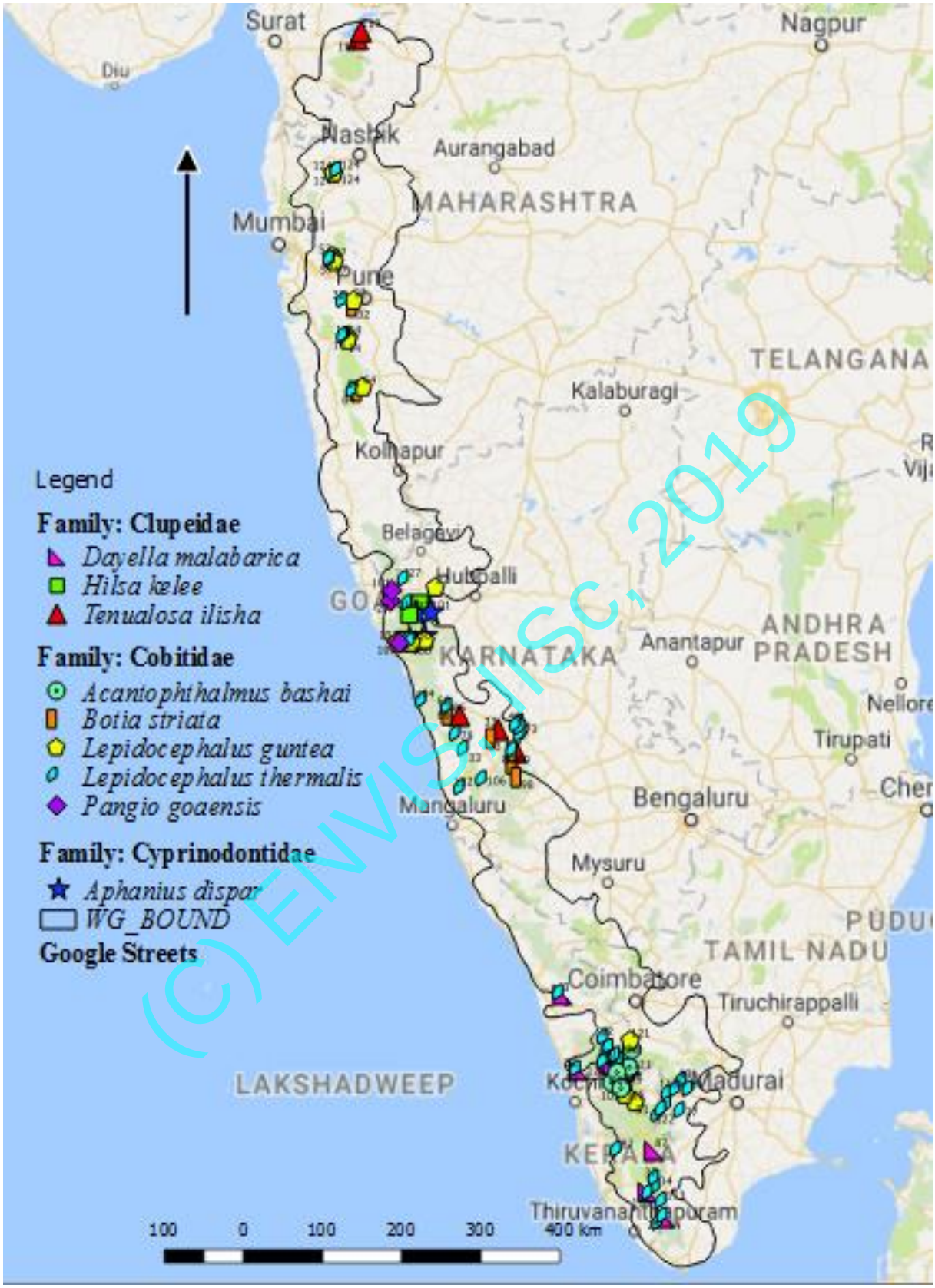


Fig. 6.2.9. Spatial distribution of the Clupeidae, Cobitidae and Cyprinodontidae families.

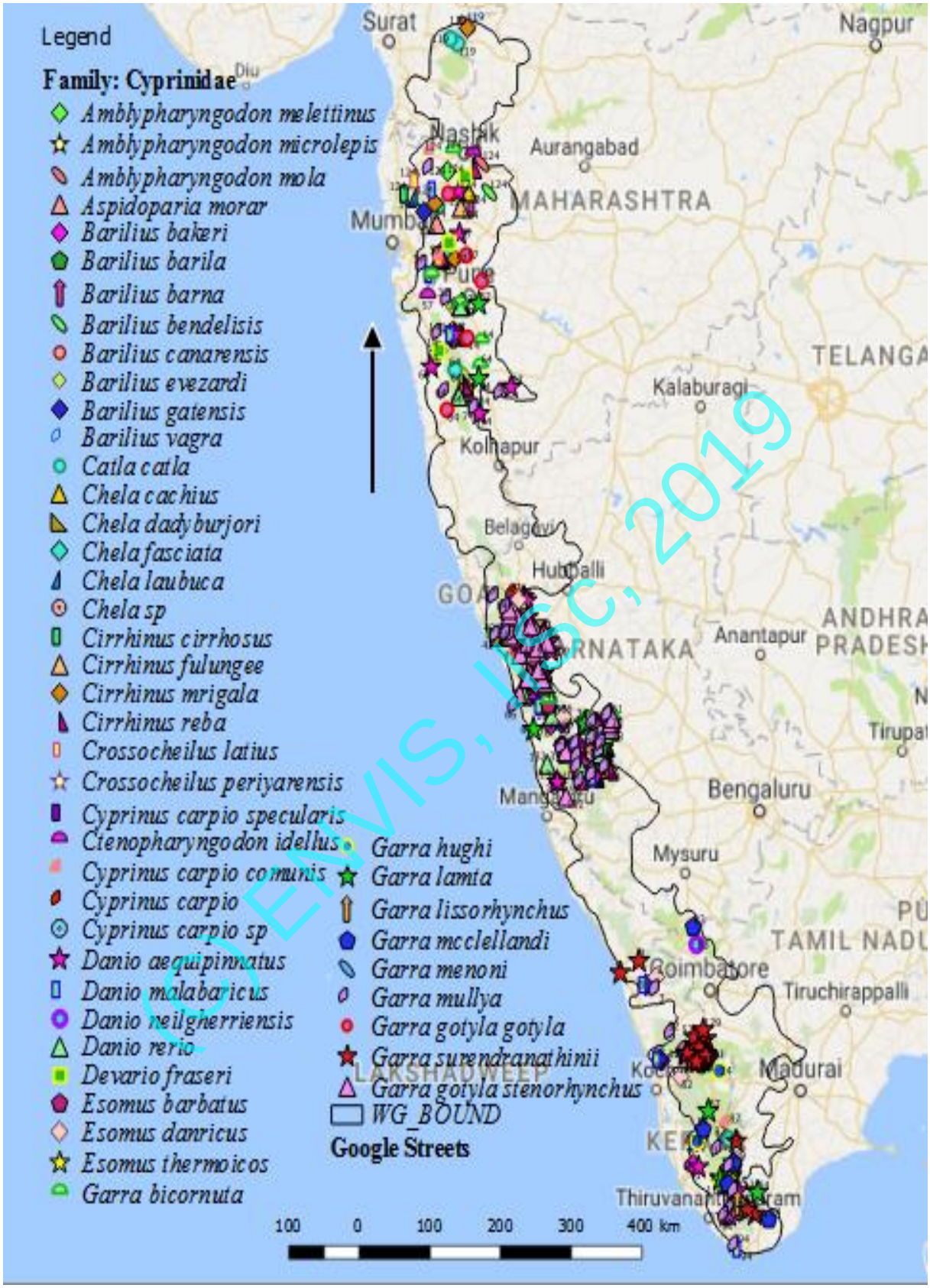


Fig. 6.2.10a. Spatial distribution of the Cyprinidae family.

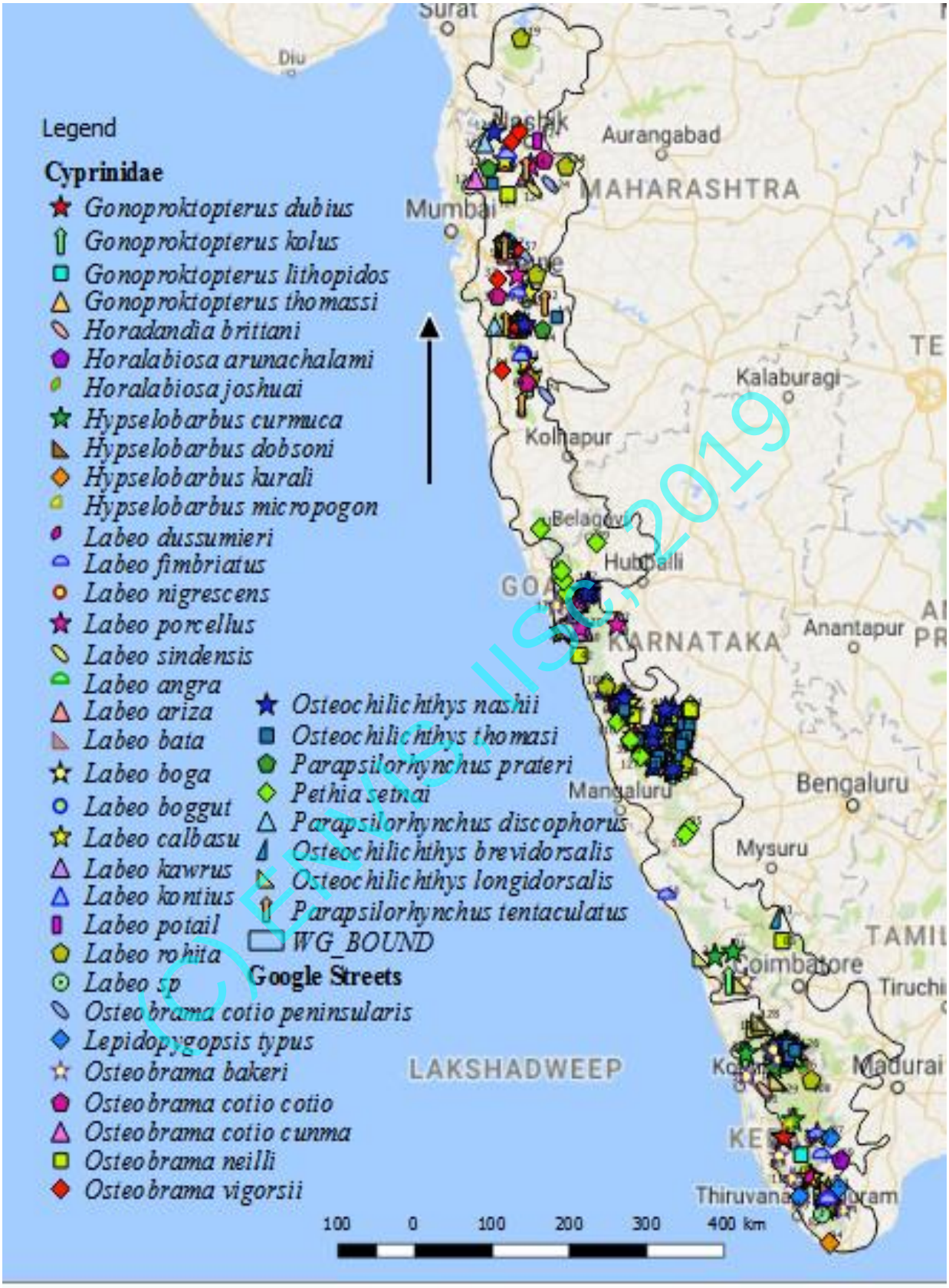


Fig. 6.2.10b. Spatial distribution of the Cyprinidae family.

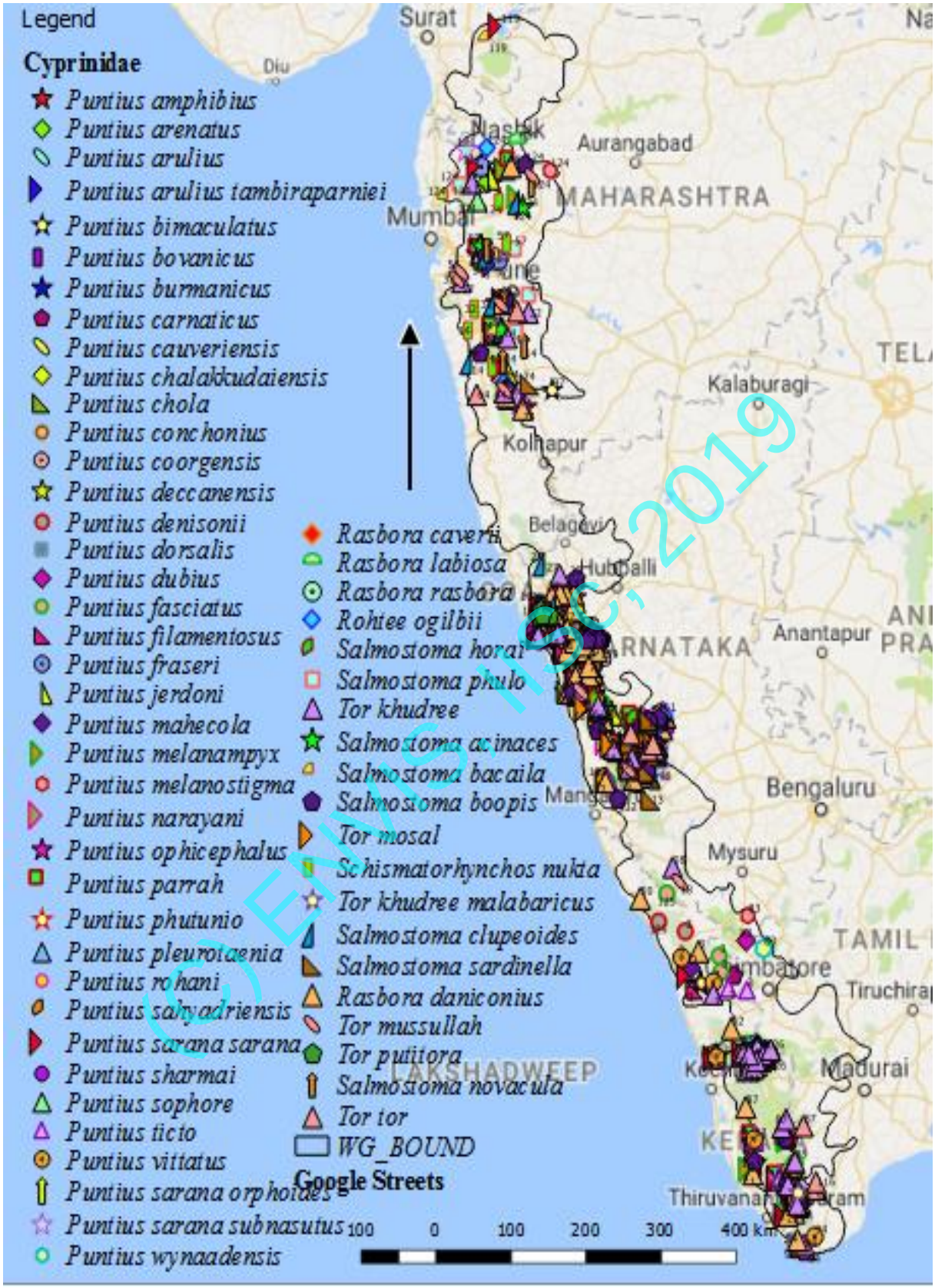


Fig. 6.2.10c. Spatial distribution of the Cyprinidae family.

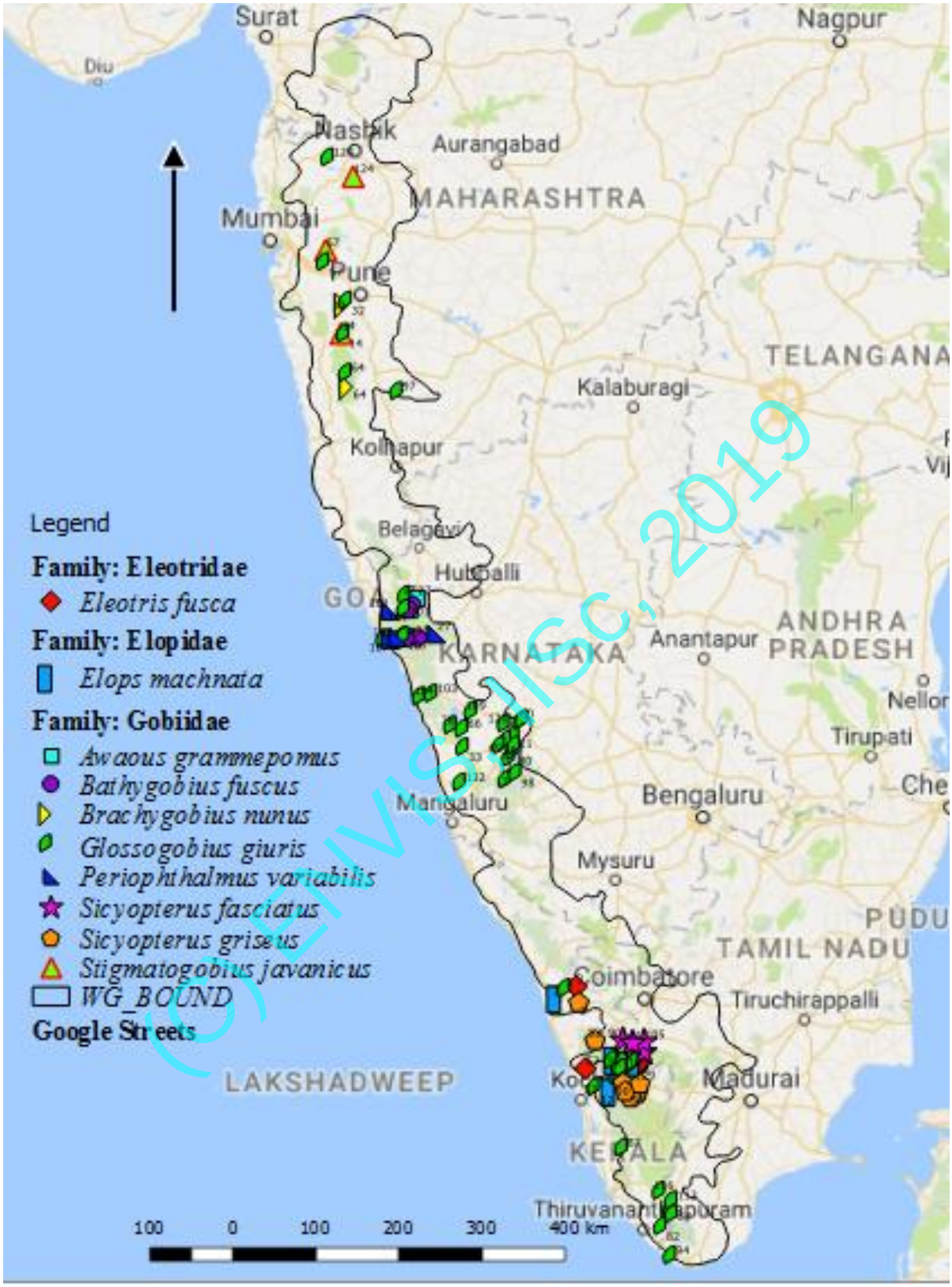


Fig. 6.2.11. Spatial distribution of the Eleotridae, Elopidae and Gobiidae families.

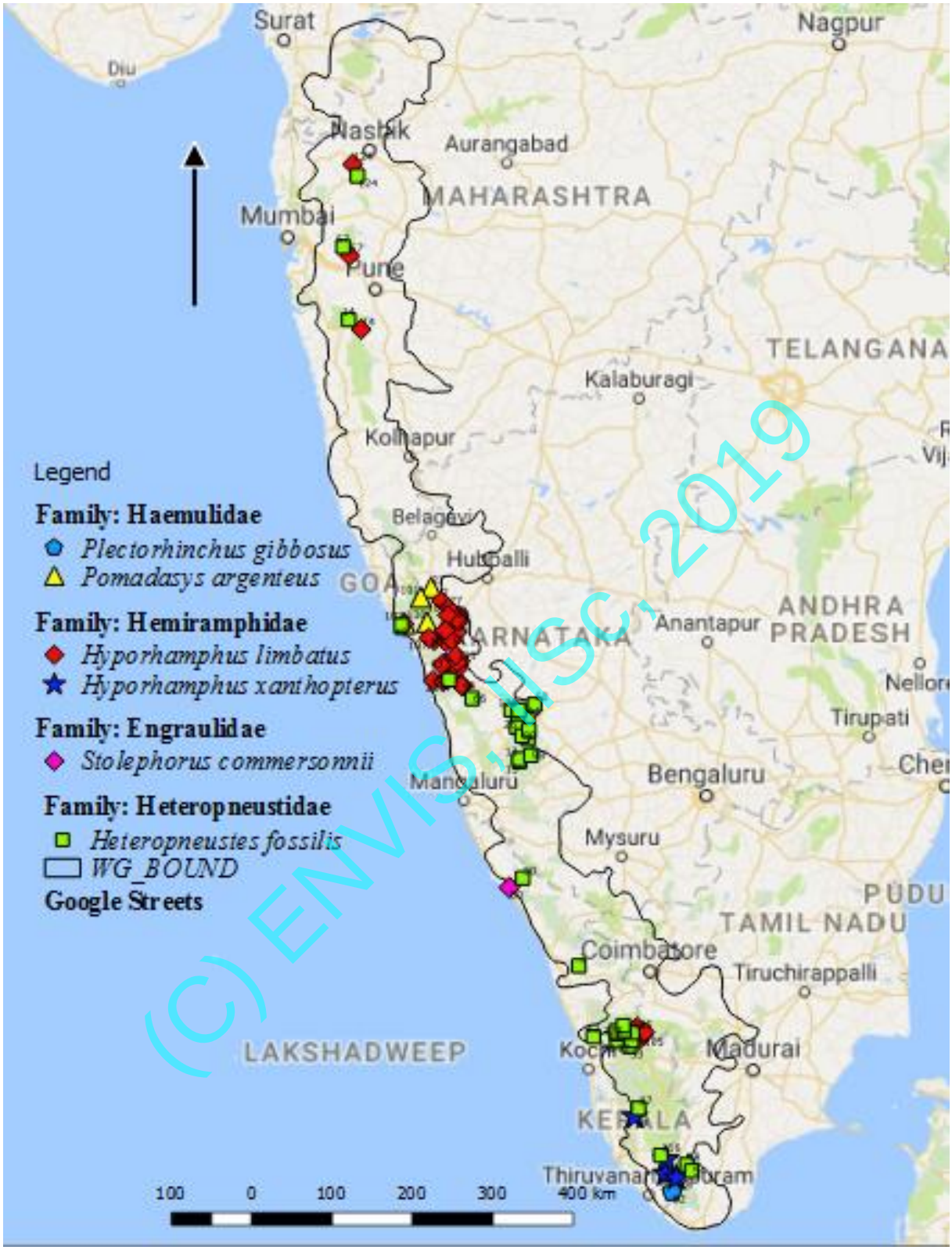


Fig. 6.2.12. Spatial distribution of the Haemulidae, Hemiramphidae, Engranulidae and Heteropneustidae families.

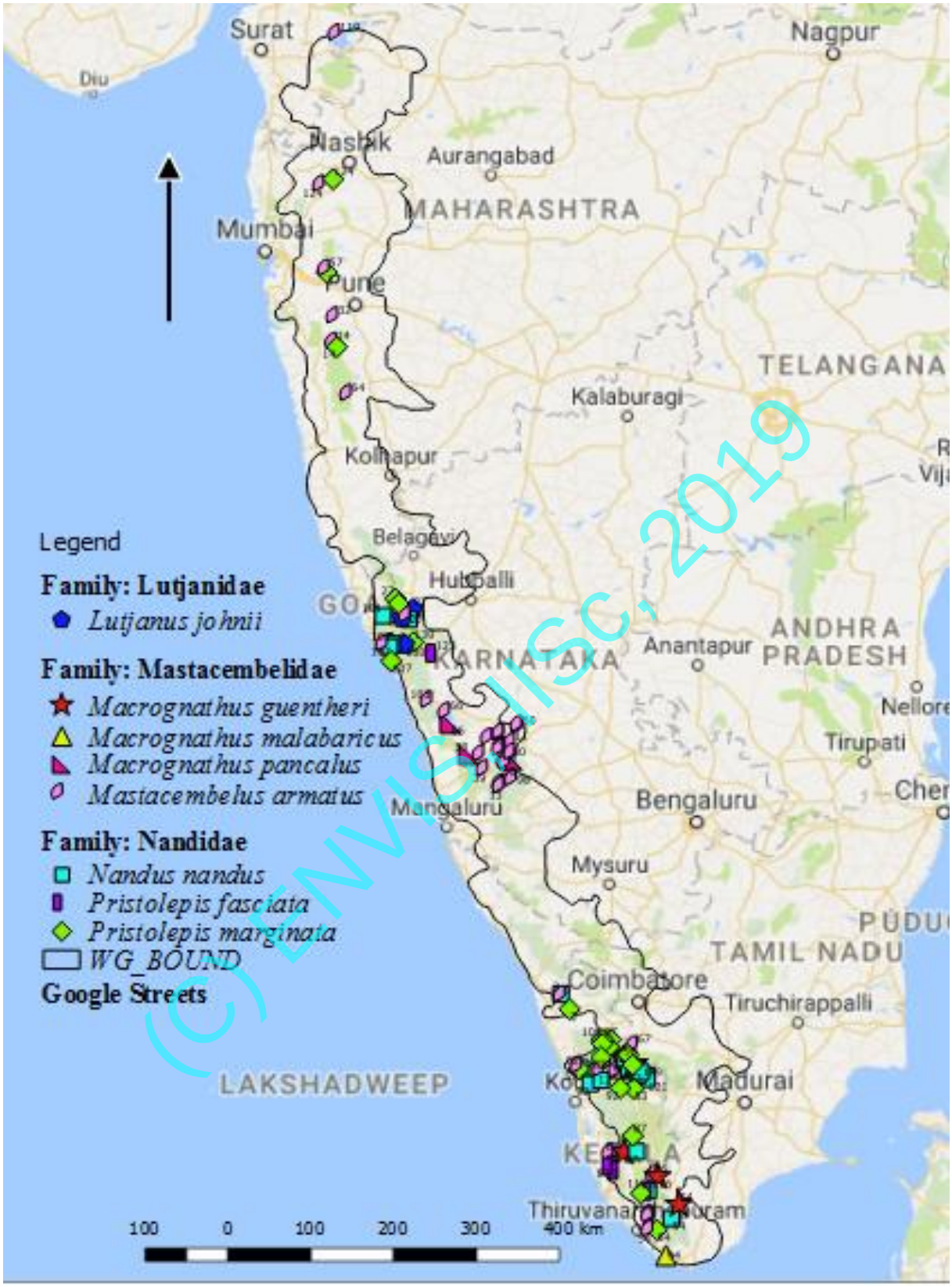


Fig. 6.2.13. Spatial distribution of the Lutjanidae, Mastacembelidae and Nandidae families.

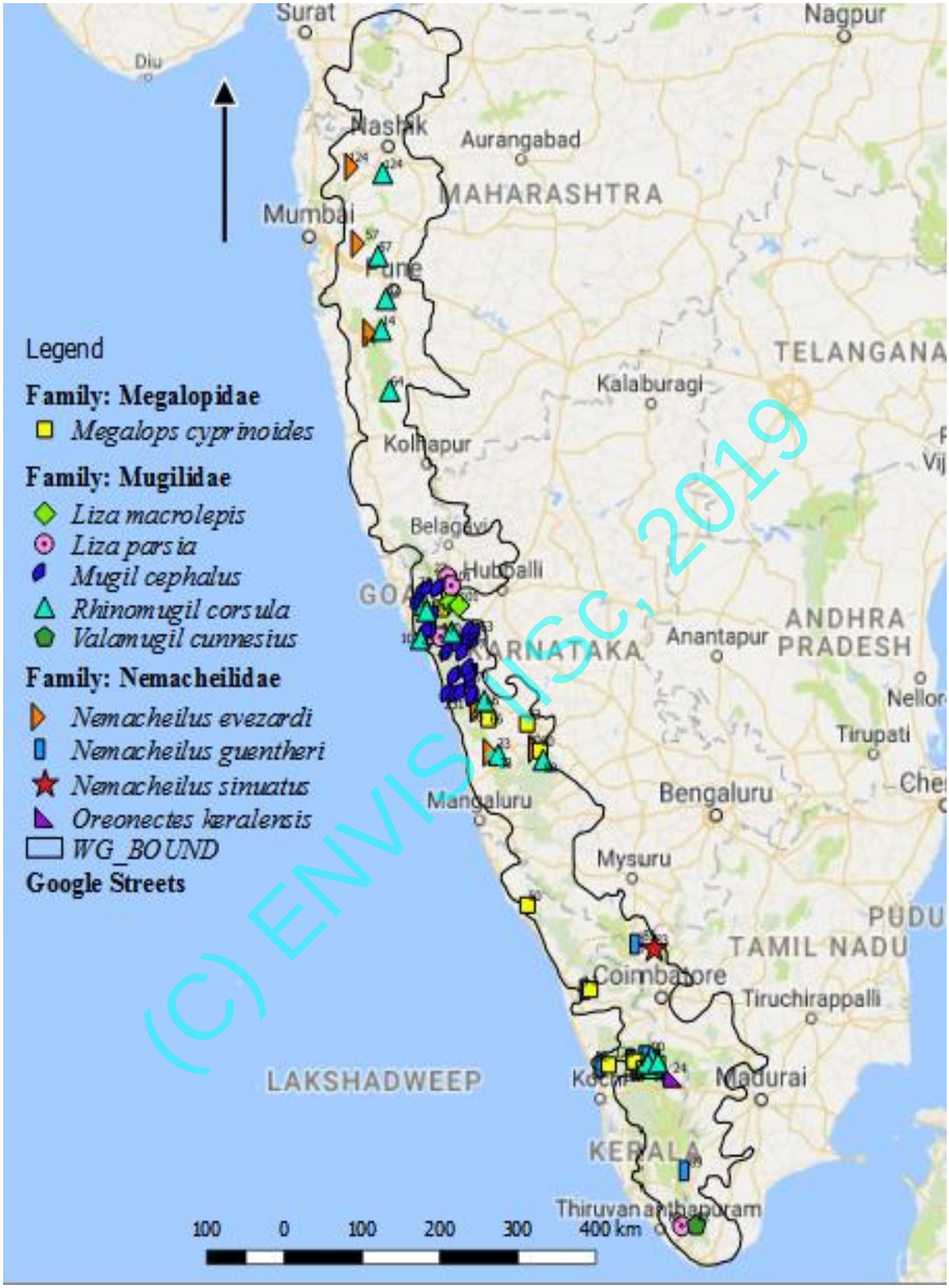


Fig. 6.2.14. Spatial distribution of the Megalopidae, Mugilidae and Nemacheilidae families.

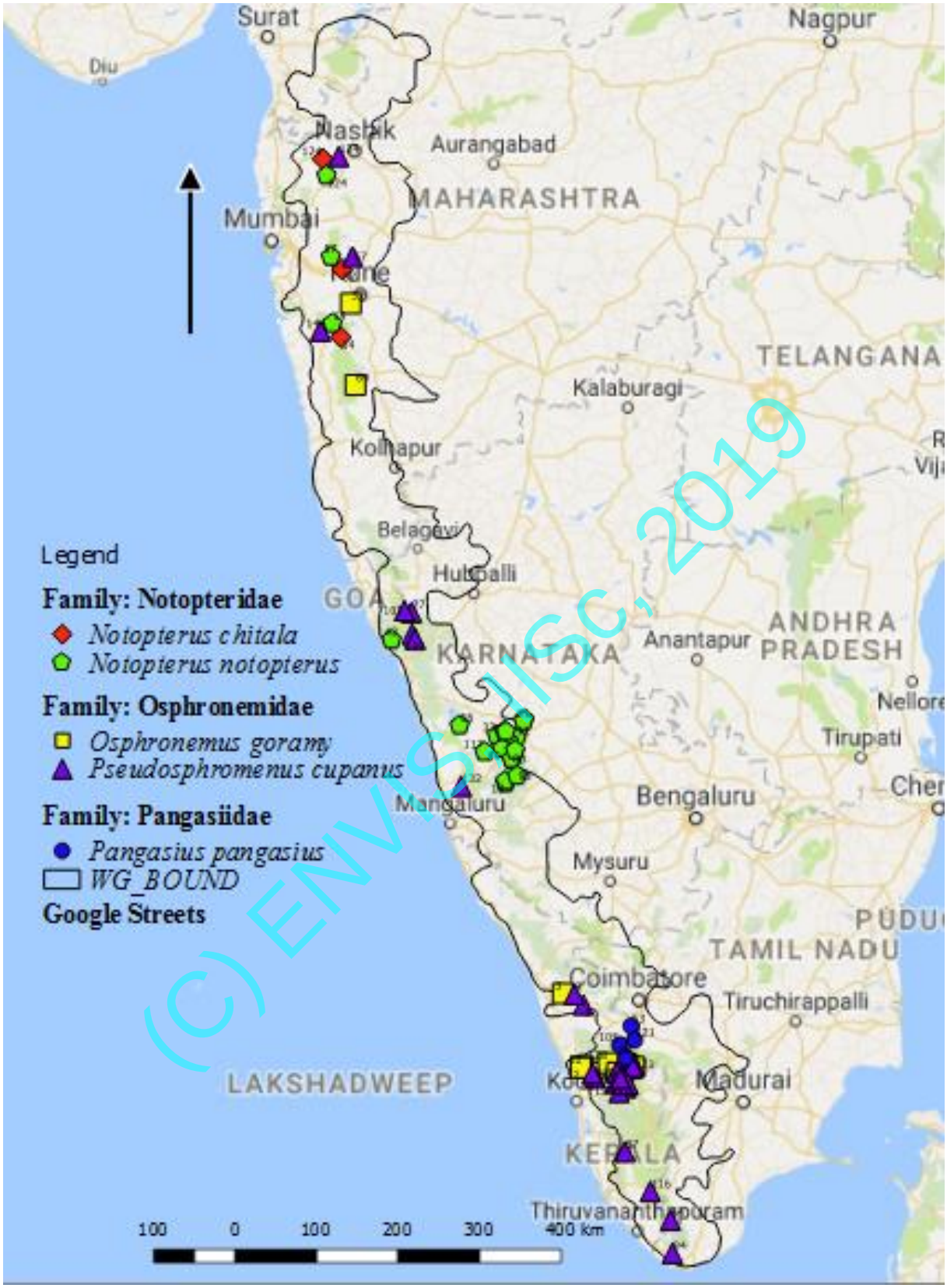


Fig. 6.2.15. Spatial distribution of the Notopteridae, Osphronemidae and Pangasiidae families.

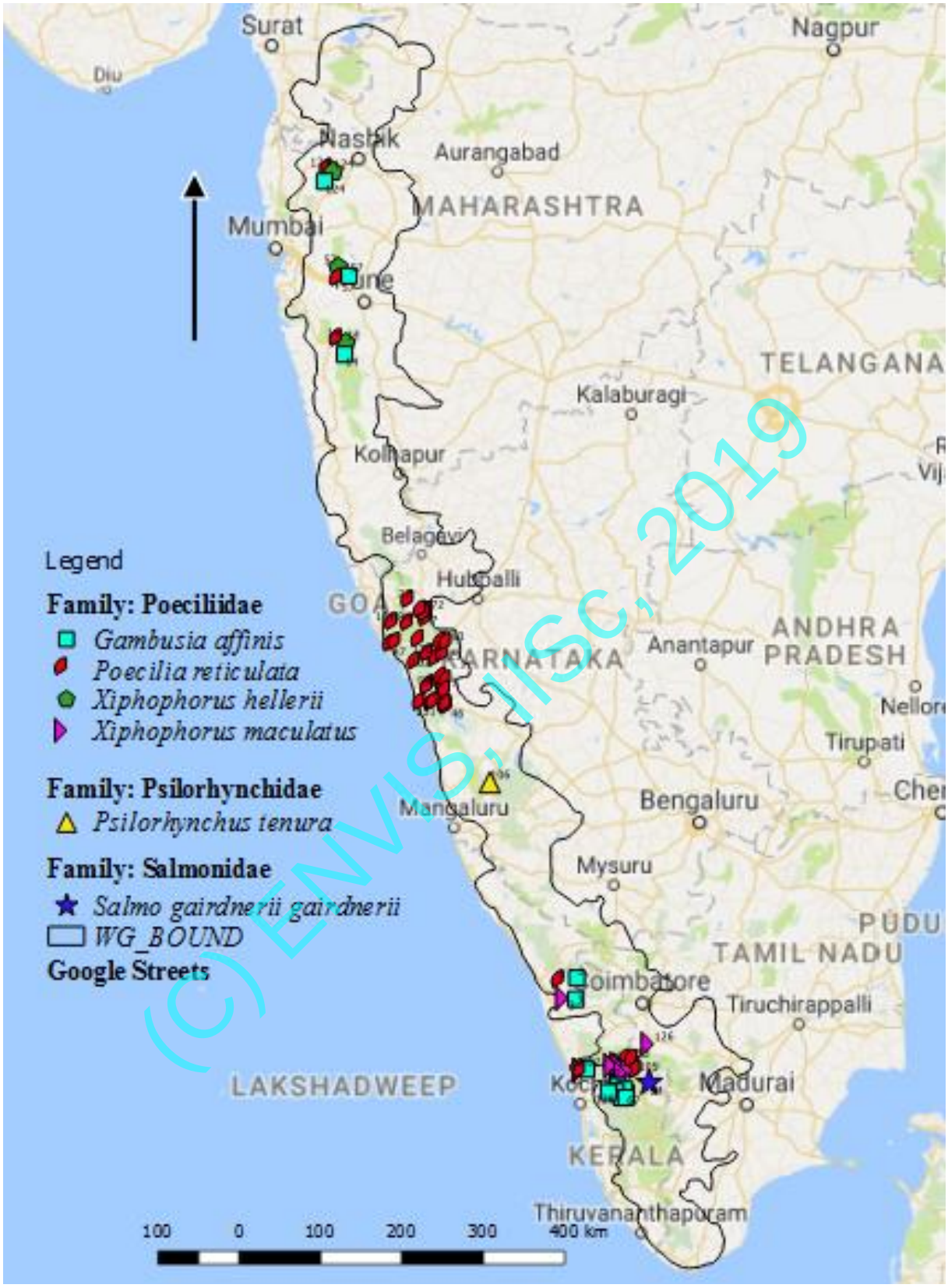


Fig. 6.2.16. Spatial distribution of the Poeciliidae, Psilorhynchidae and Salmonidae families.

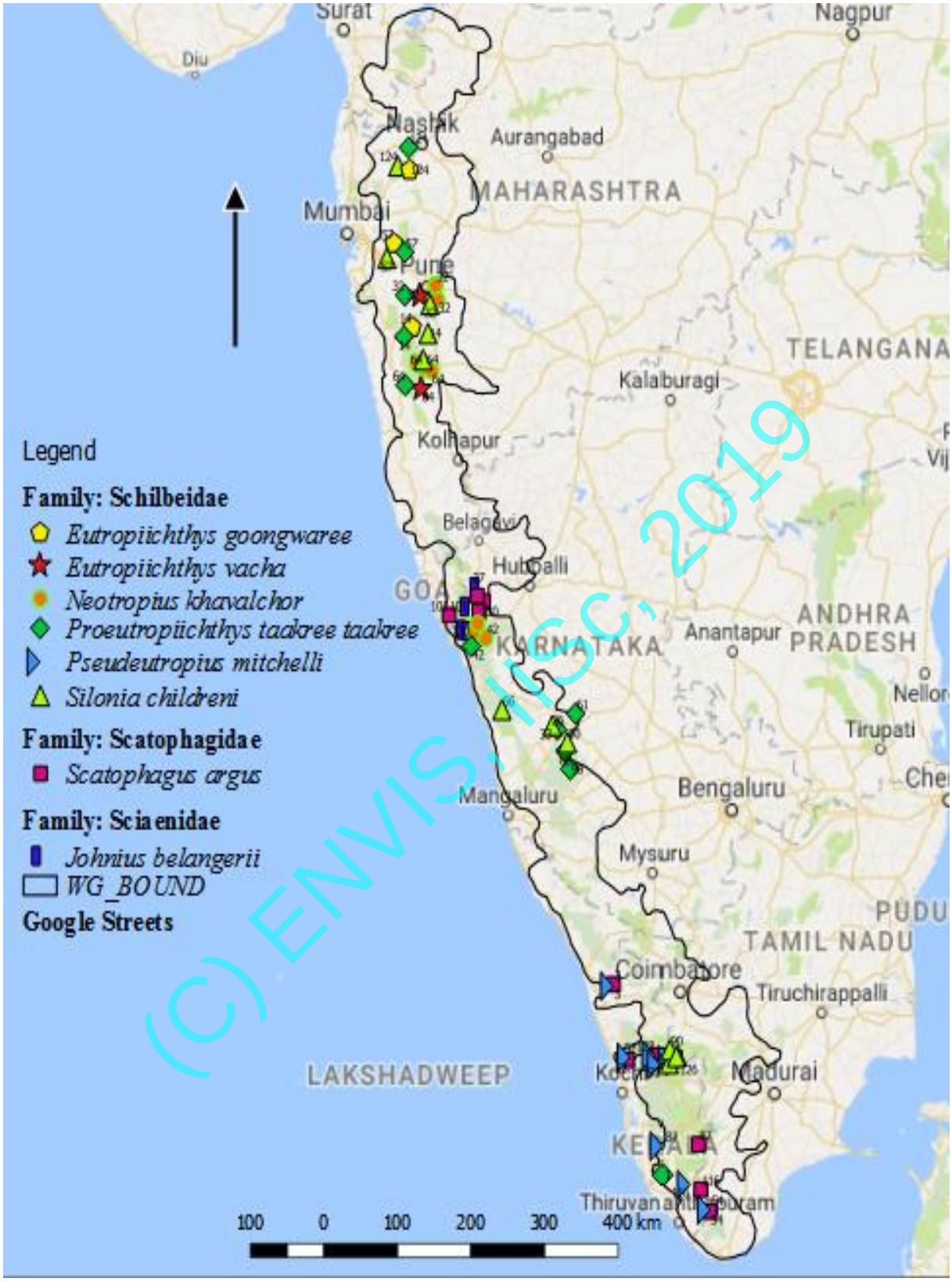


Fig. 6.2.17. Spatial distribution of the Schilbeidae, Scatophagidae and Sciaenidae families.

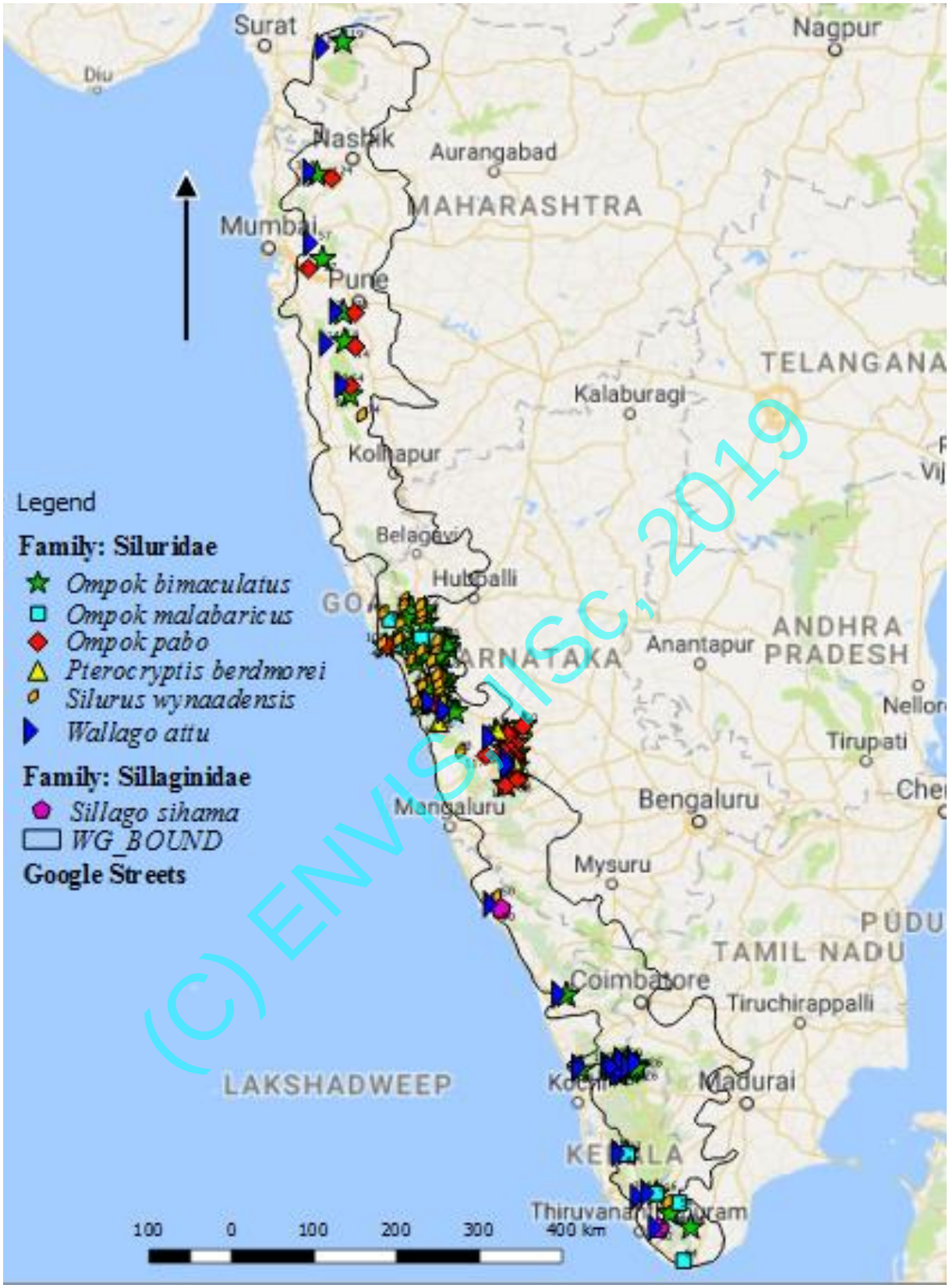


Fig. 6.2.18. Spatial distribution of the Siluridae and Sillaginidae families.

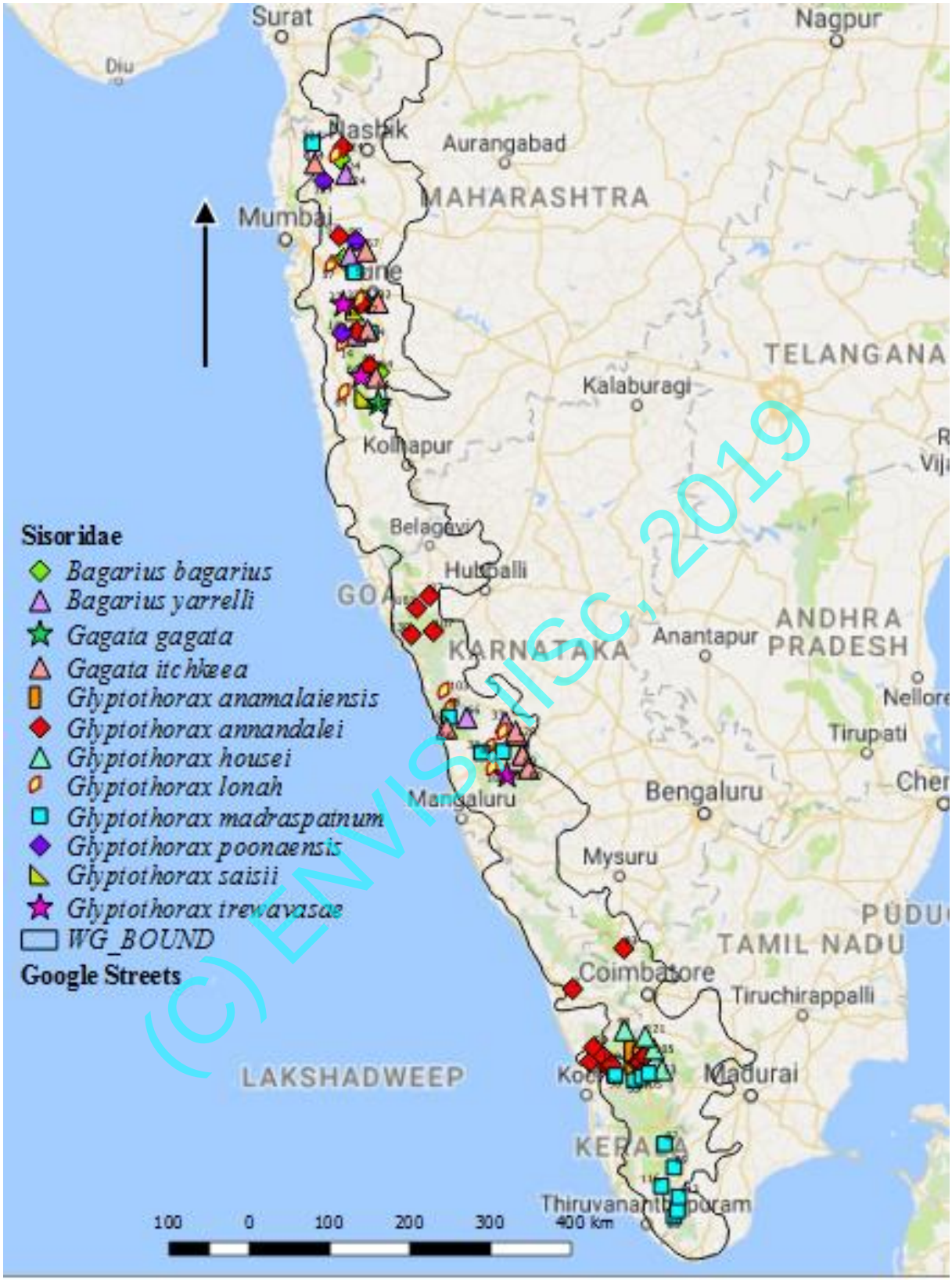


Fig. 6.2.19. Spatial distribution of the Sisoridae family.

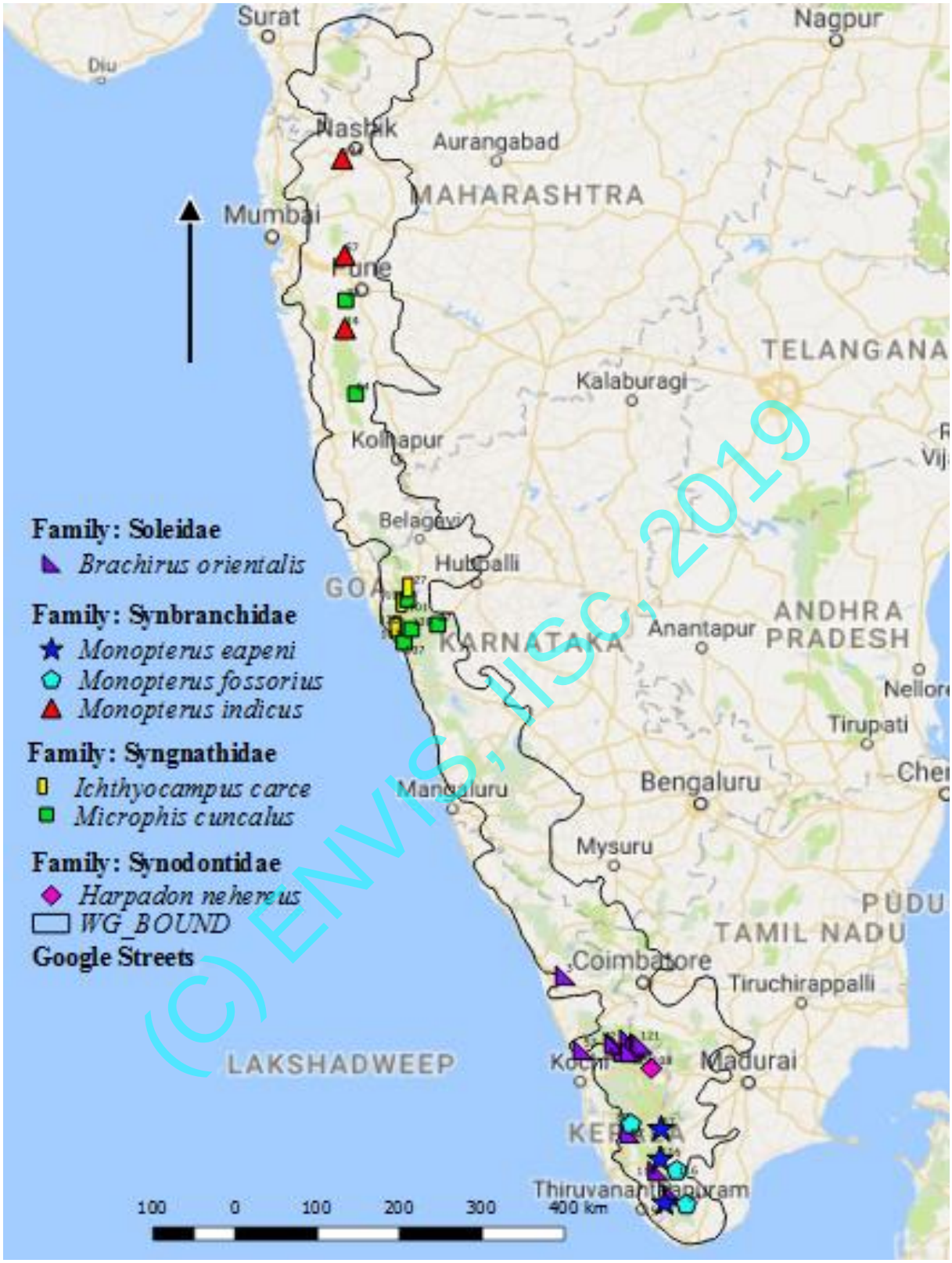


Fig. 6.2.20. Spatial distribution of the Soleidae, Synbranchidae, Syngnathidae and Synodontidae families.

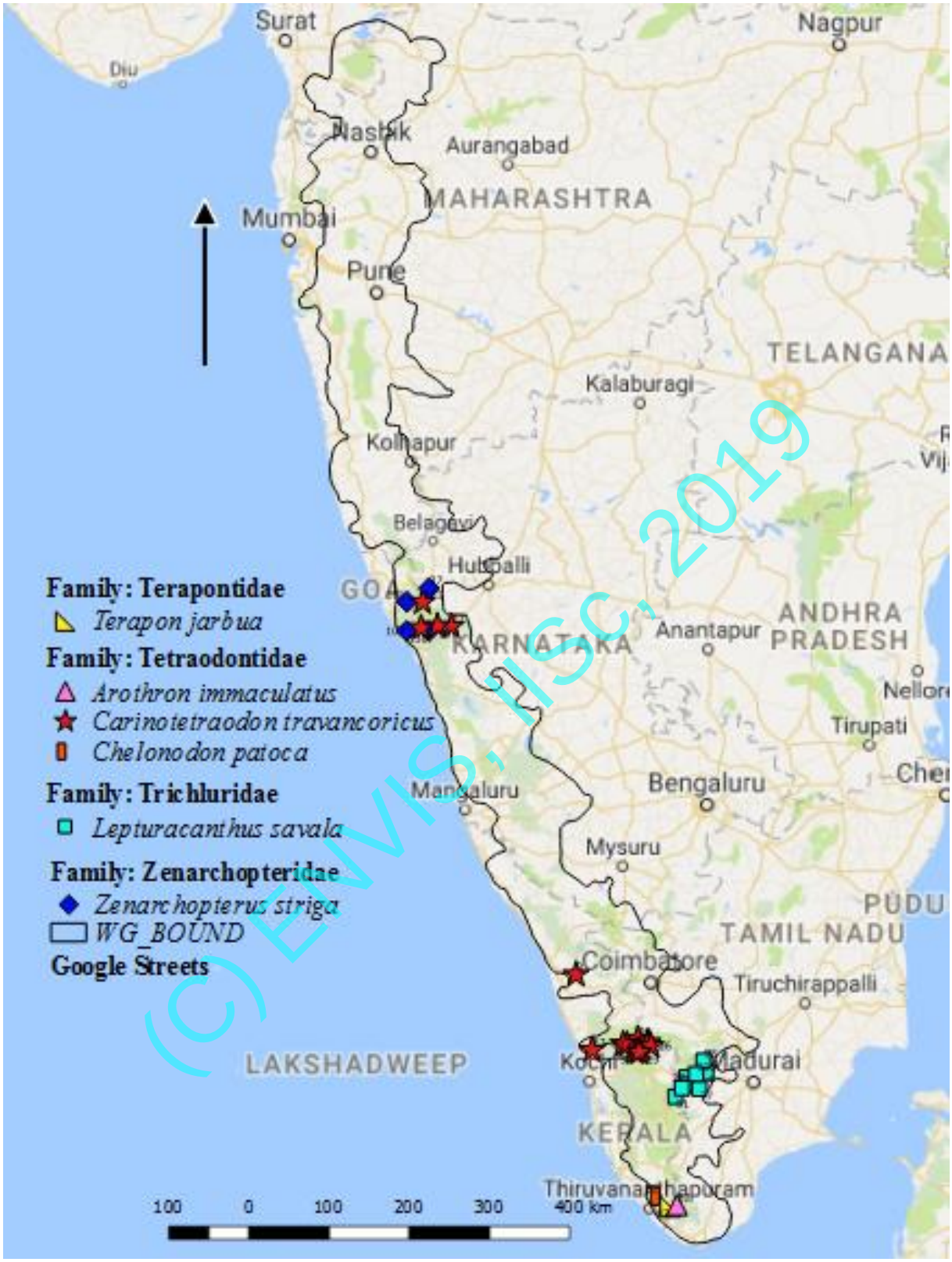


Fig. 6.2.21. Spatial distribution of the Terapontidae, Tetraodontidae, Trichluridae and Zenarchopteridae families.

Distribution of endemic species

Among the 335 species of Fishes, 88 species (26%) are endemic to WG (Fig. 22 & 23).

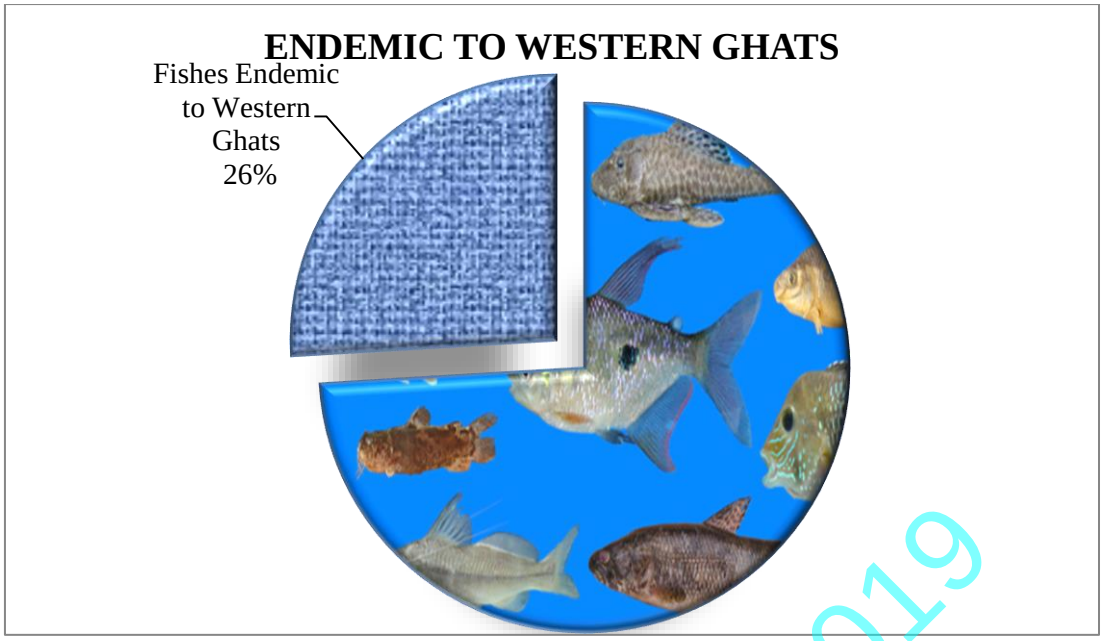


Fig. 6.2.22. Pie chart showing Endemism of Fishes in WG

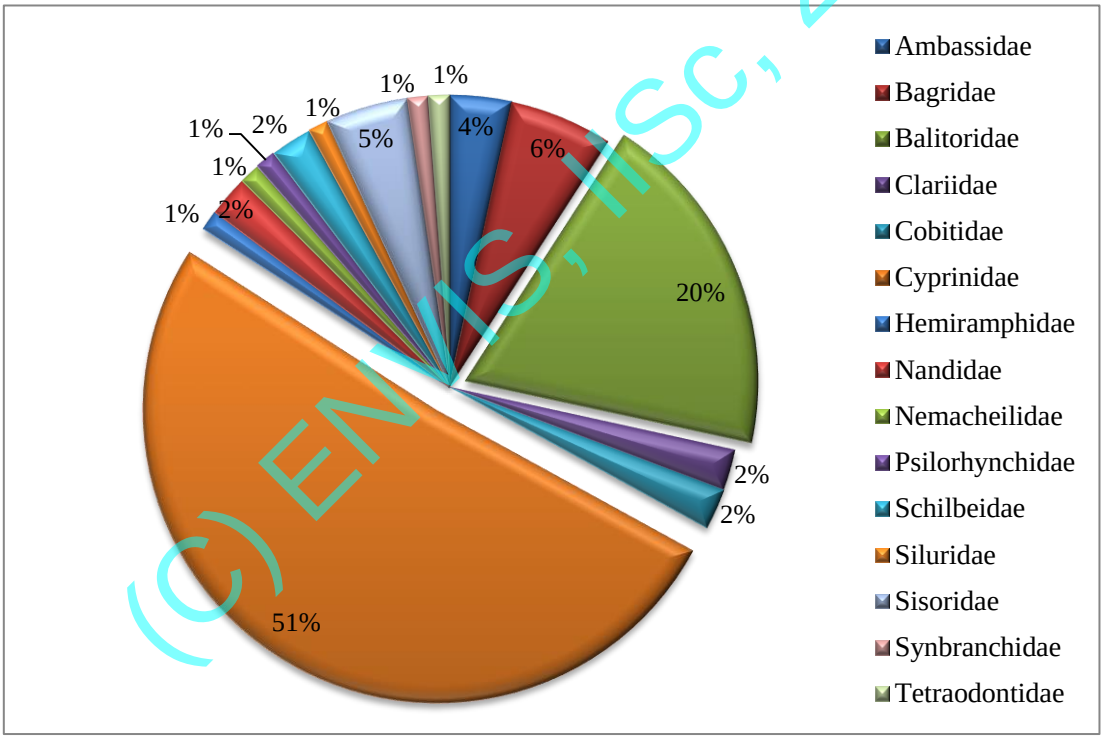


Fig. 6.2.24. Pie chart showing Endemic Fish families.

The endemic species are from the families Ambassidae, Bagridae, Balitoridae, Clariidae, Cobitidae, Cyprinidae, Hemiramphidae, Nandidae, Nemacheilidae, Psilorhynchidae, Schilbeidae, Siluridae, Sisoridae, Synbranchidae, and Tetraodontidae (Fig. 6.2.24). The majority of the endemic species belongs to the family Cyprinidae (51%) followed by the family

Balitoridae (20%) and Bagridae (6%). The families Hemiramphidae, Nemacheilidae, Psilorhynchidae, Siluridae, Synbranchida, and Tetraodontidae show only 1% endemism.

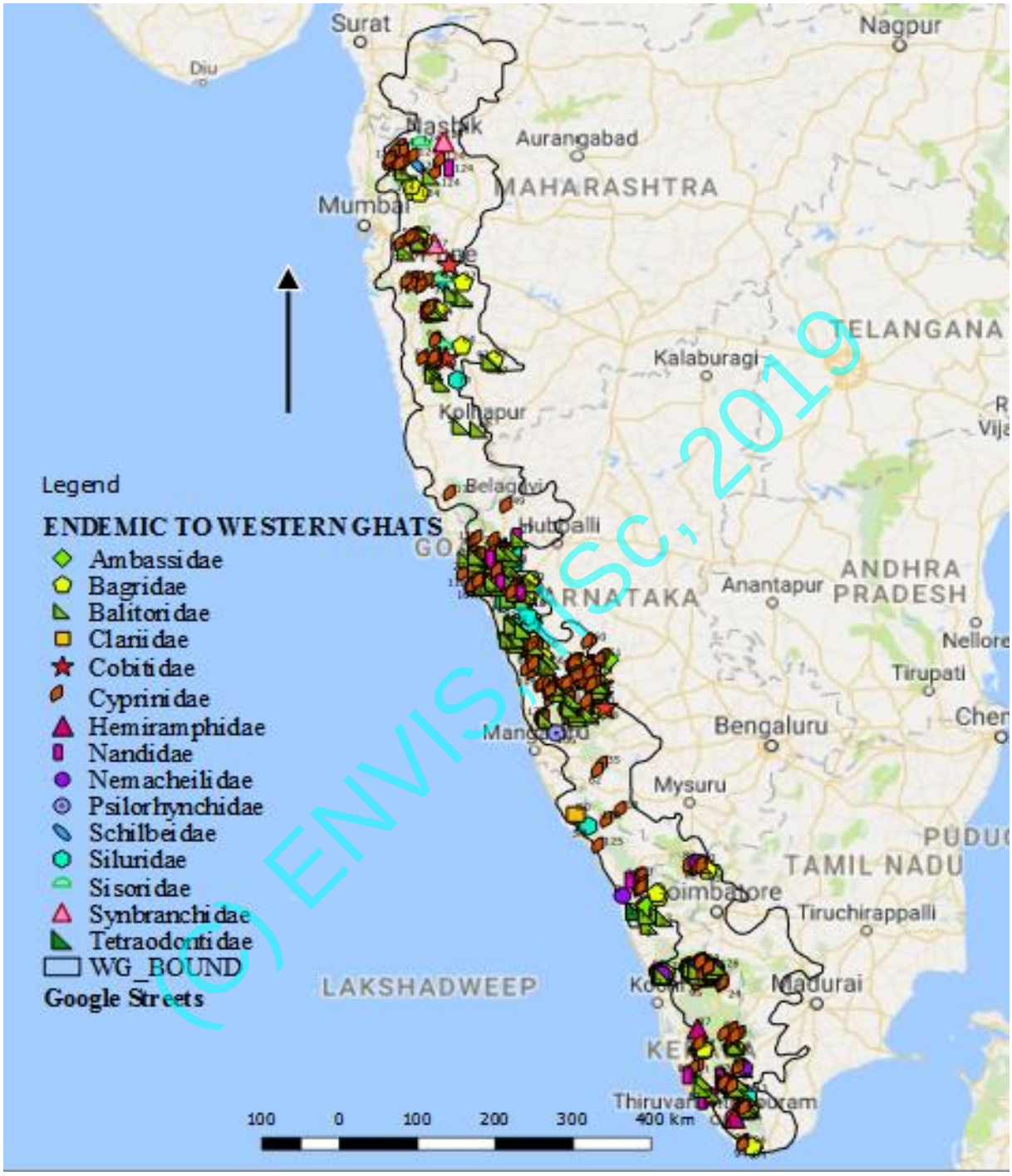


Fig. 6.2.23. Spatial distribution of the Fish families endemic to WG.

Distribution based on conservation status

According to the IUCN conservation status, fish species present in the WG were classified into different categories on the basis of threat status i.e., Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern, Data Deficient and Not Evaluated (Fig. 6.2.25). Among the 335 fish species present in the WG region, 8 species were categorized as Critically Endangered species (CE), 43 species were classified as Endangered (EN), 27 species were considered as Vulnerable (VU), 12 species comes under the category Near Threatened (NT), 171 species were grouped under the Least Concern category and 17 species were categorized under the group Data Deficient (DD). Conservation Status for 57 species of amphibians was not evaluated (Fig. 6.2.26).

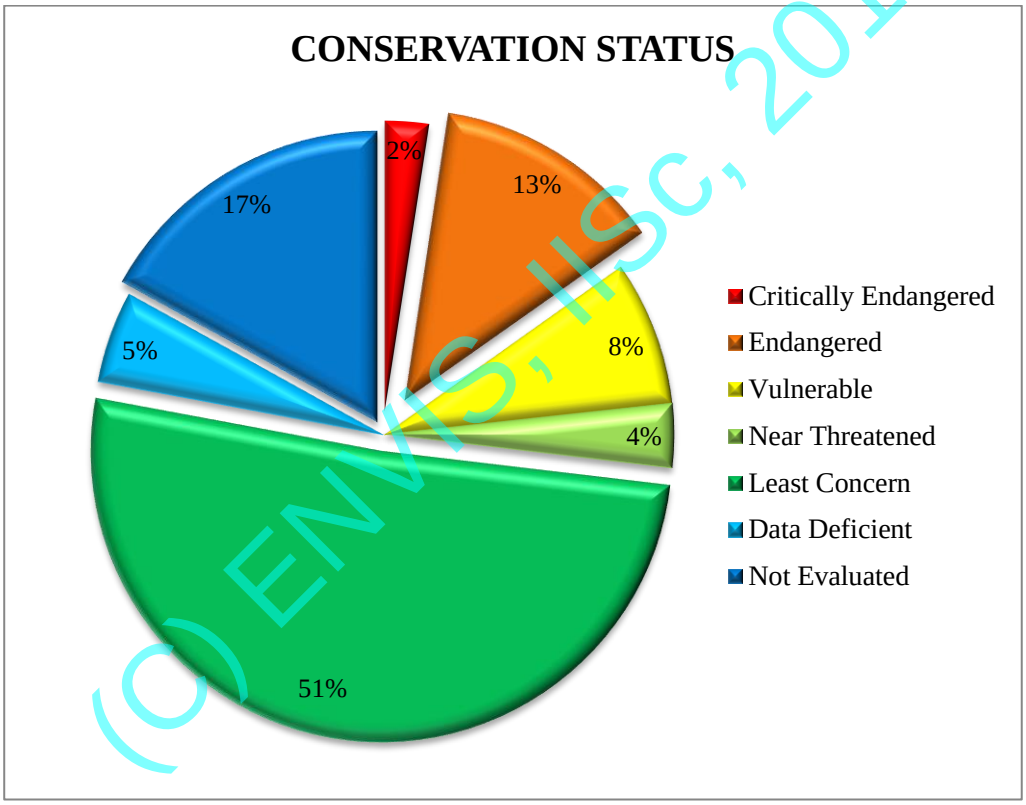


Fig. 6.2.26. Pie Chart showing Conservation status of fishes in WG.

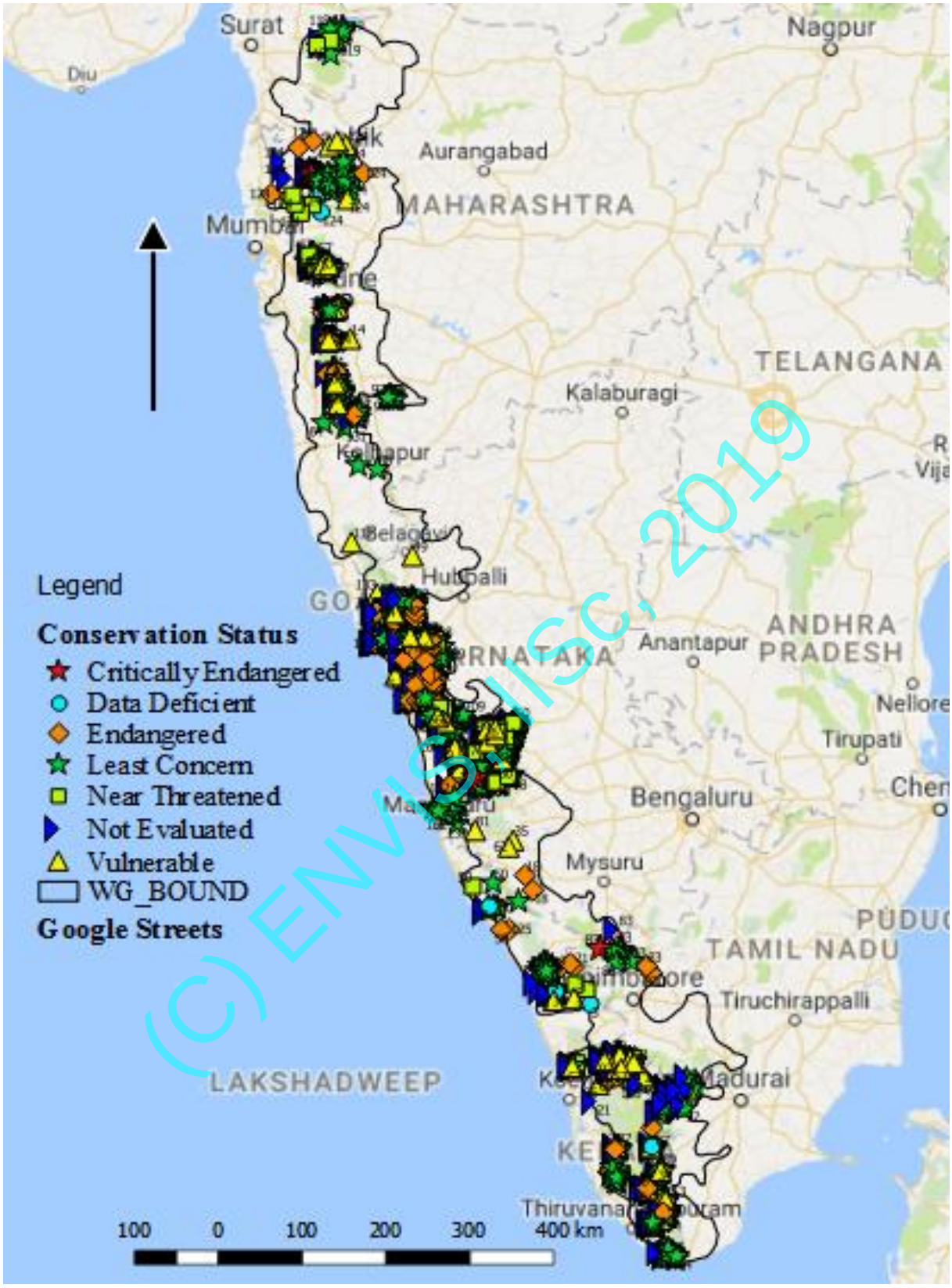


Fig. 6.2.25. Spatial distribution of the Fish species according to IUCN status.

According to IUCN Red data list, 2% of the total fish population in WG comes under the critically endangered category. It includes *Gonoproktopterus thomassi*, *Horalabiosa arunachalami*, *Mystus punctatus*, *Parapsilorhynchus prateri*, *Psilorhynchus tenura*, *Puntius*

bovanicus, *Puntius deccanensis* and *Puntius wynaadensis*. These species have distributed across the WG regions of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.2.27). Most of the critically endangered species are endemic to WG and show higher distribution towards Karnataka and Maharashtra regions.

WG region has 43 endangered fish species. It shows that 13% of the total fish population present in the WG is categorized as Endangered. These endangered species are from the families Bagridae, Balitoridae, Cobitidae, Cyprinidae, Schilbeidae, Siluridae, Sisoridae, and Synbranchidae (Fig. 6.2.28). Endangered species were reported from the WG regions of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu. According to the IUCN conservation status, 27 fish species present in the WG region were classified as Vulnerable (VU) species. It comprises the 8% of the total fish population present in the WG (Fig. 6.2.29). These vulnerable species belong to the families Bagridae, Balitoridae, Cyprinidae, Hemiramphidae, Nemacheilidae, Sisoridae, Synbranchidae, and Tetraodontidae. The species shows distribution across all regions of WG. More than 55% of the vulnerable species shows the distribution in the WG region of Karnataka and Kerala. *Anguilla bengalensis*, *Anguilla bicolor*, *Bagarius bagarius*, *Bagarius yarrelli*, *Balitora brucei*, *Clarias dussumieri*, *Garra bicornuta*, *Mystus malabaricus*, *Ompok bimaculatus*, *Ompok pabo*, *Tor tor* and *Wallago attu* are the 12 fish species which are considered as Near Threatened (NT) species (Fig. 6.2.30). This species distribution in all states of WG, but higher distribution is observed in Maharashtra, Karnataka, Kerala and Tamilnadu regions of WG.

According to the conservation status, the majority (171) of the fish species present in the WG were categorized under Least Concern category. Of the total population of fishes in WG, 51% were categorized as Least Concern species (Fig. 6.2.31a & 6.2.31b). These species were reported from all states of WG. In the WG region, 17 fish species were categorized under Data Deficient (DD), comprising the 5% of the total fish population (Fig. 6.2.32). The species are *Anabas testudineus*, *Barilius evezardi*, *Cyprinus carpio comunis*, *Danio neilgherriensis*, *Eutropiichthys goongwaree*, *Gonoproktopterus lithopidos*, *Horaglanis krishnai*, *Hypselobarbus dobsoni*, *Megalops cyprinoides*, *Monopterus eapeni*, *Neotropius khavalchor*, *Puntius amphibius*, *Puntius burmanicus*, *Puntius mahecola*, *Puntius melanampyx*, and *Sicyopterus fasciatus* has distributed across the WG region of Maharashtra, Goa, Karnataka, Kerala and Tamilnadu. Conservation Status of 57 species of fishes was not evaluated, that comprises about 17% of the total number of species present in the WG (Fig. 6.2.33). The species from the families, Balitoridae, Cobitidae, Bagridae, Aplocheilidae, Ariidae, Badidae,

Soleidae, Gobiidae, Carangidae, Cyprinidae, Channidae, Synodontidae, Clupeidae, Sciaenidae, Trichluridae, Mugilidae, Mastacembelidae, Nemacheilidae, Cichlidae, Poeciliidae, Salmonidae, Engraulidae, and Zenarchopteridae. These species show distribution across the entire WG regions of Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu.

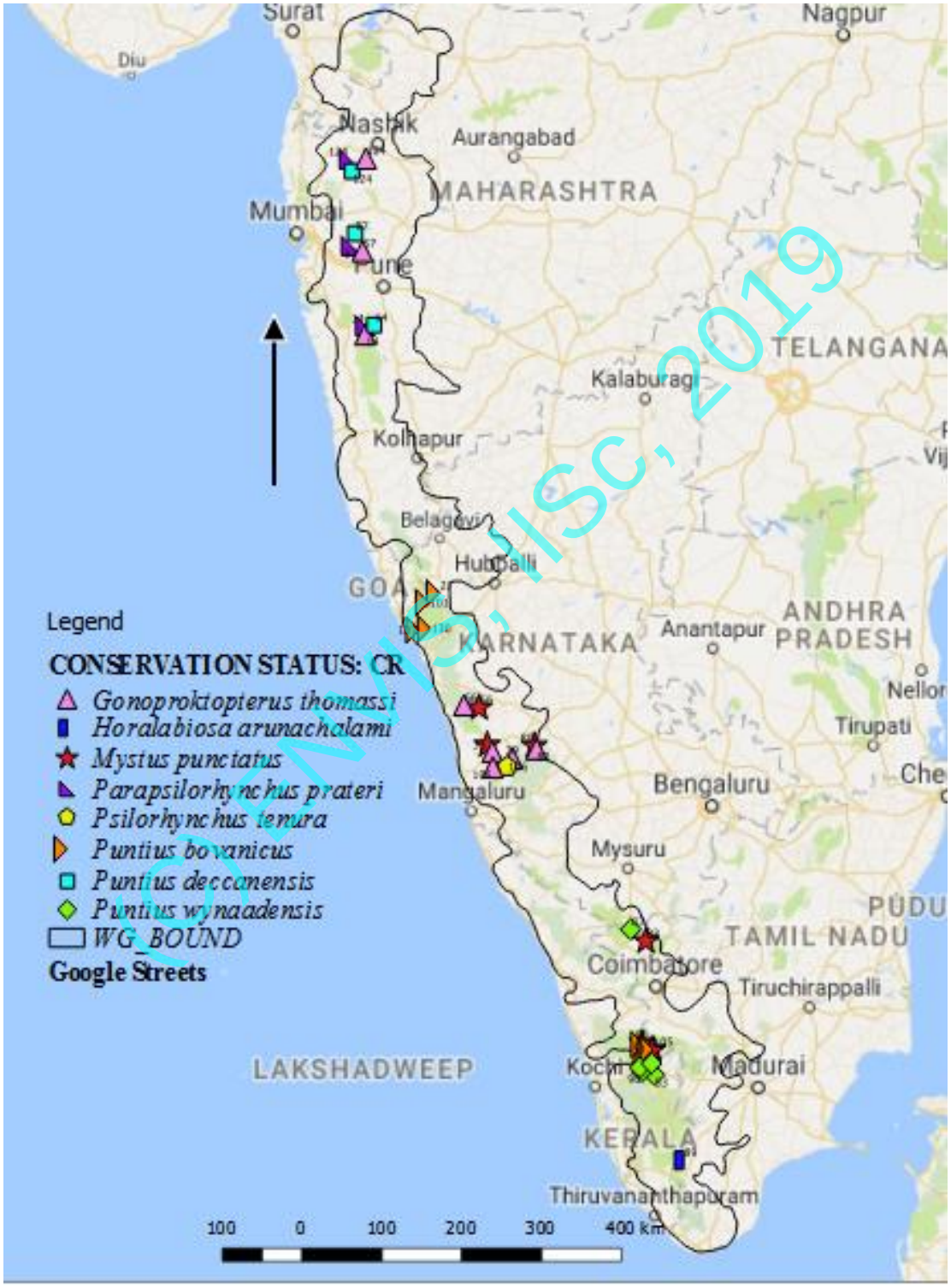


Fig. 6.2.27. Spatial distribution of the Critically Endangered Fish species.

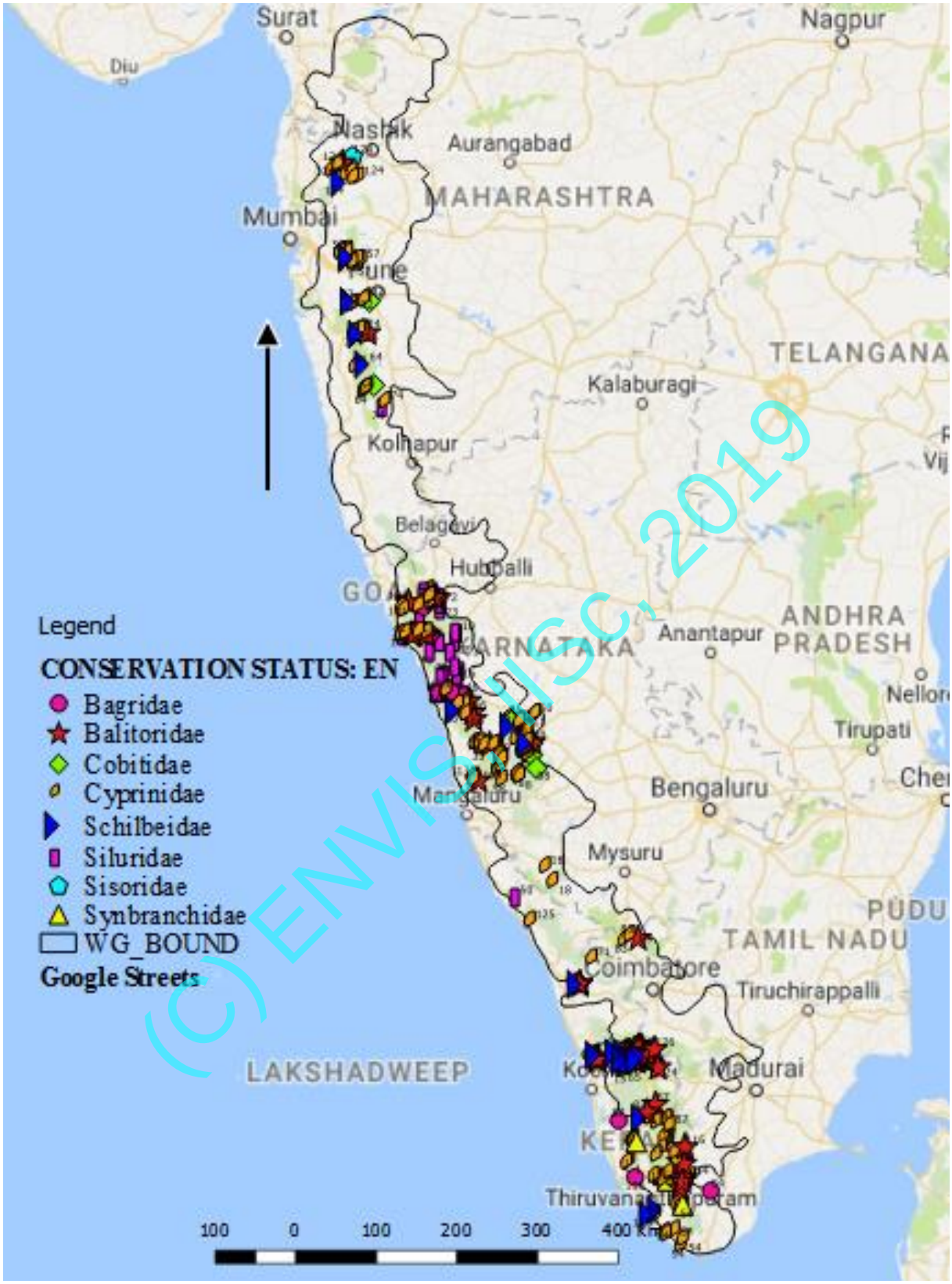


Fig. 6.2.28. Spatial distribution of the Endangered Fish families.

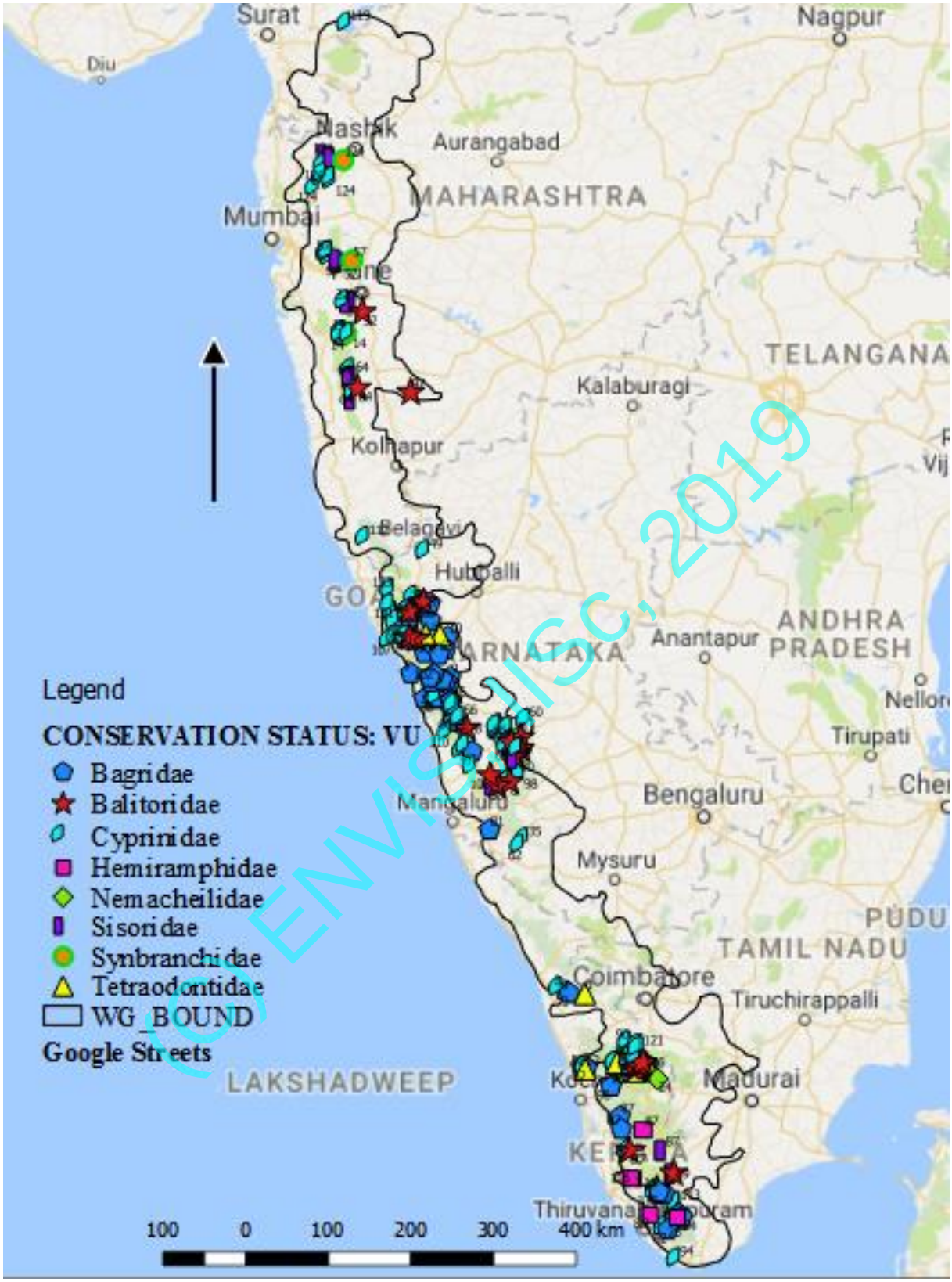


Fig. 6.2.29. Spatial distribution of the Vulnerable Fish species.

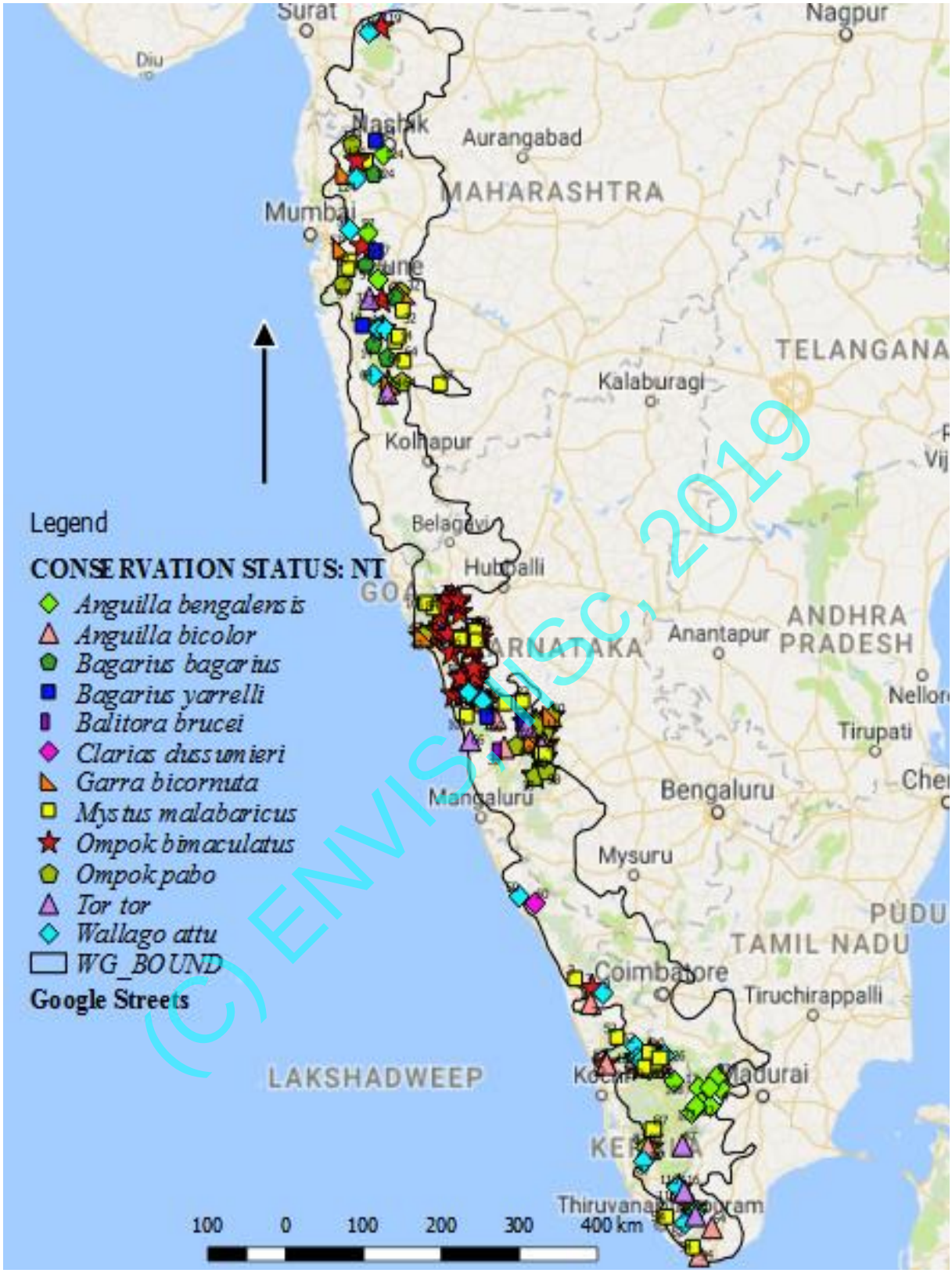


Fig. 6.2.30. Spatial distribution of the Near Threatened Fish species.

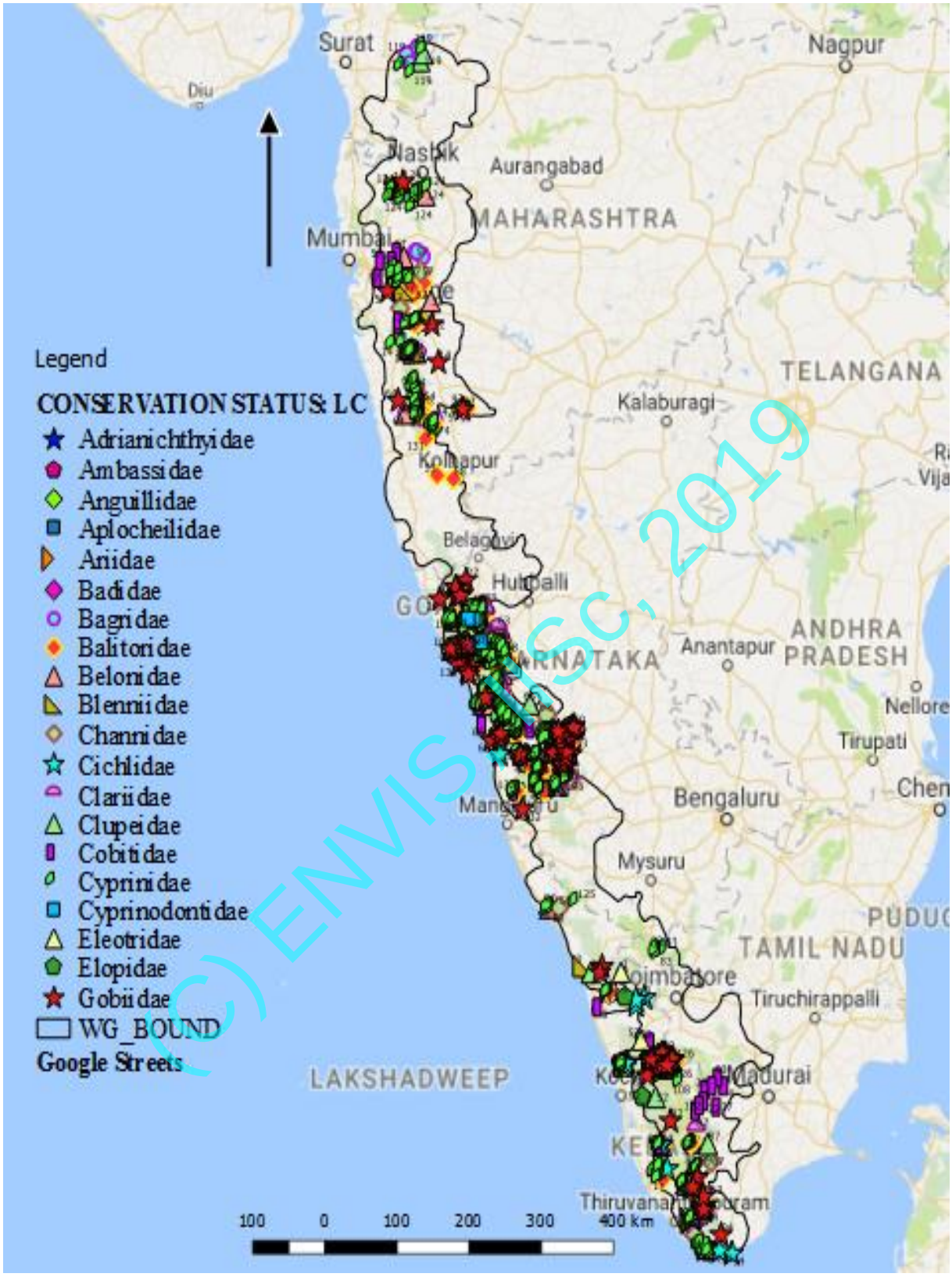


Fig. 6.2.31a. Spatial distribution of the Least Concern Fish species.

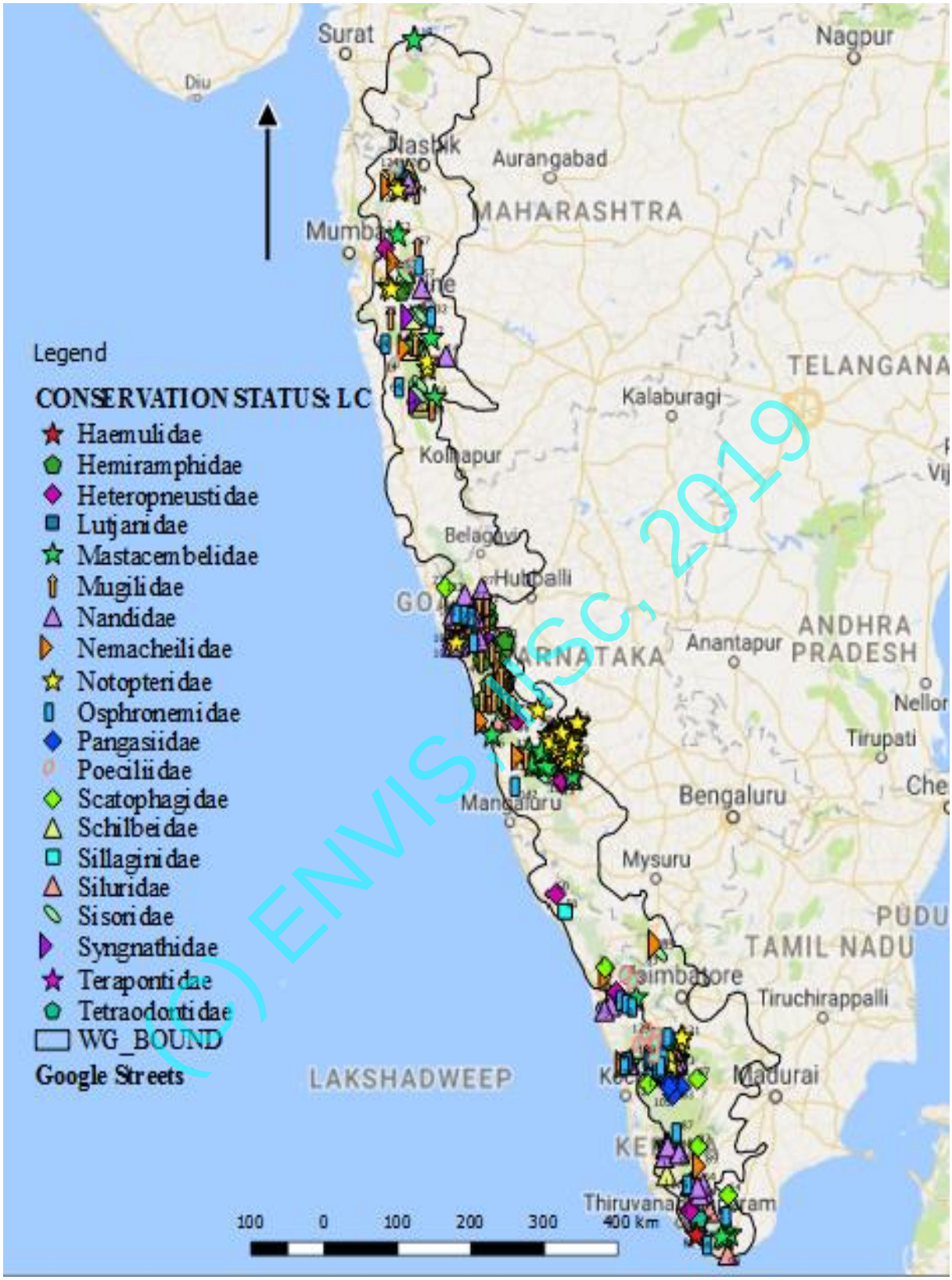


Fig. 6.2.31b. Spatial distribution of the Least Concern Fish species.

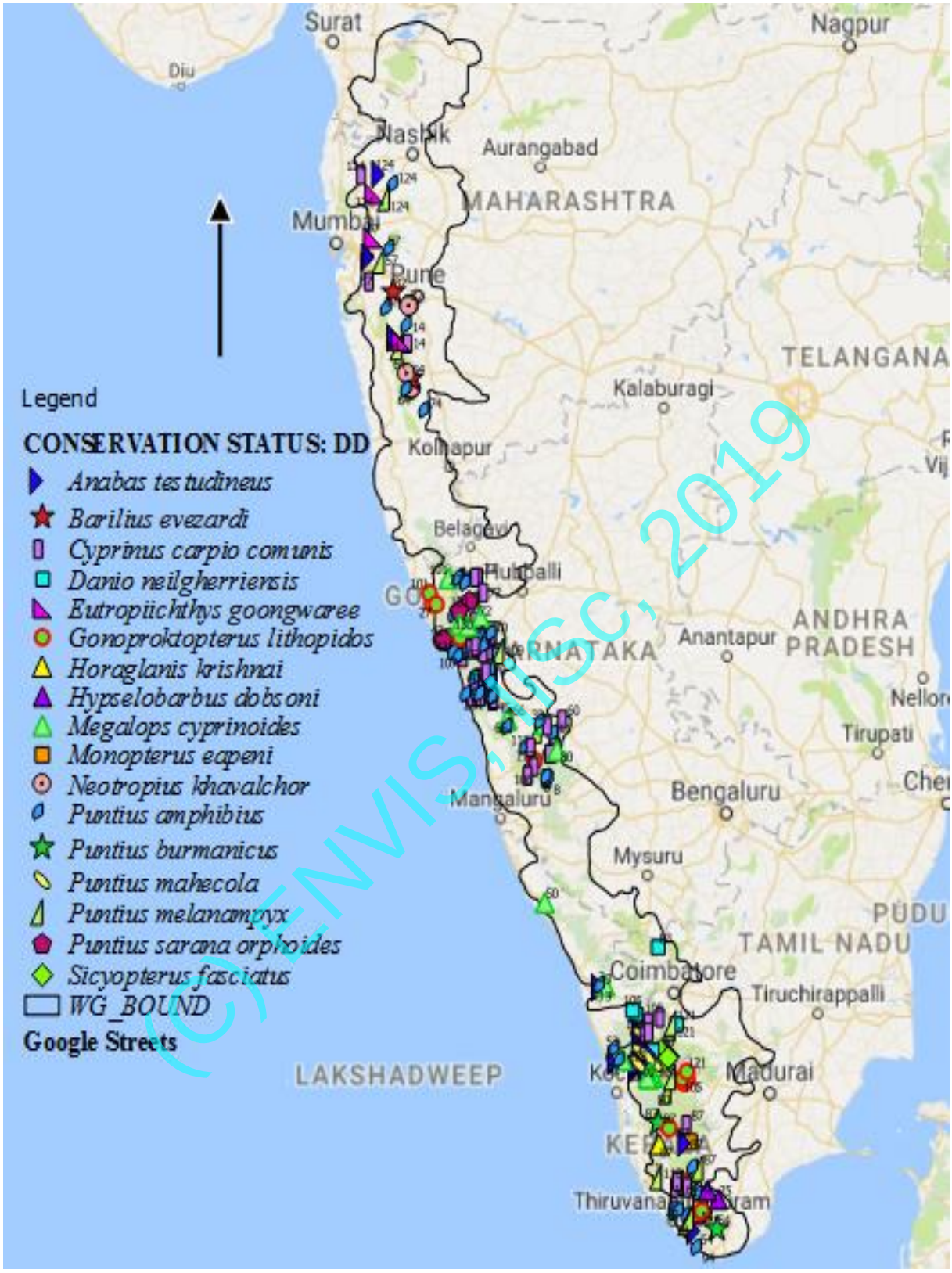


Fig. 6.2.32. Spatial distribution of the Data Deficient Fish species.

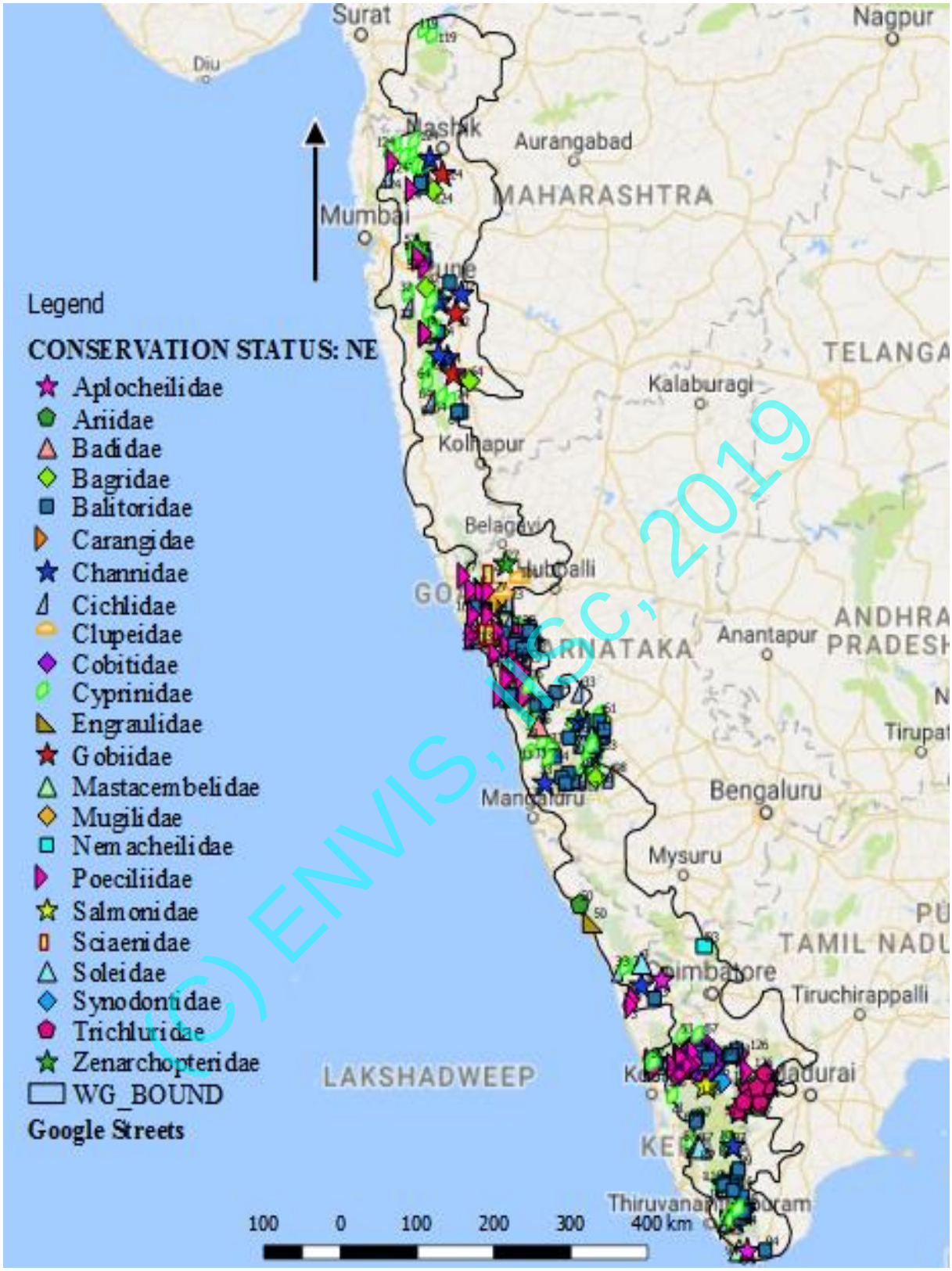


Fig. 6.2.33. Spatial distribution of the Not Evaluated Fish species.

6.3. AMPHIBIANS

Amphibians are ectothermic, tetrapod vertebrates of the Kingdom Animalia, Phylum Chordata, Subphylum Vertebrata and class Amphibia. They can live in both aquatic and terrestrial habitats. Class Amphibia has three orders, Anura, Urodela, and Apoda. There are 6400 amphibian species were reported from the world (Dodd, 2009).

Western Ghats has 248 species of Amphibians across 383 locations, as per the reviewed literature. The study sites include Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamilnadu state portions of Western Ghats (W.G) region (Fig. 6.3.1). The review highlights studies have identified 215 species up to species level and 33 has up to genera level. WG region has 11 families of amphibians. The families such as Bufonidae, Dicroglossidae, Ichthyophiidae, Indotyphlidae, Micrixalidae, Microhylidae, Nasikabatrachidae, Nyctibatrachidae, Ranidae, Ranixalidae, and Rhacophoridae are present in the WG. Rhacophoridae is the largest family consists of 82 species and Nasikabatrachidae is the smallest family consists of only one amphibian species, *Nasikabatrachus sahyadrensis* (Fig. 6.3.2). Ranixalidae is widely distributed family, reported across all states of WG. Indotyphilidae is reported from all states except Gujarat. Dicroglossidae, Bufonidae, Ranidae, Rhacophoridae, Microhylidae and Nyctibatrachidae shows higher distribution in the WG portion of Maharashtra, Karnataka, Kerala, and Tamilnadu. Ichthyophiidae, Micrixalidae, and Nasikabatrachidae show higher distribution in the Central and Southern WG region.

Distribution based on the family

Among 11 amphibian families present in the WG, **Ranixalidae** has the highest distribution. *Indirana* is the only one genus belongs to this family. *Indirana beddomii, I. brachytarsus, I. chiravasi, I. diplostictus, I. duboisi, I. gundia, I. leithii, I. leptodactylus, I. lonicrus, I. phynoderma, I. salelkari, I. sarojamma, I. semipalmata, I. tenuilingua, I. tysoni,* and *I. yadera* are the members of Ranixalidae family present in the WG region (Fig. 6.3.3). These 16 members were distributed across the WG regions of Gujarat, Goa, Maharashtra, Karnataka, Kerala, and Tamilnadu. *Indirana beddomii, I. gundia,* and *I. semipalmata* has higher distribution towards the central and southern regions of WG. *Indirana brachytarsus, I. diplostictus, I. leptodactylus,* and *I. phynoderma* are highly distributed in the Southern WG regions. *Indirana tysoni* and *Indirana yadera* were highly distributed in the WG regions of Karnataka and Kerala. *Indirana leithii* is distributed in the Northern regions of WG. A major distribution of *Indirana chiravasi* was seen in the Maharashtra regions of WG. *Indirana lonicrus, Indirana duboisi* and *Indirana tenuilingua* show distribution only in the WG regions

of Karnataka. *Indirana salelkari* and *Indirana sarojamma* are the species present only in the Netravali and Ponmudi regions of Goa and Kerala respectively. Dahanukar et al., 2016 reported the new species of Ranixalidae species, *Indirana duboisi*, from the regions of Mookambika, Udupi district, Karnataka, *Indirana tysoni* and *Indirana yadera* from the WG regions of Kerala, *Indirana sarojamma* from the Ponmudi regions of Kerala and *Indirana phynoderma* from the Anamalai regions of Tamilnadu. Modak et al. 2015 reported a new species, *Indirana salelkari* from the Netravali regions of Goa. The majority of the Ranixalidae species are endemic to WG. *Indirana leithii, I. beddomi, I. semipalmata, I. phynoderma, I. brachytarsus, I. leptodactylus, I. gundia, I. tenuilingua, I. lonicrus* and *I. diplostictus* are the endemic species.

Indotyphlidae is the next highly distributed Amphibian family present in the WG region. It is the family of common caecilians, 16 members of this family have distributed across the WG regions of Goa, Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.3.4). The family includes *Gegeneophis carnosus, G. danieli, G. goaensis, G. krishni, G. madhavi, G. mhadeiensis, G. nadkarnii, G. primus, G. ramaswamii, G. seshachari, G. tejaswini, Indotyphlus battersbyi, I. maharashtraensis* and 3 species, *G. cfdanieli, G. cf. mhadeiensis* and *G. sp* which has been identified only up to the genera level. *Gegeneophis danieli, G. seshachari, Indotyphlus battersbyi* and *Indotyphlus maharashtraensis* are the species shows higher distribution in WG regions of Maharashtra. *Gegeneophis madhavai, G. carnosus, G. krishni* and *G. mhadeiensis* has higher distribution in the WG regions of Karnataka. *Gegeneophis ramaswamii, G. primus* and *G. tejaswini* has distributed towards the Southern regions of WG. *Gegeneophis goaensis* is the species present in the WG regions of Goa. *Gegeneophis danieli, G. ramaswamii, G. krishni, G. carnosus, G. madhavai, G. seshachari, Indotyphlus maharashtraensis* and *Indotyphlus battersbyi* are the Indotyphlidae species which are endemic to WG.

Bufonidae is the only family of true Toads. From the WG regions, 13 members of this family were reported. The members include *Ansonia ornata, Ansonia rubigina, Duttaphrynus beddomii, D. fergusoni, D. hololius, D. melanostictus, D. microtympanum, D. parietalis, D. scaber, D. silentvalleyensis, Pedostibes tuberculosus, Duttaphrynus cf. microtympanum and D. sp* (Fig. 6.3.5). Bufonidae family has distributed across the WG regions of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu. *Duttaphrynus melanostictus* is the highly distributed species in the Bufonidae family; it shows distribution across the regions of Maharashtra, Karnataka, Kerala and Tamilnadu. *Duttaphrynus fergusoni* is a new Bufonidae species reported from the Kalakad-Mundanthurai Tiger Reserve, Tamilnadu (Johnsingh, 2001). Most of the

members of the Bufonidae family shows higher distribution in the regions of Central and Southern WG. The only species which shows higher distribution in the regions of Northern WG is *Pedostibes tuberculosus*is. *Pedostibes tuberculosus, Duttaphrynus beddomii, D. parietalis, D. microtympanum, D. silentvalleyensis, Ansonia ornata* and *Ansonia rubigina* are the Bufonidae species endemic to WG.

Dicroglossidae is one of the largest amphibian families present in the WG region. The family includes 29 species of amphibians. This family shows higher distribution towards the regions of Central and Southern WG (Fig. 6.3.6). *Fejervarya modestus*, is a new Dicroglossidae species discovered by K. P. Dinesh et al in 2015 from the Shimoga District of Karnataka (Dinesh et al., 2015). *Fejervarya keralensis, F. Sahyadrensis, F. brevipalmata, F. rufescens, F. nilagirica, F. mysorensis, F. caperata, F. kudremukhensis, F. murthii, F. parambikulamana, F. granosa, F. sauriceps, F. mudduraja, Minervarya sahyadris* and *Euphlyctis aloysii* are the endemic species present in the WG.

Nasikabatrachidae is the smallest endemic amphibian family (new discovery) present in the WG (Biju et al., 2008). *Nasikabatrachus sahyadrensis* is the only species belongs to this family and it distributed across the regions of Karnataka, Kerala, and Tamilnadu (Fig. 6.3.7). *Nasikabatrachus sahyadrensisis* is commonly known as Pig-nosed Frog or Sahyadri Pig Nosed Frog, categorized under endangered category by IUCN Red List.

The **Ichthyophiidae** are the family of Asiatic tailed caecilians or fish caecilians. WG has two genera of Ichthyophiidae family; they are Ichthyophis and Uraeotyphlus. *Ichthyophis beddomei, I. kodaguensis, I. longcephalus, I. malabarensis, I. tricolor. I cf. tricolor* and *I. sp* are the species belongs to the genera *Ichthyophis*. *Uraeotyphlus interruptus, U. malabaricus, U. menoni, U. narayani, U. oommeni* and *U. oxyurus* are the species belongs to the genera *Uraeotyphlus* (Fig. 6.3.8). Most of the members of this family prefer moist evergreen or semi-evergreen habitats since it shows higher distribution towards the Central and Southern WG. Out of the 14 Ichthyophiidae species present in the WG region, *Ichthyophis beddomei, I. malabarensis, I. tricolor, I. bombayensis, I. longicephalus, I. kodaguensis, Uraeotyphlus narayani, U. malabaricus, U. oxyurus* and *U. menoni* are endemic to WG.

The **Micrixalidae** family contains only one genus, Micrixalus. WG region has 18 amphibian species belongs to the family Micrixalidae, shows higher distribution in the Karnataka, Kerala and Tamilnadu regions (Fig. 6.3.9). Sandeep, 2015 reported most of the Micrixalidae species *Micrixalus thampii, M. silvaticus, M. sali, M. sairandhri, M. phyllophilus, M. nigraventris, M.*

nelliyampathi, M. mallani, M. kurichiyari, M. herrei, M. adonis, M. elegans and *M. frigidus* from the WG regions of Kerala. *Micrixalus fuscus, M. saxicola, M. nudis, M. phyllophilus, M. nigraventris, M. herrei, M. gadgili, M. silvaticus, M. frigidus* and *M. elegans* are the species which are endemic to WG.

Microhylidae is the family of Narrow-mouthed frogs. *Microhyla rubra, M. ornata, M. sholigari, Ramanella montana, R. variegata, R. triangularis, R. mormorata, Uperodon anamalaiensis, U. systoma, U. globulosus, Melanobatrachus indicus, Kaloula taprobanica* and *K. pulchra* are the species of Microhylidae family present in the regions of WG. Members of this family show higher distribution in the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.3.10). *Ramanella montana, R. triangularis, R. mormorata* and *Melanobatrachus indicus* are the Microhylidae species which are endemic to the WG.

Nyctibatrachidae is family present only in the regions of India and Sri Lanka. It is the second largest amphibian family present in the WG region. Nyctibatrachus is the only genus belongs to this family. As per the review, 31 species of this family has highly distributed across the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.3.11). The majority of the Nyctibatrachidae species are endemic to WG. *Nyctibatrachus major, N. danieli, N. petraeus, N. pygmaeus, N. deccanensis, N. minor, N. aliciae, N. vasanthi, N. beddomii, N. dattatreyaensis, N. humayuni, N. gavi, N. poocha, N. anamallaiensis, N. kempholeyensis, N. jog, N. pillaii, N. minimus, N. karnatakaensis, N. sanctipalustris, N. vrijeuni, N. acanthodermis, N. deveni, N. sylvaticus, N. shiradi, N. grandis* and *N. periyar* are the endemic species. *Nyctibatrachus indraneili* is a new Nyctibatrachidae species from the Nilgiri District of Tamilnadu (Van Bocxlaer et al, 2012). *Nyctibatrachus humayuni* and *Nyctibatrachus danieli* shows higher distribution in the WG regions of Maharashtra. *Nyctibatrachus deveni, N. gavi, N. grandis, N. deccanensis, N. periyar* and *N. minimus* shows higher distribution in Kerala regions. *Nyctibatrachus jog, N. karnatakaensis, N. kempholeyensis, N. pygmaeus, N. petraeus and N. sylvaticus* shows higher distribution in Karnataka regions of WG.

Ranidae is one of the highly distributed amphibian families in the WG. *Clinotarsus curtipes, Hylarana aurantiaca, H. malabarica, H. temporalis, H. sp, Indosylvirana doni, I. flavescens, I. indica, I. intermedius, I. magna, I. sreeni, I. urbis and Rana clamitans* are the Ranidae species present in the WG regions (Fig. 6.3.12). In these *Clinotarsus curtipes, Hylarana aurantiaca, H. malabarica, H. temporalis* shows wide distribution across the regions of Maharashtra, Karnataka, Kerala, and Tamilnadu. Among the Ranidae species, *Hylarana malabarica* shows

highest distribution across the regions of Maharahtra, Karnataka, and Kerala. Other Ranidae species are highly distributed in the central and southern regions of WG. Sandeep, 2015 has reported the species *Indosylvirana doni, I. flavescens, I. indica, I. intermedius, I. magna, I. sreeni, I. urbis* from the WG regions of Kerala. Among the 13 Ranidae species, *Clinotarsu scurtipes, Hylarana aurantiaca, H. malabarica, Indosylvirana intermedius, I. flavescens, I. magna, I. indica* and *I. sreeni* are the endemic species of WG region.

Rhacophoridae is the largest amphibian family present, consists of 82 species and it has highly distributed across the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.3.13a & Fig. 6.3.13b). Biju et al., 2008 had discovered a new genus belongs to the family Rhacophoridae and it is named as *Ghatixalus*. The genus *Ghatixalus* has two species, *Ghatixalus variabilis and Ghatixalus asterops. Philautus akroparallagi, P. graminirupes, P. ponmudi, P. bobingeri, P. kani, P. chotta, P. tuberohumerus, P. temporalis, P. amboli, P. bombayensis, P. wynaadensis, P. chalazodes, P. griet, P. jayarami, P. sushili, P. beddomii, P. tinniens, P. travancoricus, P. agasthyaensis, P. crustai, P. johnceei, P. munnarensis, P. dubois, P. luteolus, P. kadalarensis, P. kaikatti, P. marki, P. ochlandrae, P. glandulosus, P. charius, P. anili, P. nerostagona, P. occidentalis, P. chromasynchysi, P. cf amboli, Rhacophorus pseudomalabaricus, R. malabaricus, R. calcadensis, R. lateralis, R. cflateralis, Ghatixalus variabilis, G. asterops, Raorchestes manohari, Raorchestes honnametti, R. resplendens, R. leucolatus, R. theuerkaufi, R. blandus, R. flaviventris, R. ravii, R. archeos, R. uthamani, Polypedates maculates and Polypedates pseudocruciger* are the 54 Rhacophoridae species which are endemic to the WG region. *Philautus pulcherrimus* is a new record of Rhacophoridae species reported by Andrews et al (2005) from the protected areas of Kerala. *Philautus chlorosommai* is a new record of Green-eyed Bush frog reported by Bjiu and Franky (2008) from the Munnar regions of Kerala. Seshadri et al, (2012) discovered a new Rhacophoridae species, *Raorchestes kakachi* from the Kakachi region of Tirunelveli district, Tamilnadu. Anil et al, (2011) discovered *Philautus kadalarensis* from Kadalar regions of Idukki District, Kerala, *Philautus johnceei, Philautus crustai* and *Philautus agasthyaensis* from Bonacaud regions of Kerala.

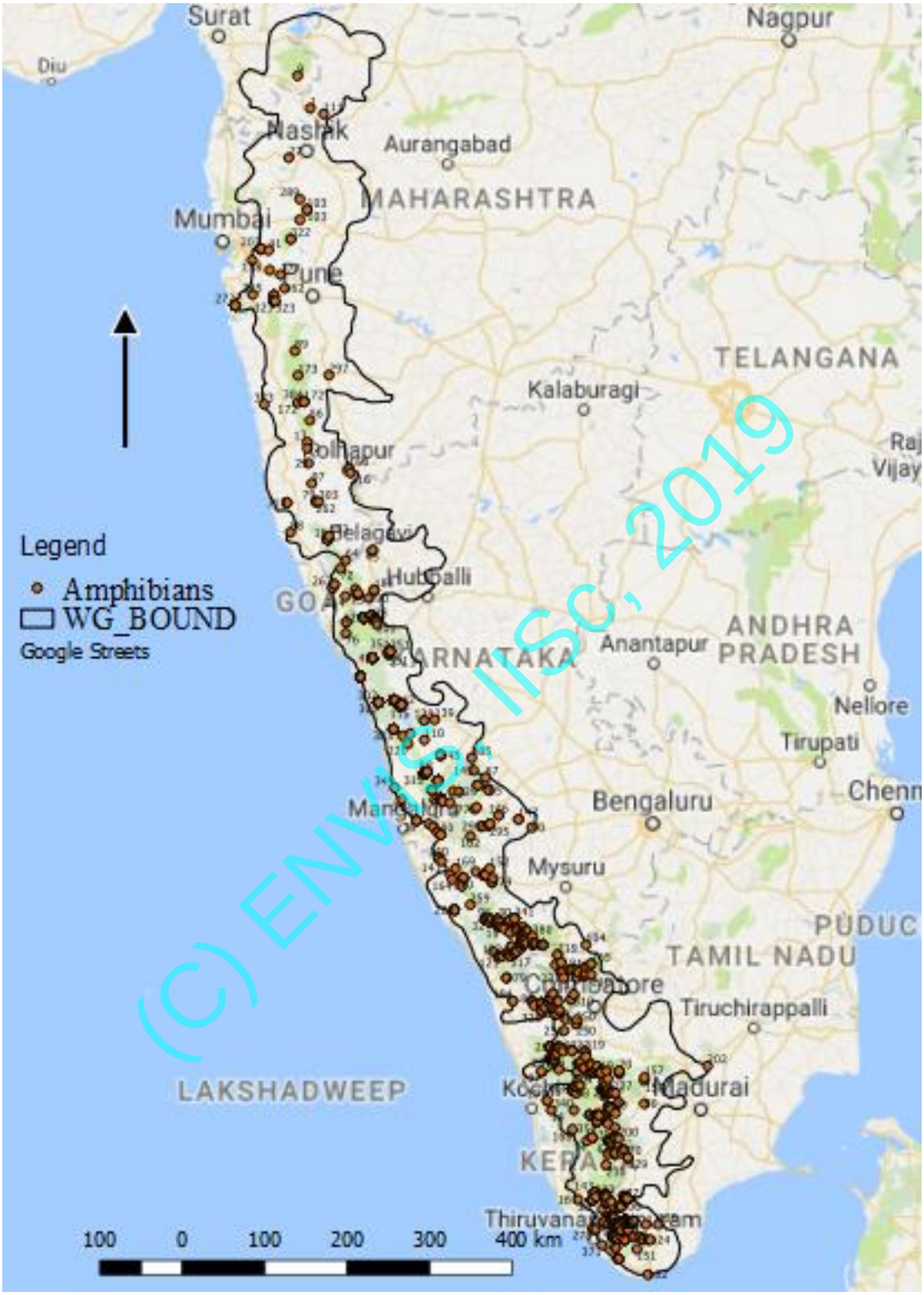


Fig. 6.3.1. Spatial distribution of Amphibians in the WG.

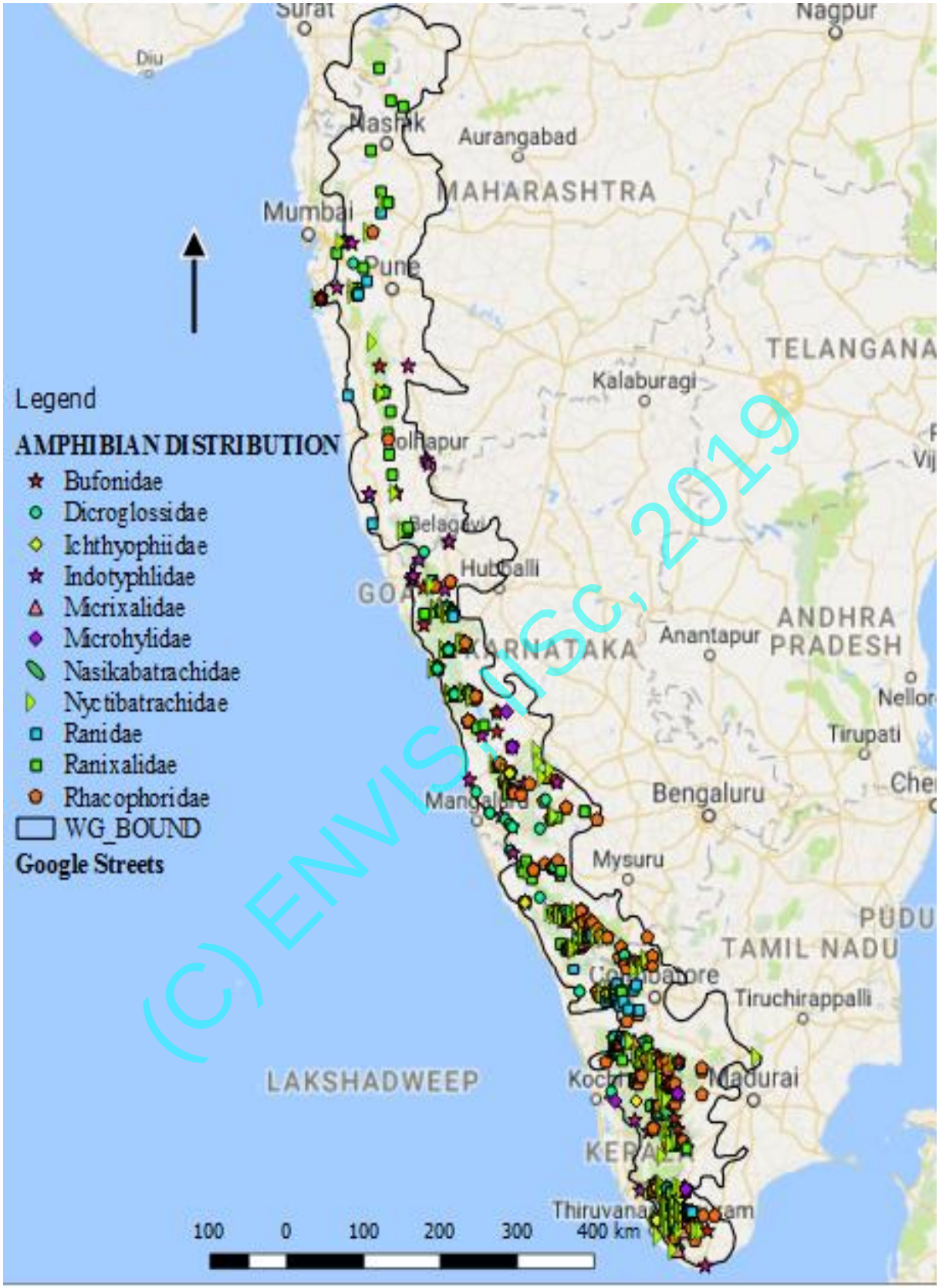


Fig. 6.3.2. Spatial distribution of Amphibian families in WG.

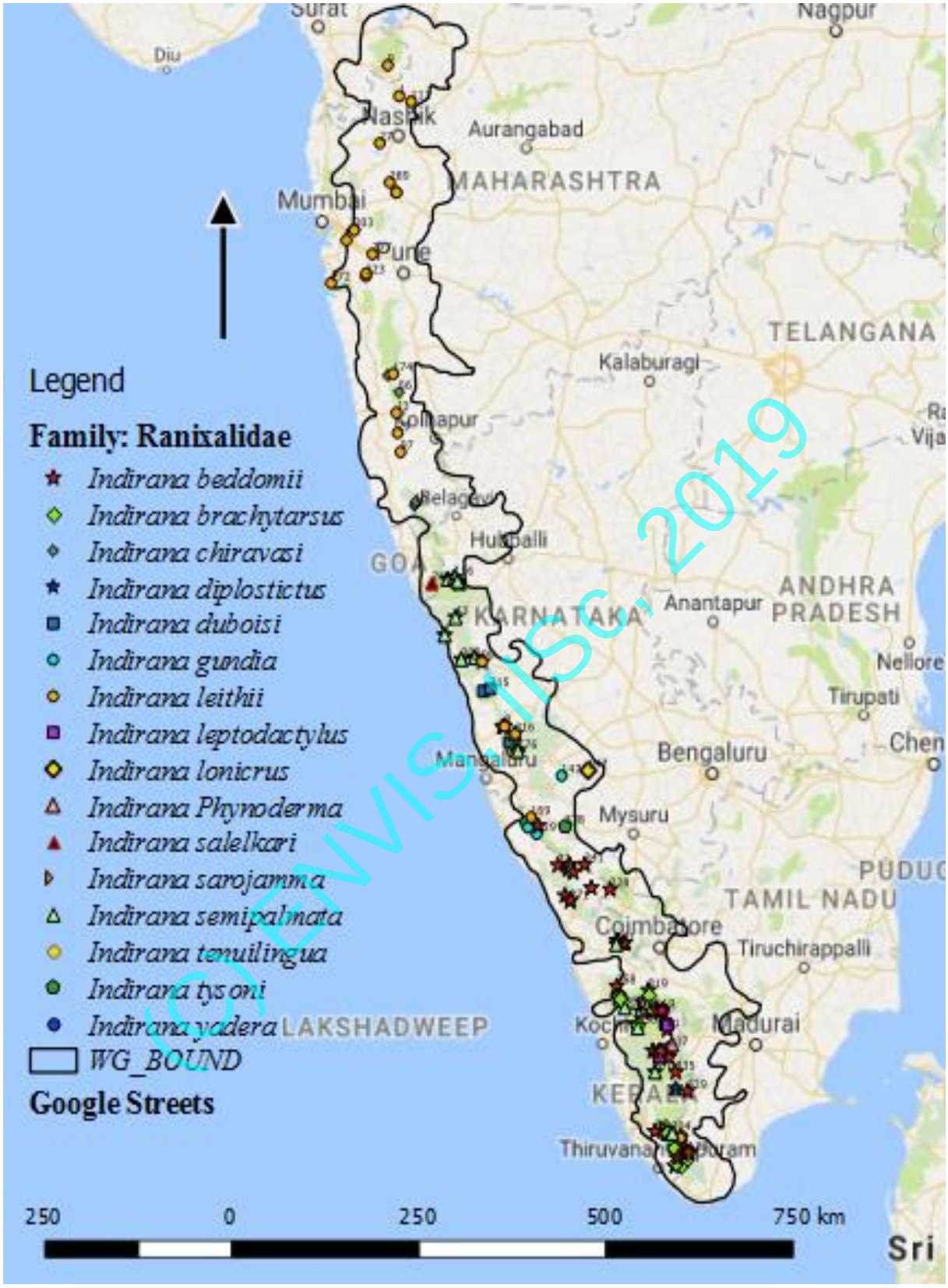


Fig. 6.3.3. Spatial distribution of the Ranixalidae family.

Fig. 6.3.4. Spatial distribution of the Indotyphilidae family.

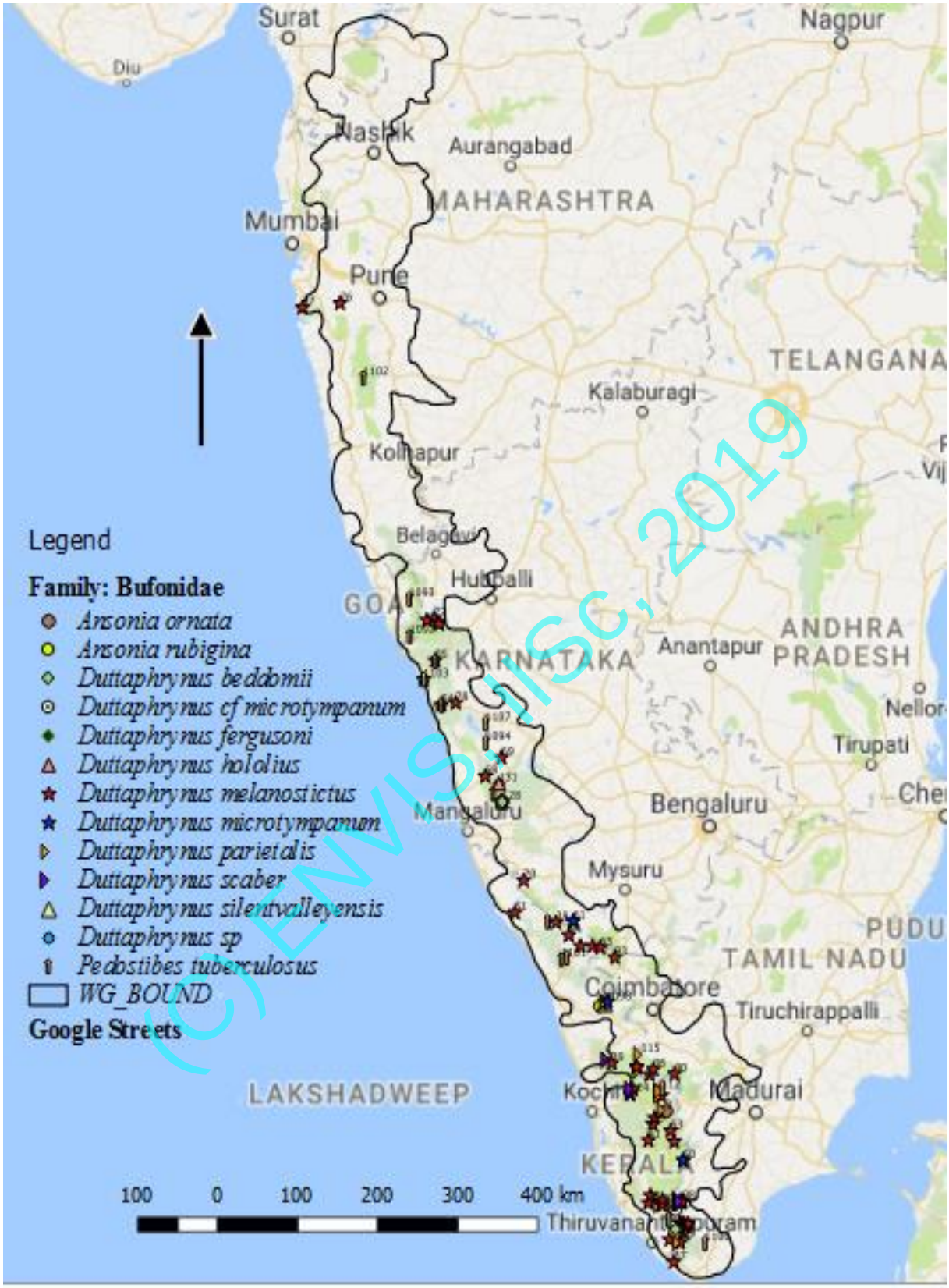


Fig. 6.3.5. Spatial distribution of the Bufonidae family.

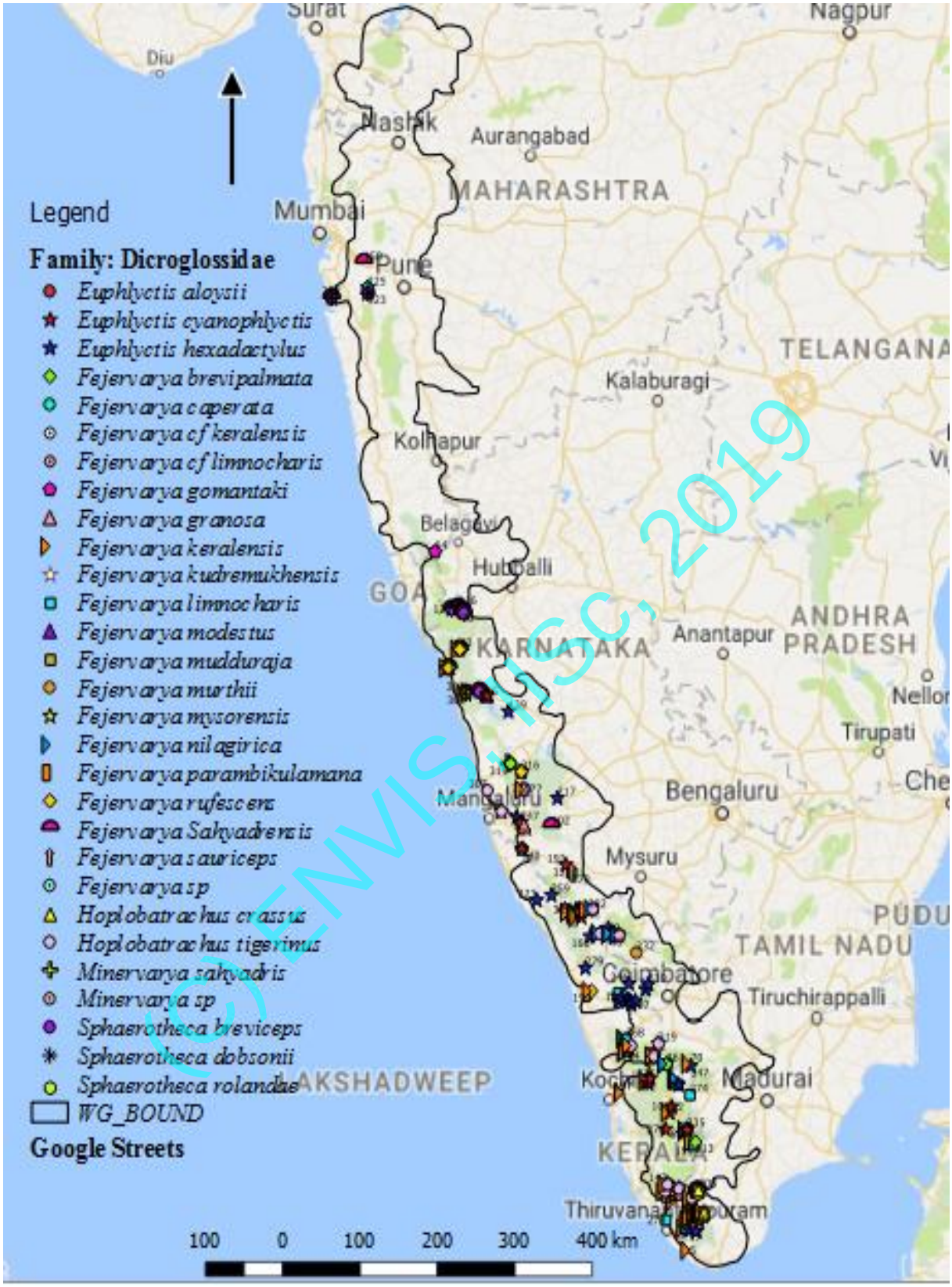


Fig. 6.3.6. Spatial distribution of the Dicroglossidae family.

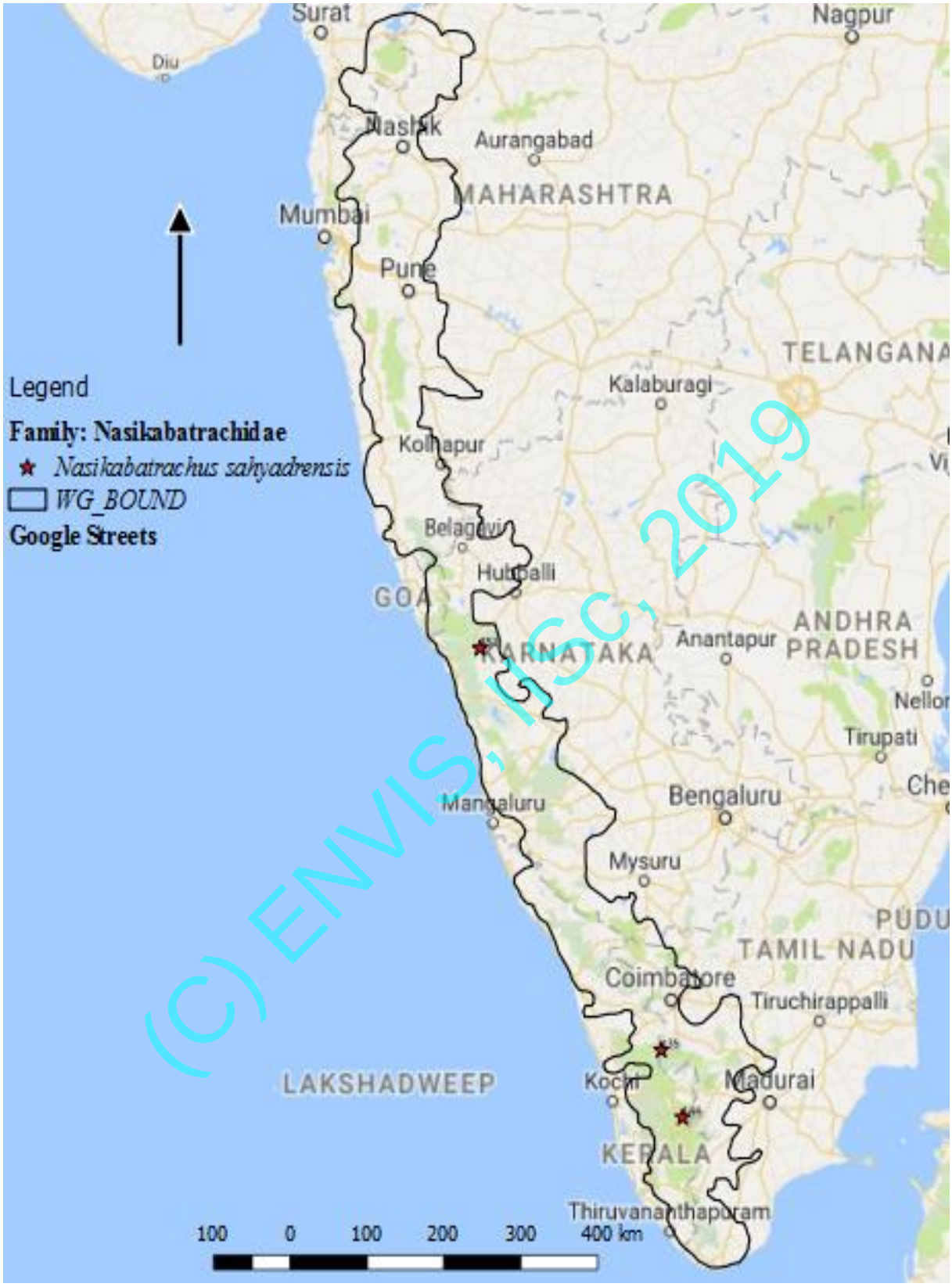


Fig. 6.3.7. Spatial distribution of the Nasikabatrachidae family.

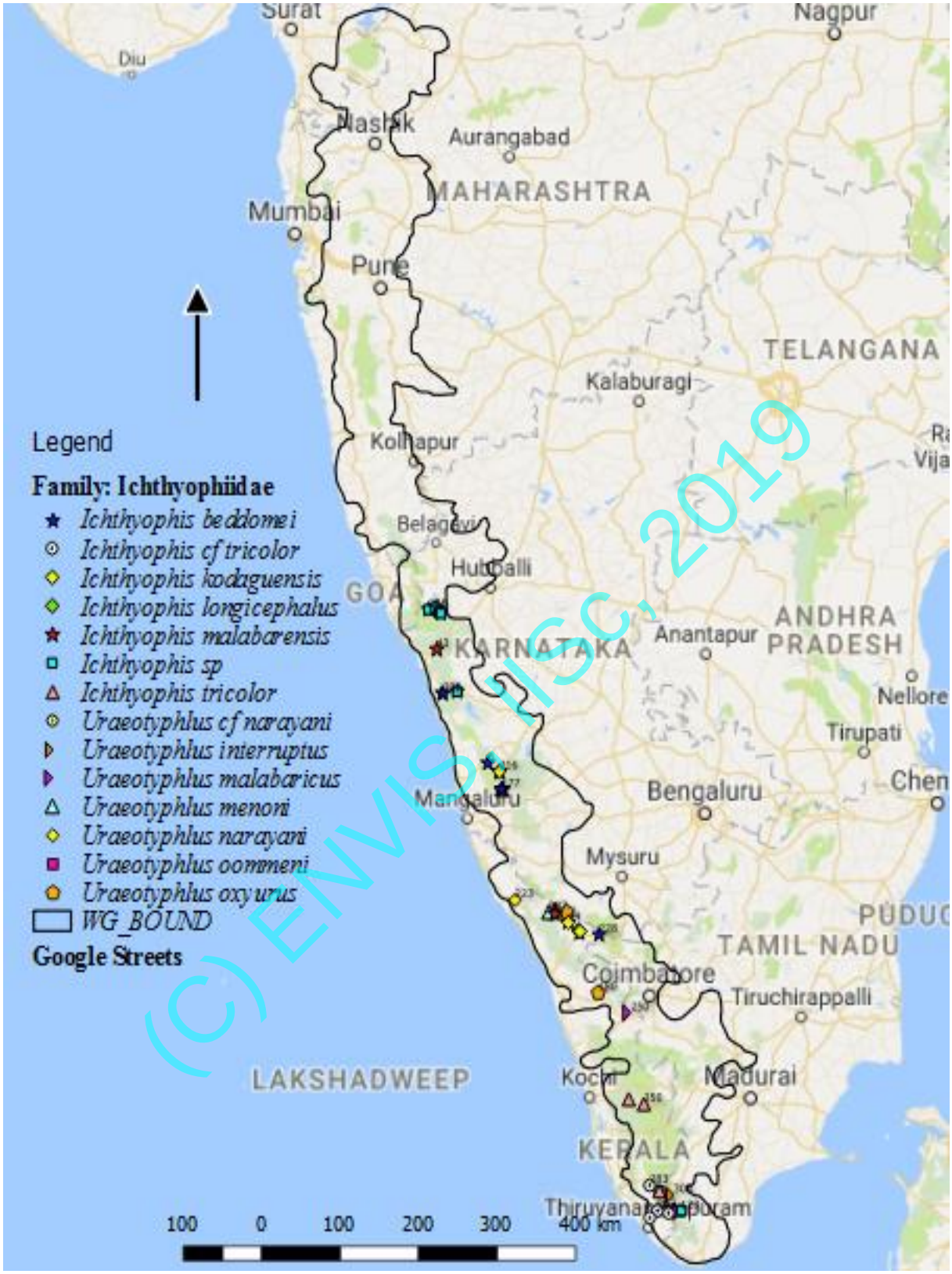


Fig. 6.3.8. Spatial distribution of the Ichthyophiidae family.

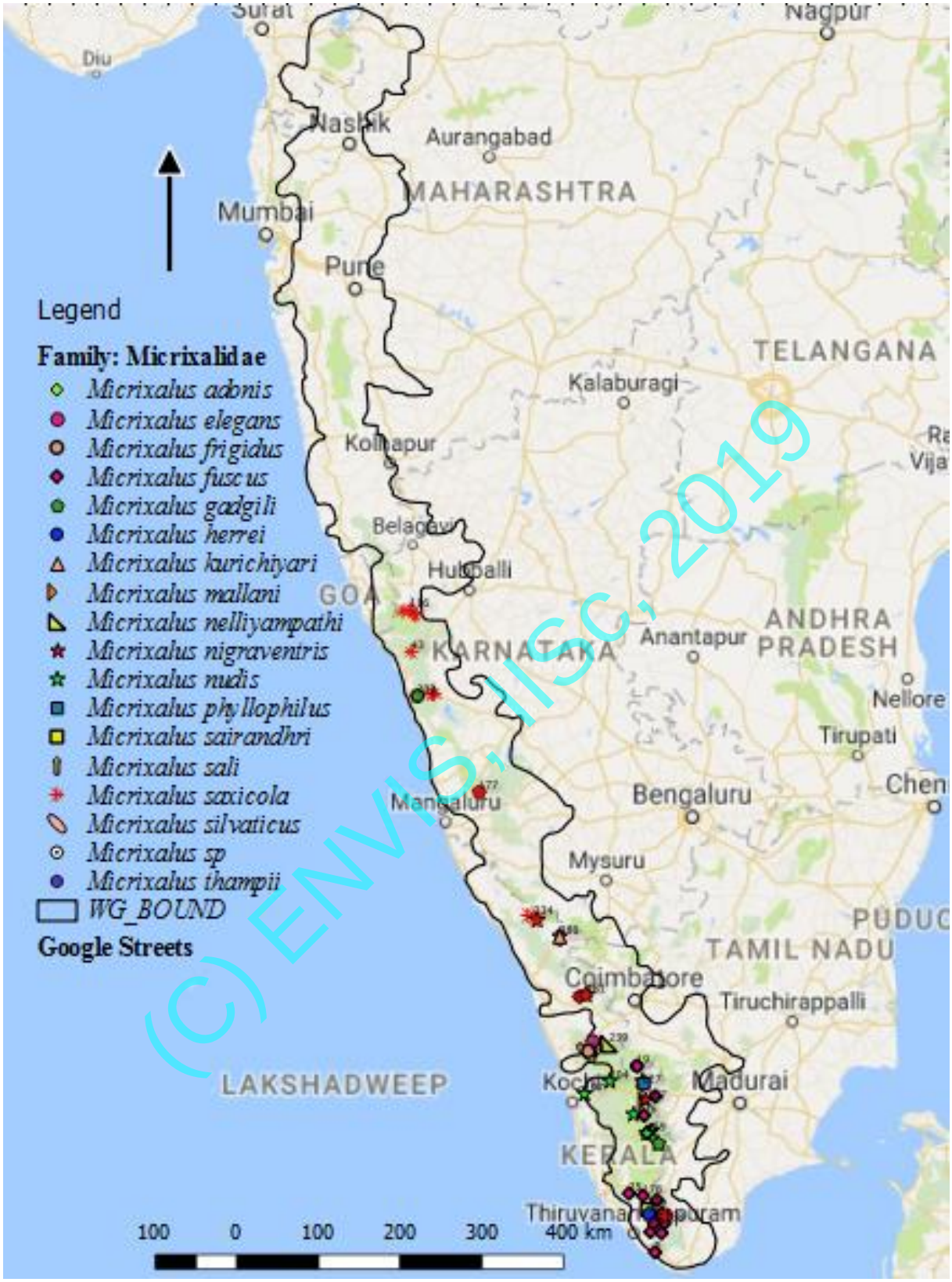


Fig. 6.3.9. Spatial distribution of the Micrixalidae family.

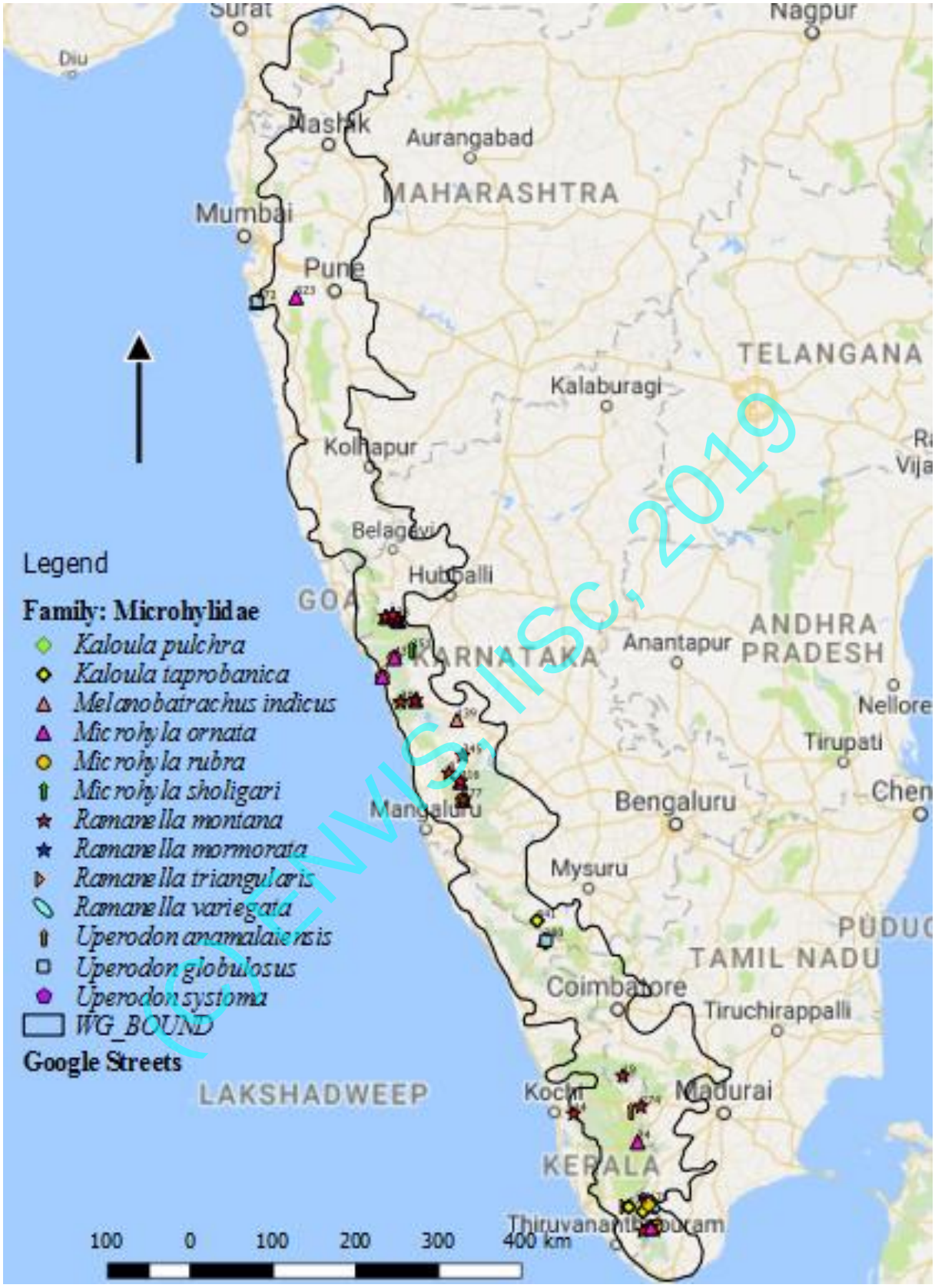


Fig. 6.3.10. Spatial distribution of the Microhylidae family.

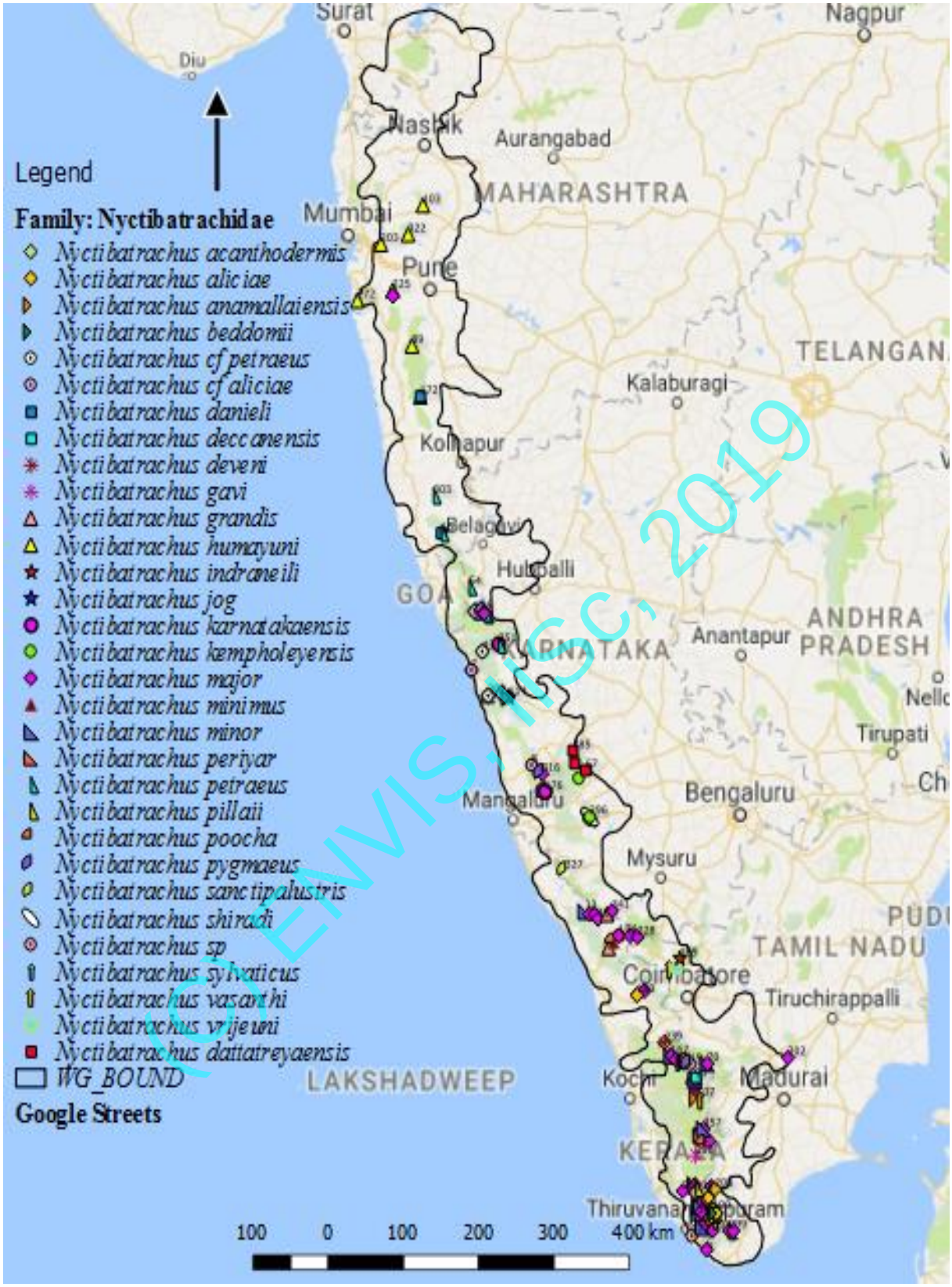


Fig. 6.3.11. Spatial distribution of the Nyctibatrachidae family.

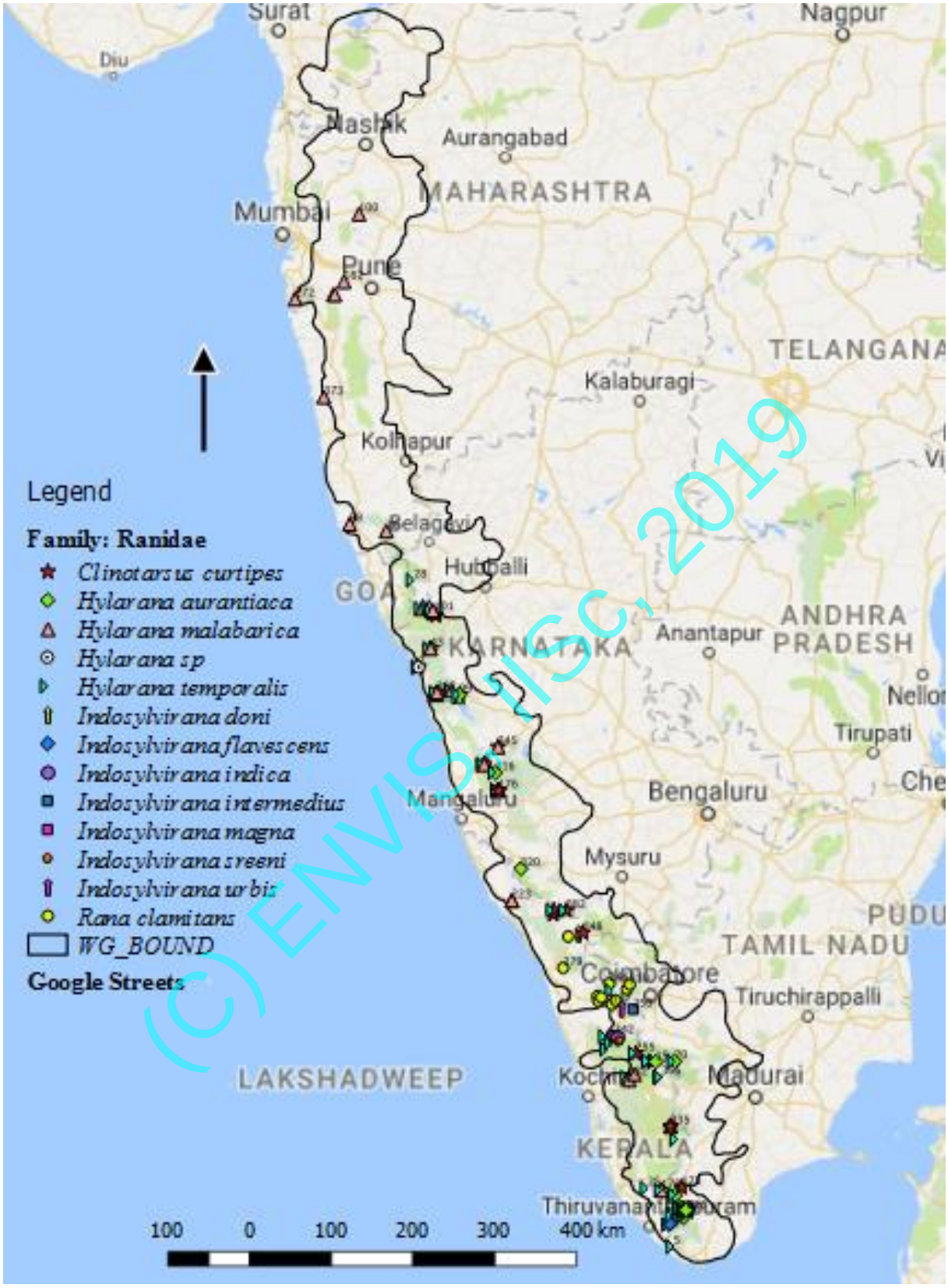


Fig. 6.3.12. Spatial distribution of the Ranidae family.

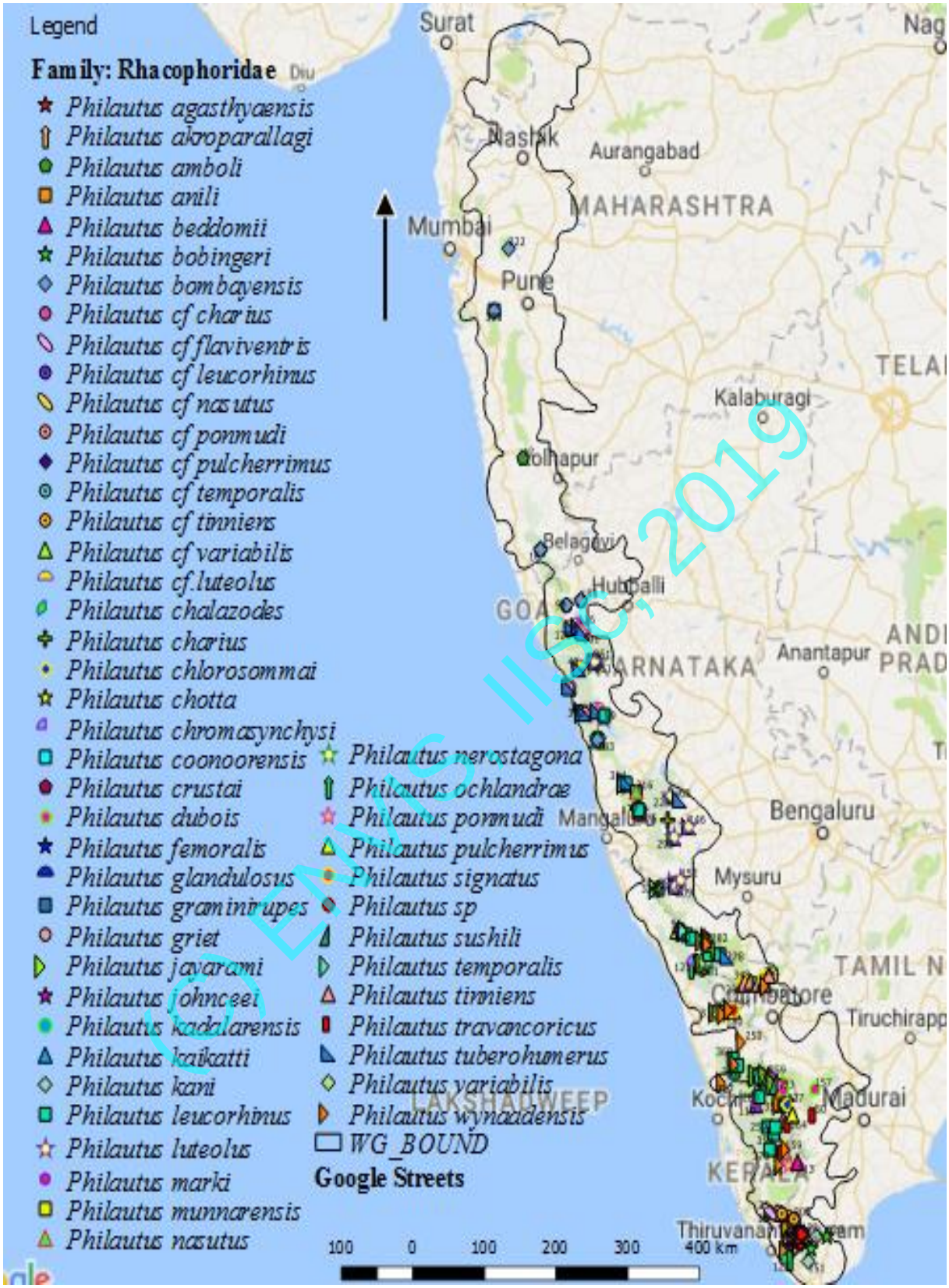


Fig. 6.3.13a. Spatial distribution of the Rhacophoridae family.

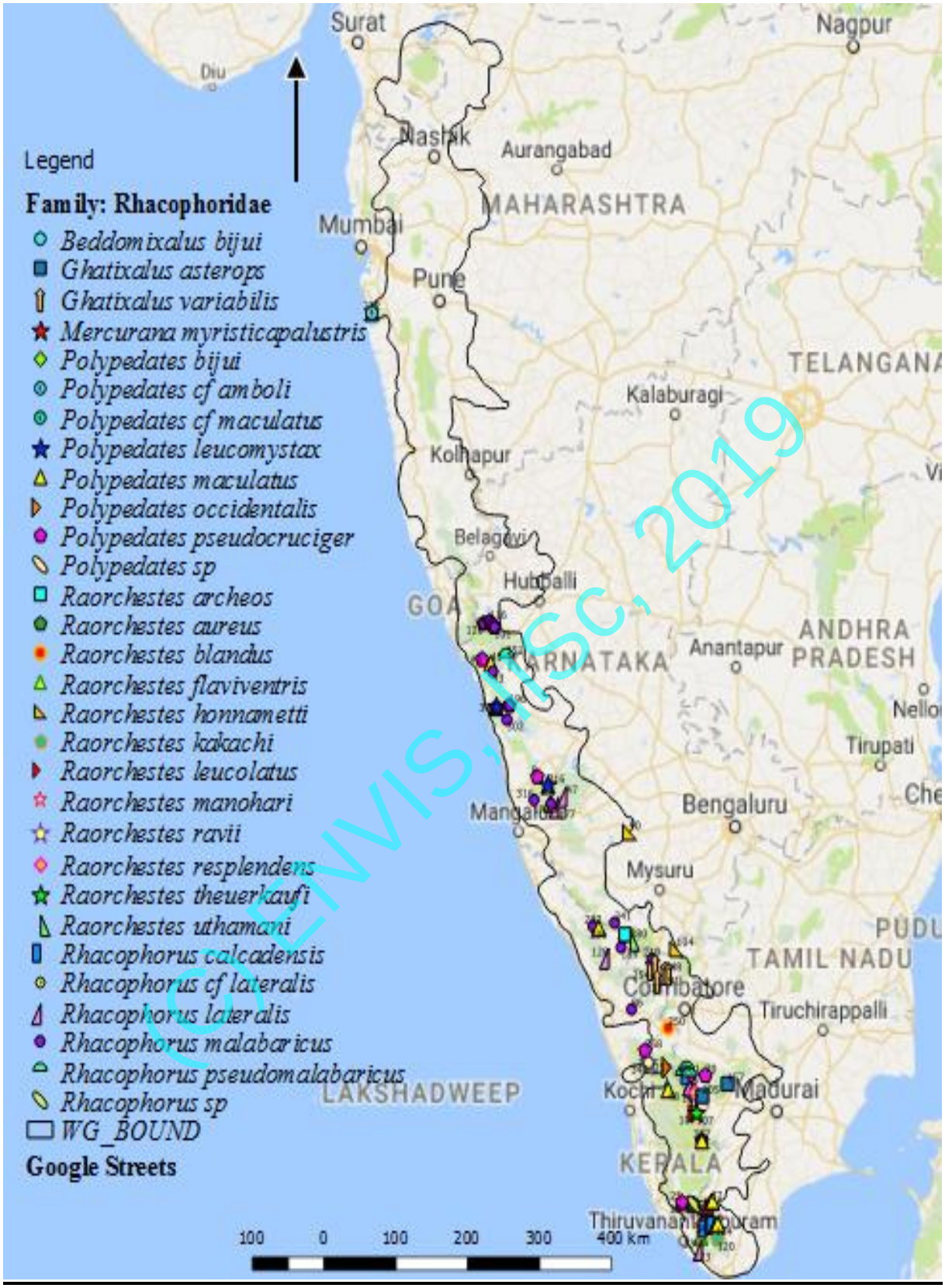


Fig. 6.3.13b. Spatial distribution of the Rhacophoridae family.

Distribution of endemic species

Among the 248 species of Amphibians, 154 species (62%) are endemic to WG (Fig. 6.3.14 & 6.3.15). All 11 families that are present in the WG region are endemic (Fig. 6.3.16).

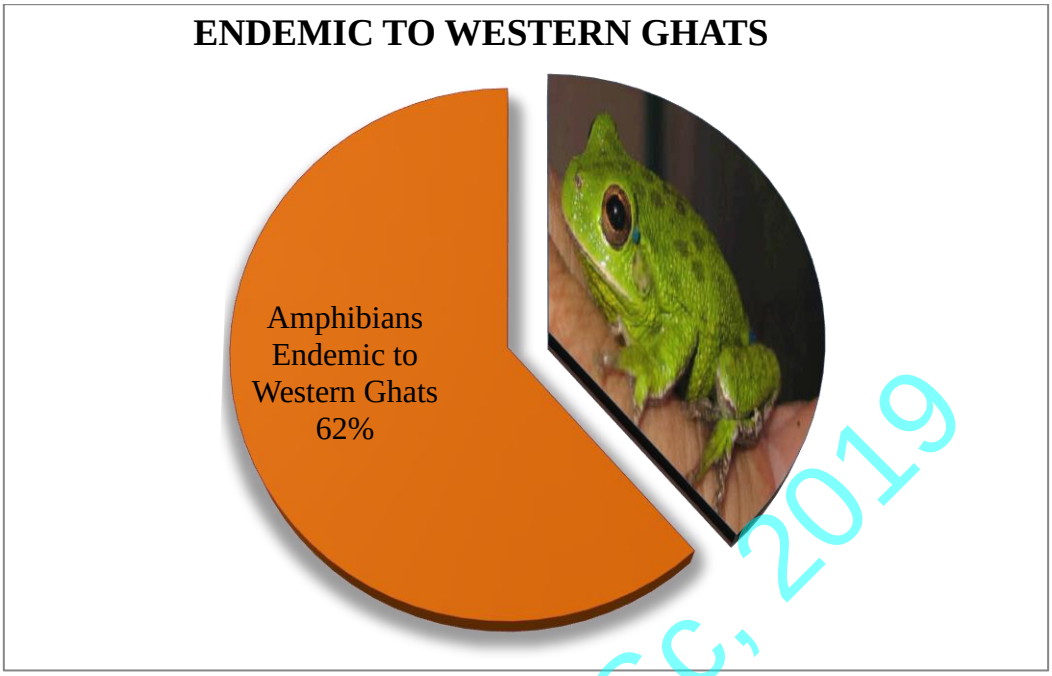


Fig. 6.3.14. Pie chart showing Endemism of Amphibians in WG.

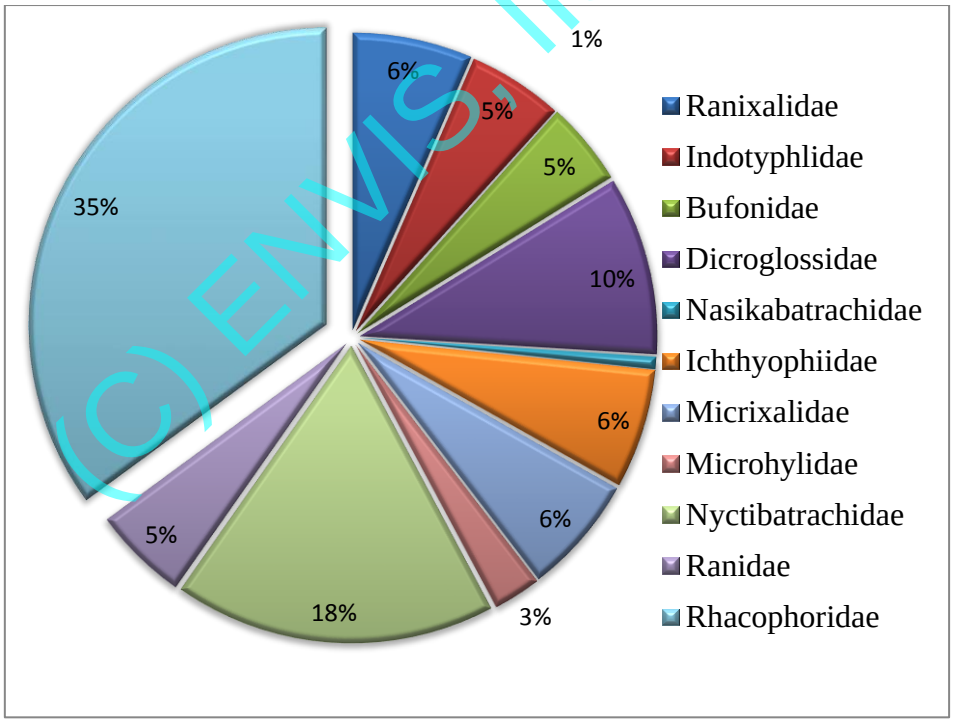


Fig. 6.3.16. Pie chart showing Endemic Amphibian families.

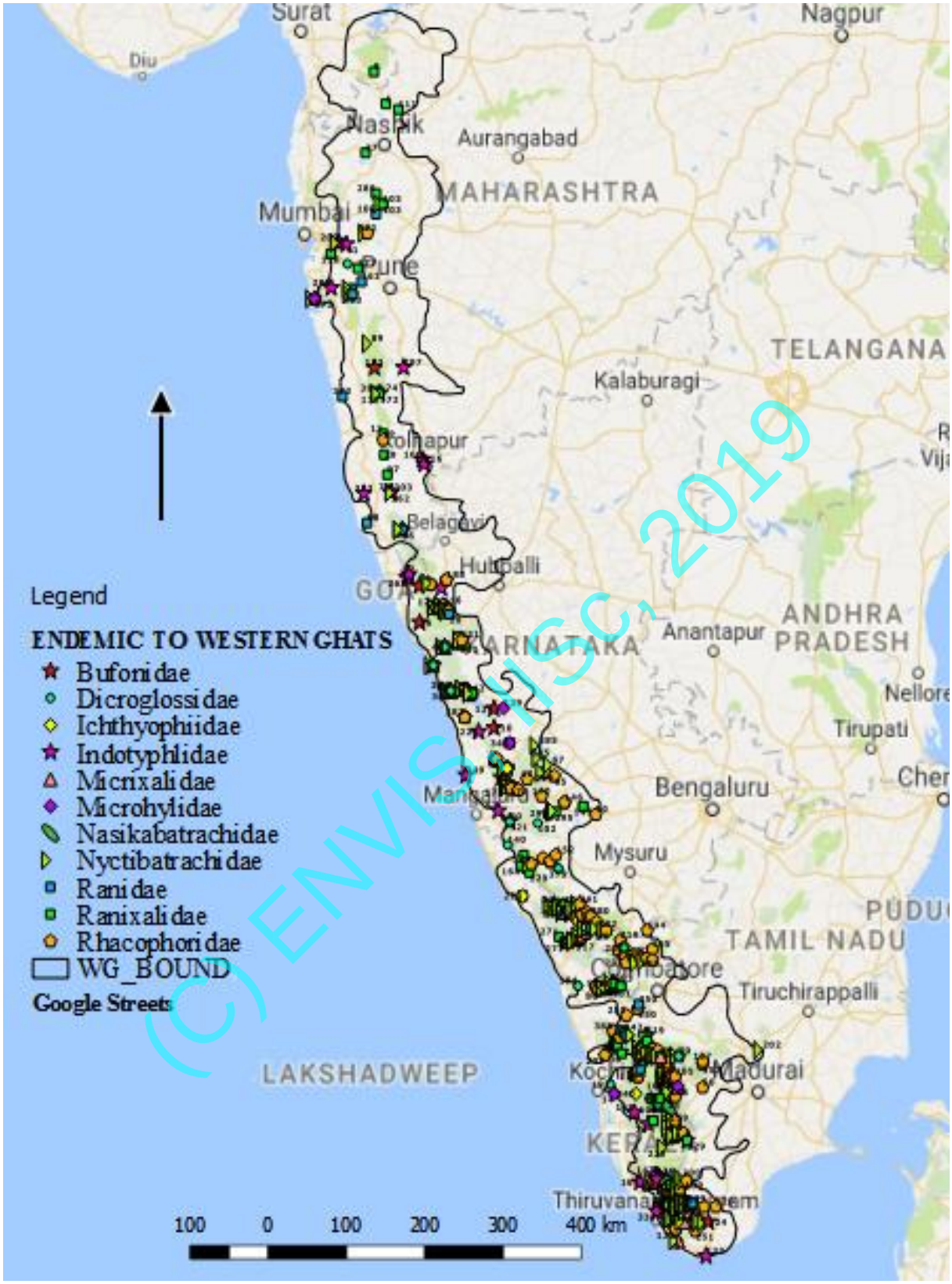


Fig. 6.3.15. Spatial distribution of the Amphibian families endemic to WG.

Distribution based on conservation status

According to the IUCN conservation status, all the amphibian species present in the WG were classified into different categories on the basis of their threat status. Extinct, Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern, Data Deficient and Not Evaluated are the different categories (Fig. 6.3.17). Among the 248 Amphibian species present in the WG region, 4 species were grouped under extinct category, 14 species were categorized as Critically Endangered (CE), 30 species were categorized as Endangered (EN), 18 species were considered as Vulnerable (VU), 7 species comes under the category Near Threatened (NT), 38 species were grouped under the Least Concern category and 69 species were categorized under the group Data Deficient (DD). Conservation Status of 73 species of amphibians was not evaluated (Fig. 6.3.18).

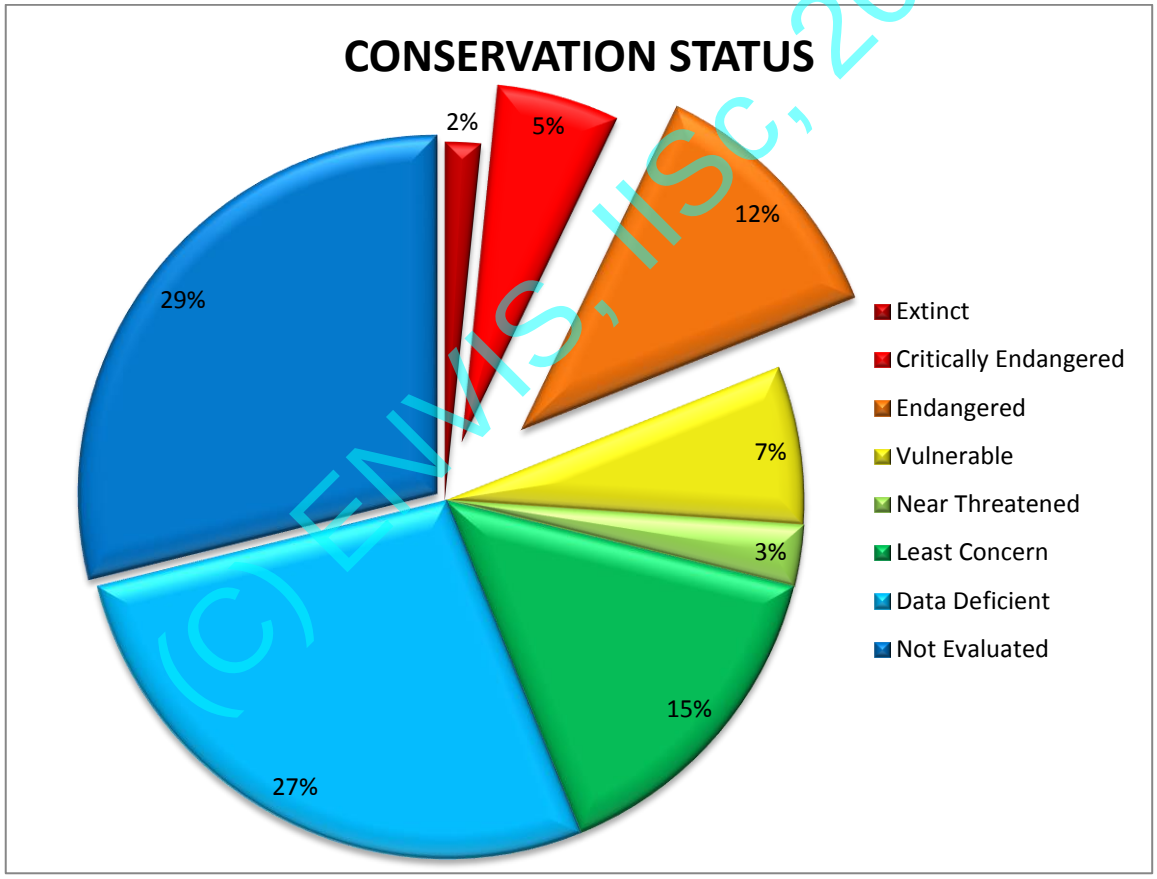


Fig. 6.3.18. Pie chart showing conservation status of Amphibians in WG.

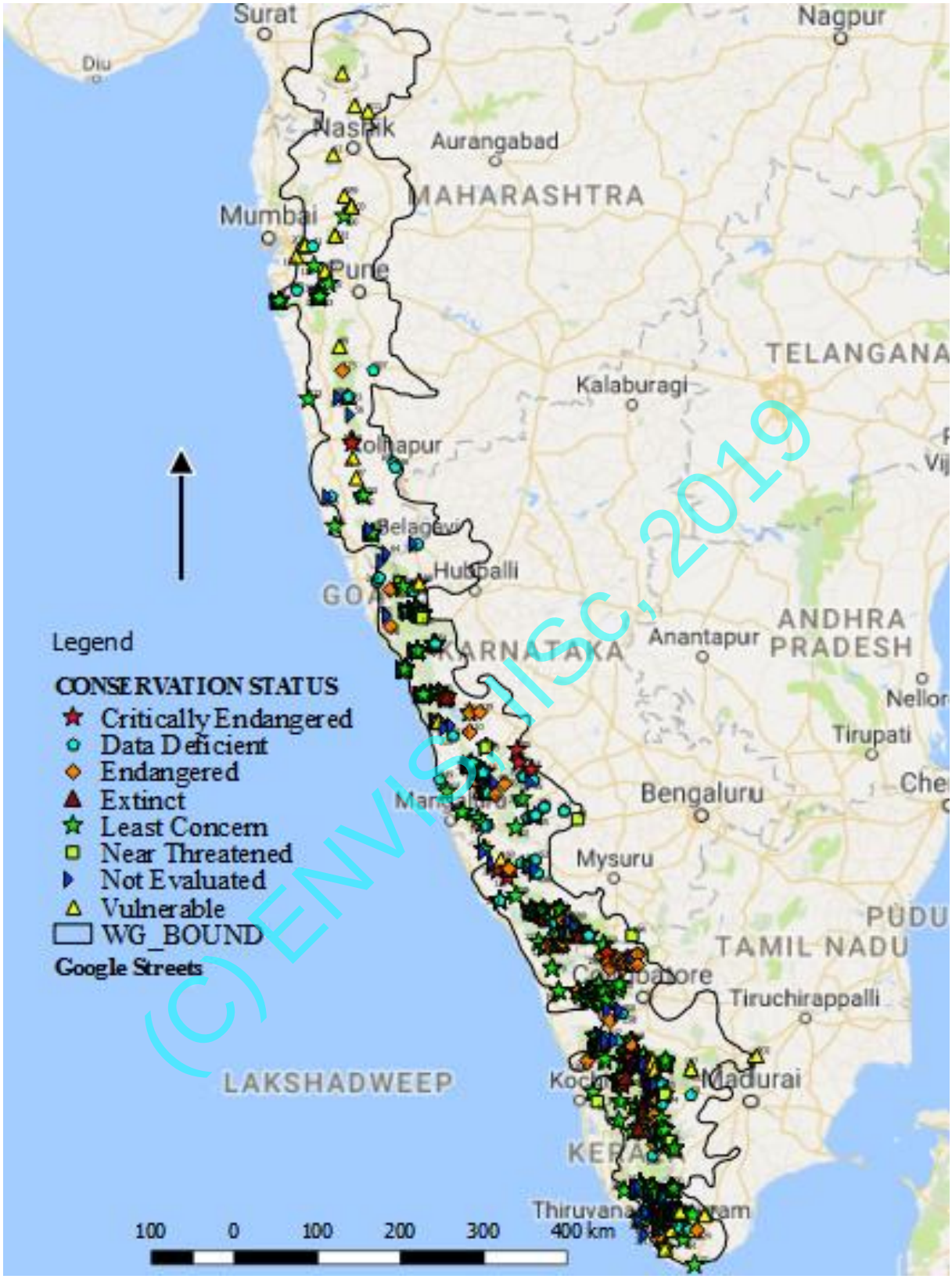


Fig. 6.3.17. Spatial distribution of the Amphibian species according to IUCN status.

Rhacophoridae species *Philautus leucorhinus, Philautus temporalis, Philautus nasutus* and *Philautus variabilis* are classified as extinct species by IUCN conservation status (Fig. 6.3.19). As per the review, these species show distribution in the WG regions of Maharashtra, Karnataka, Kerala and Tamilnadu. All the 4 extinct species were reported from the WG region of Karnataka.

According to IUCN conservation status, 14 species from the families Dicroglossidae, Ranixalidae, Nyctibatrachidae, Rhacophoridae were considered as Critically Endangered (CE). *Fejervarya murthii, Indirana gundia, Indirana phynoderma, Nyctibatrachus dattatreyaensis, Philautus chalazodes, Philautus griet, Philautus kaikatti, Philautus marki, Philautus munnarensis, Philautus ponmudi, Philautus sushili, Raorchestes resplendens* and *Rhacophorus pseudomalabaricus* are the critically endangered amphibian species present in the WG regions. These species have distributed across the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.3.20).

WG region has 30 endangered amphibian species. 12% of the total amphibian population present in the WG is categorized as Endangered. These endangered species are from the families Bufonidae, Dicroglossidae, Micrixalidae, Microhylidae, Nasikabatrachidae, Nyctibatrachidae, Ranixalidae and Rhacophoridae (Fig. 6.3.21). Endangered species were reported from the WG regions of Goa, Maharashtra, Karnataka, Kerala, and Tamilnadu. According to the IUCN conservation status, 18 amphibian species present in the WG region were categorized as Vulnerable (VU) species. It comprises the 7% of the total amphibian population present in the WG (Fig. 6.3.22). These vulnerable species belong to the families Bufonidae, Micrixalidae, Microhylidae, Nyctibatrachidae, Ranidae, Ranixalidae, and Rhacophoridae. The species shows distribution across the WG regions of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu.

Cinotarsus curtipes, Duttaphrynus parietalis, Hylarana temporalis, Micrixalus fuscus, Philautus beddomii, Ramanella montana and *Raorchestes honnametti* are the 7 amphibian species from the families Ranidae, Bufonidae, Micrixalidae, Rhacophoridae, Microhylidae was considered as Near Threatened (NT) species (Fig. 6.3.23). These species show higher distribution towards the central and southern regions of WG. According to the conservation status, 38 amphibian species present in the WG were categorized under Least Concern category. Of the total population of amphibians in WG, 15% were categorized as Least Concern species (Fig. 6.3.24). These species were reported from the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu.

In the WG region, 69 amphibian species were categorized under the category Data Deficient (DD), comprising the 28% of the total amphibian population (Fig. 6.3.25). The species under Data Deficient category belong to the families Bufonidae, Dicroglossidae, Ichthyophiidae, Indotyphlidae, Micrixalidae, Microhylidae, Nyctibatrachidae, Ranixalidae, and Rhacophoridae, distributed across the Maharashtra, Goa, Karnataka, Kerala and Tamilnadu regions of WG. Conservation Status of 73 species of amphibians was not evaluated, that comprises almost 30% of the total number of species present in the WG (Fig. 6.3.26). The conservation status of the amphibians from the families Bufonidae, Dicroglossidae, Ichthyophiidae, Indotyphlidae, Micrixalidae, Microhylidae, Nyctibatrachidae, Ranidae, Ranixalidae, and Rhacophoridae are not evaluated. These species show distribution across the WG regions of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu.

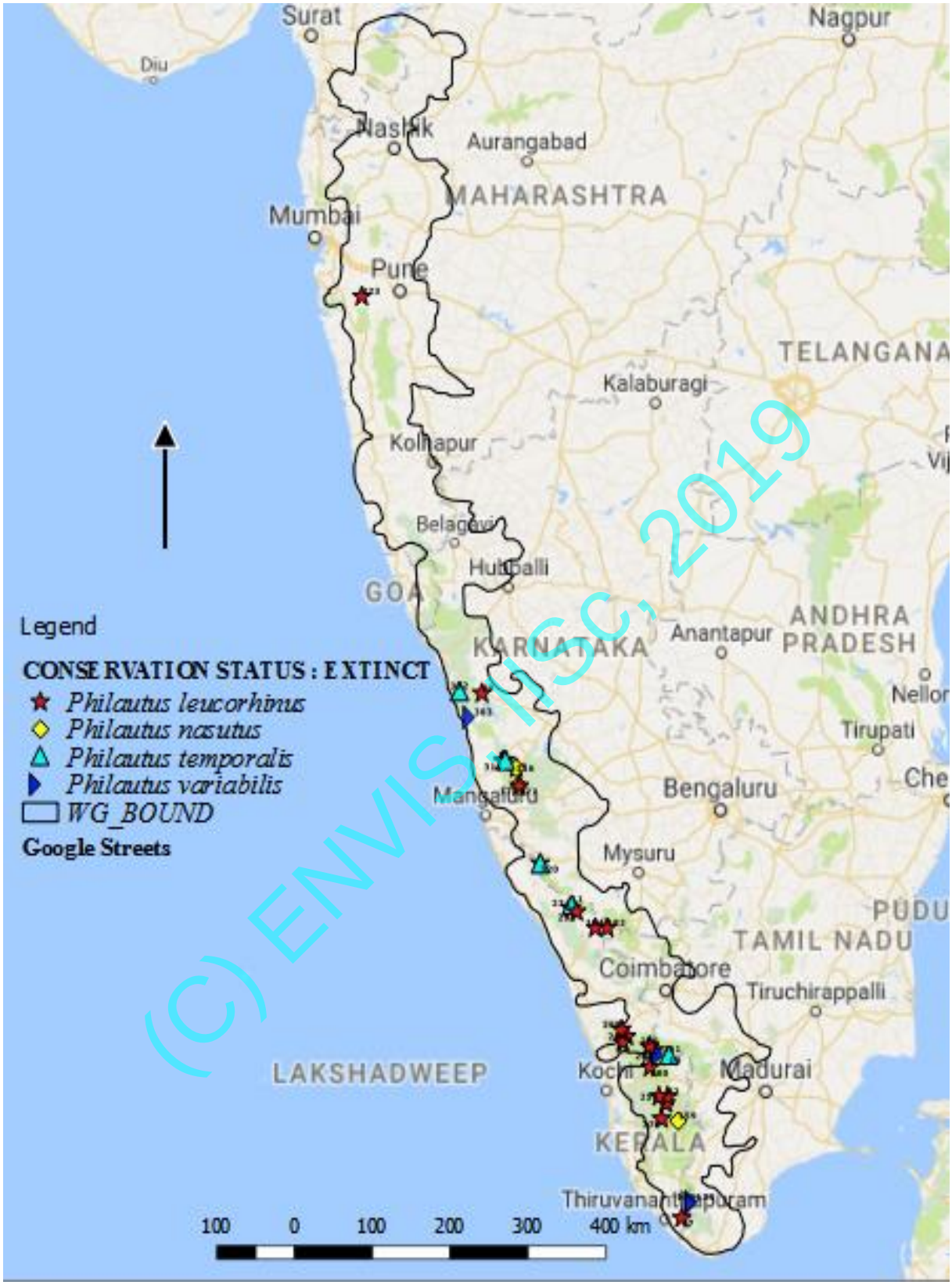


Fig. 6.3.19. Spatial distribution of the Extinct Amphibian species.

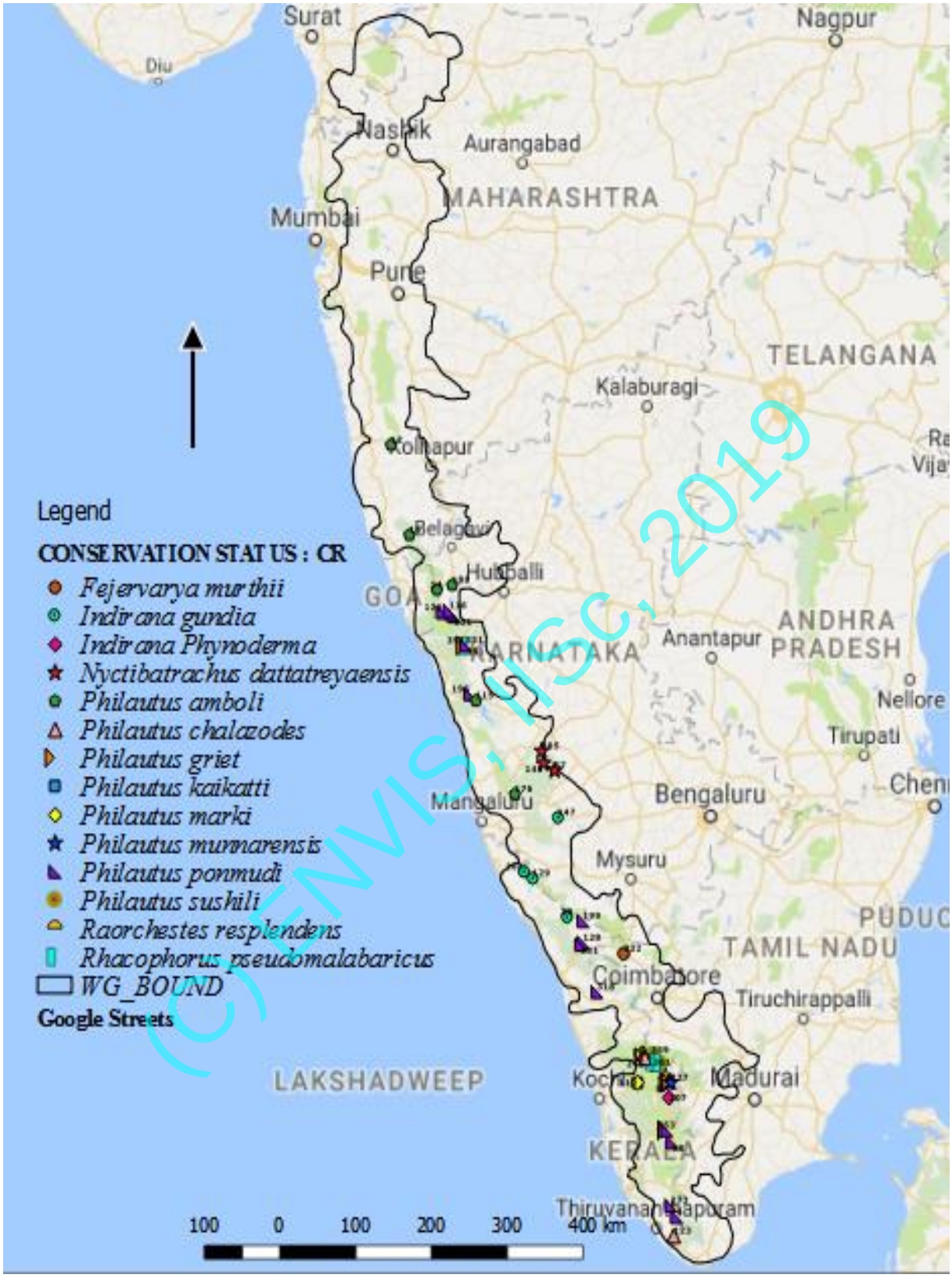


Fig. 6.3.20. Spatial distribution of the Critically Endangered Amphibian species.

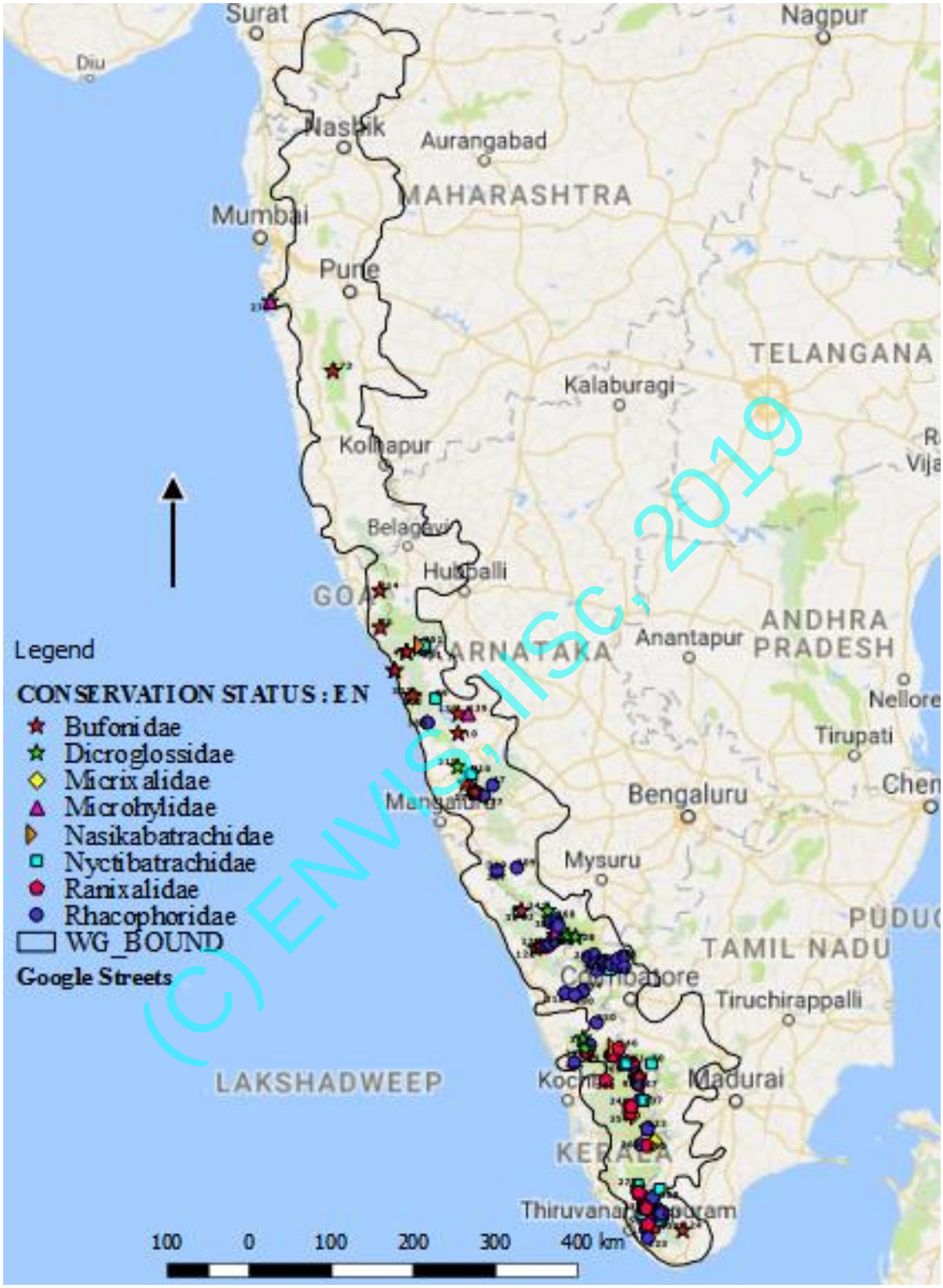


Fig. 6.3.21. Spatial distribution of the Endangered Amphibian families.

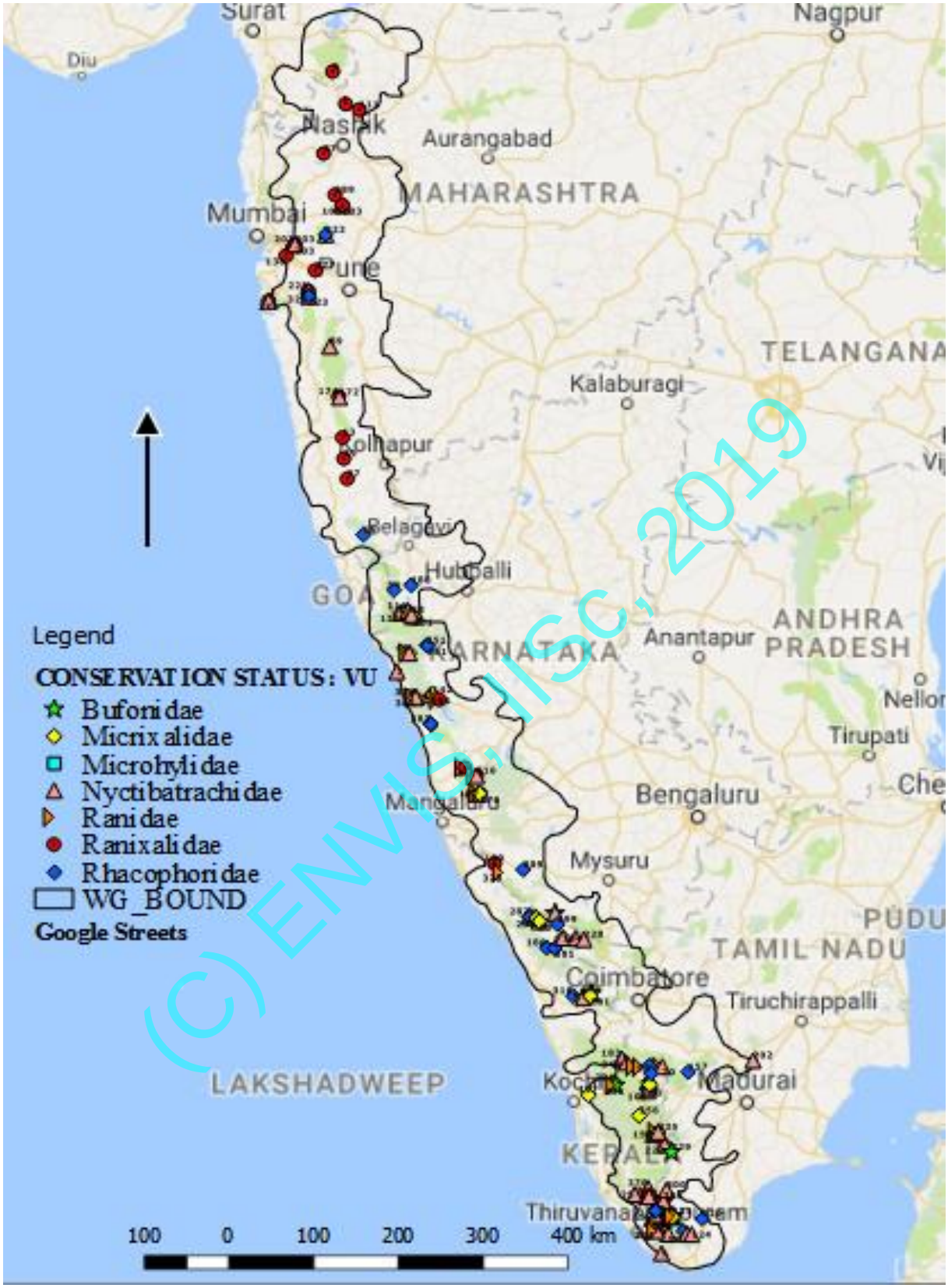


Fig. 6.3.22. Spatial distribution of the Vulnerable Amphibian families.

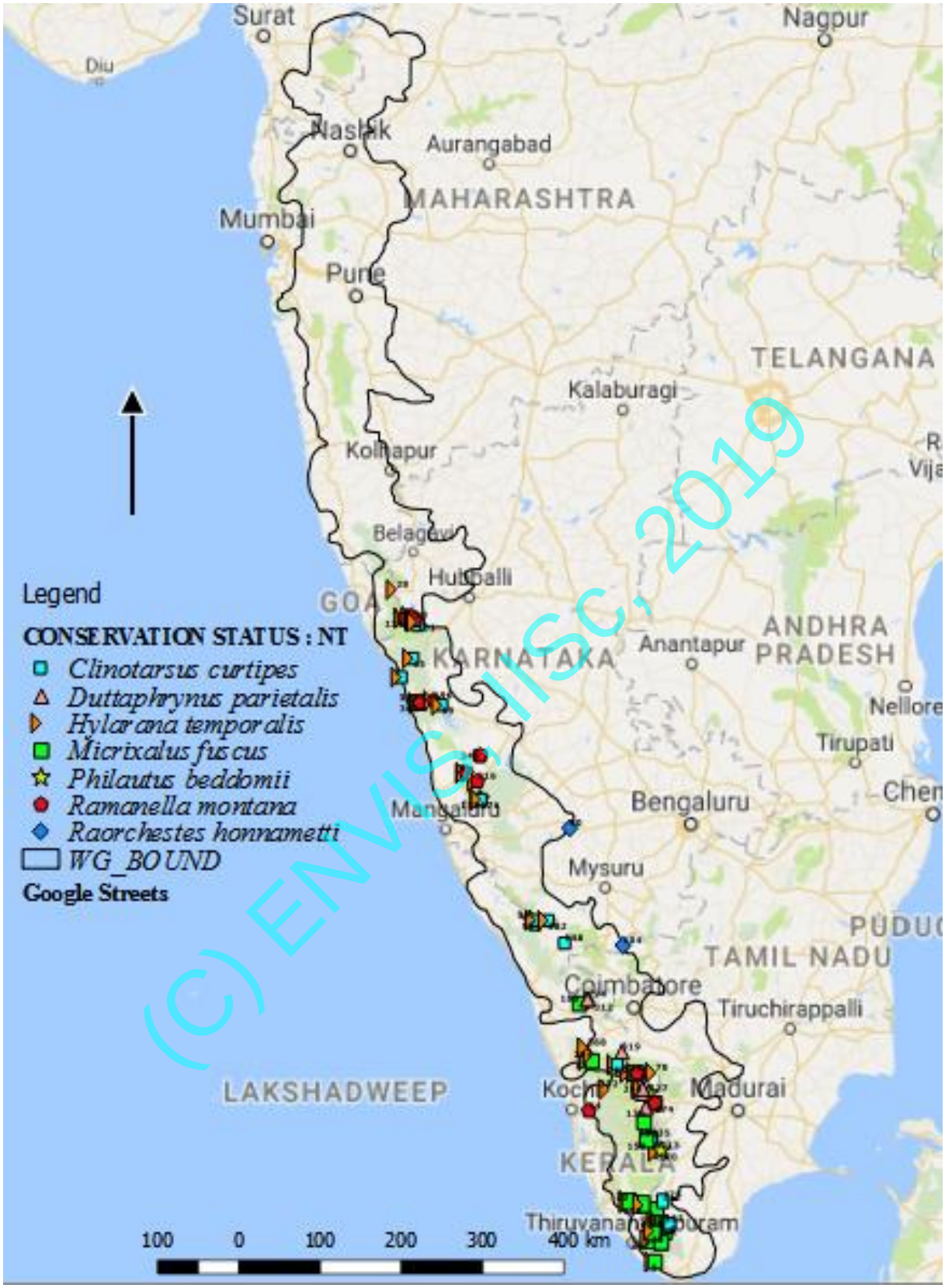


Fig. 6.3.23. Spatial distribution of the Near Threatened Amphibian species.

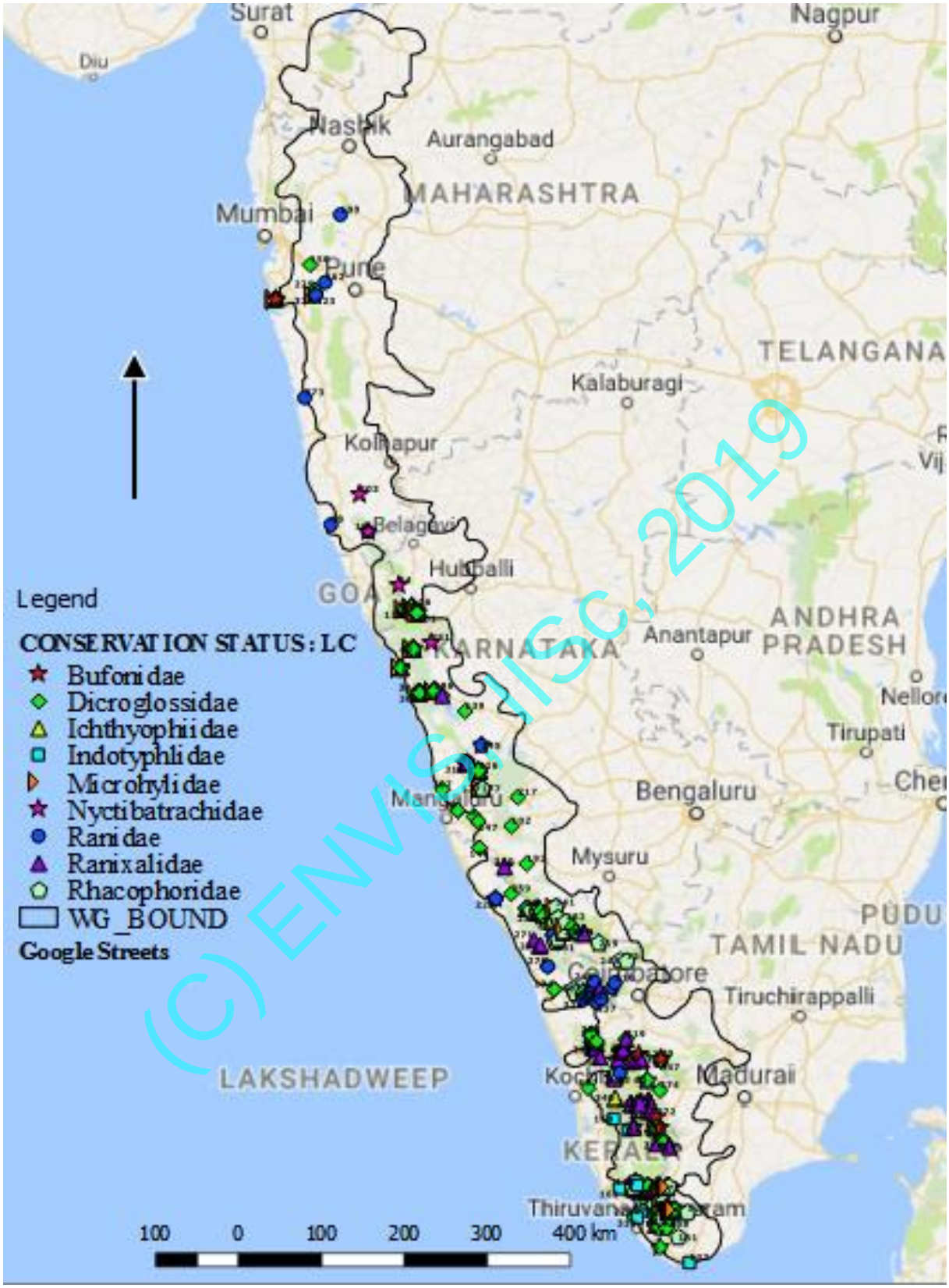


Fig. 6.3.24. Spatial distribution of the Least Concern Amphibian species.

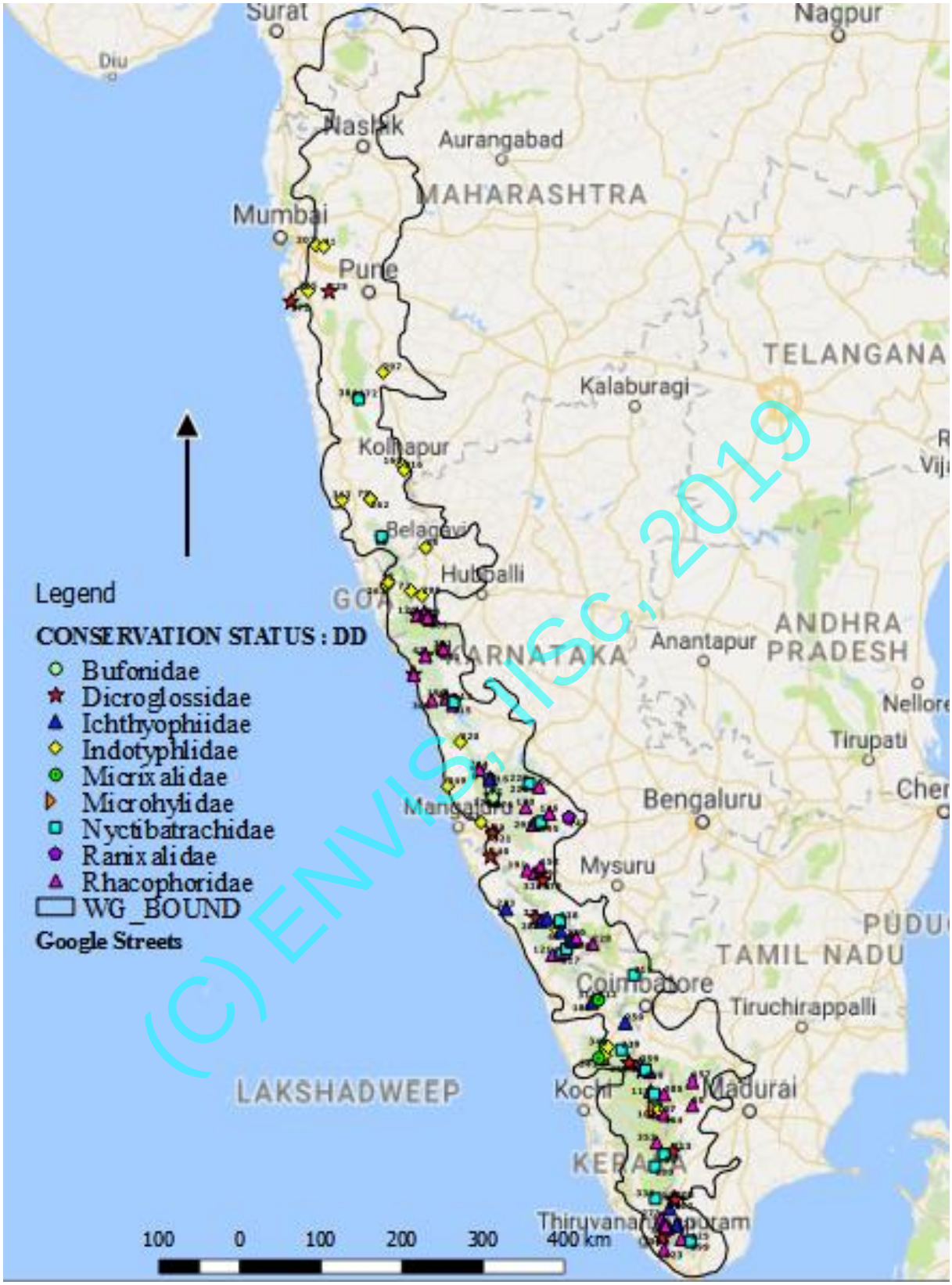


Fig. 6.3.25. Spatial distribution of the Data Deficient Amphibian species.

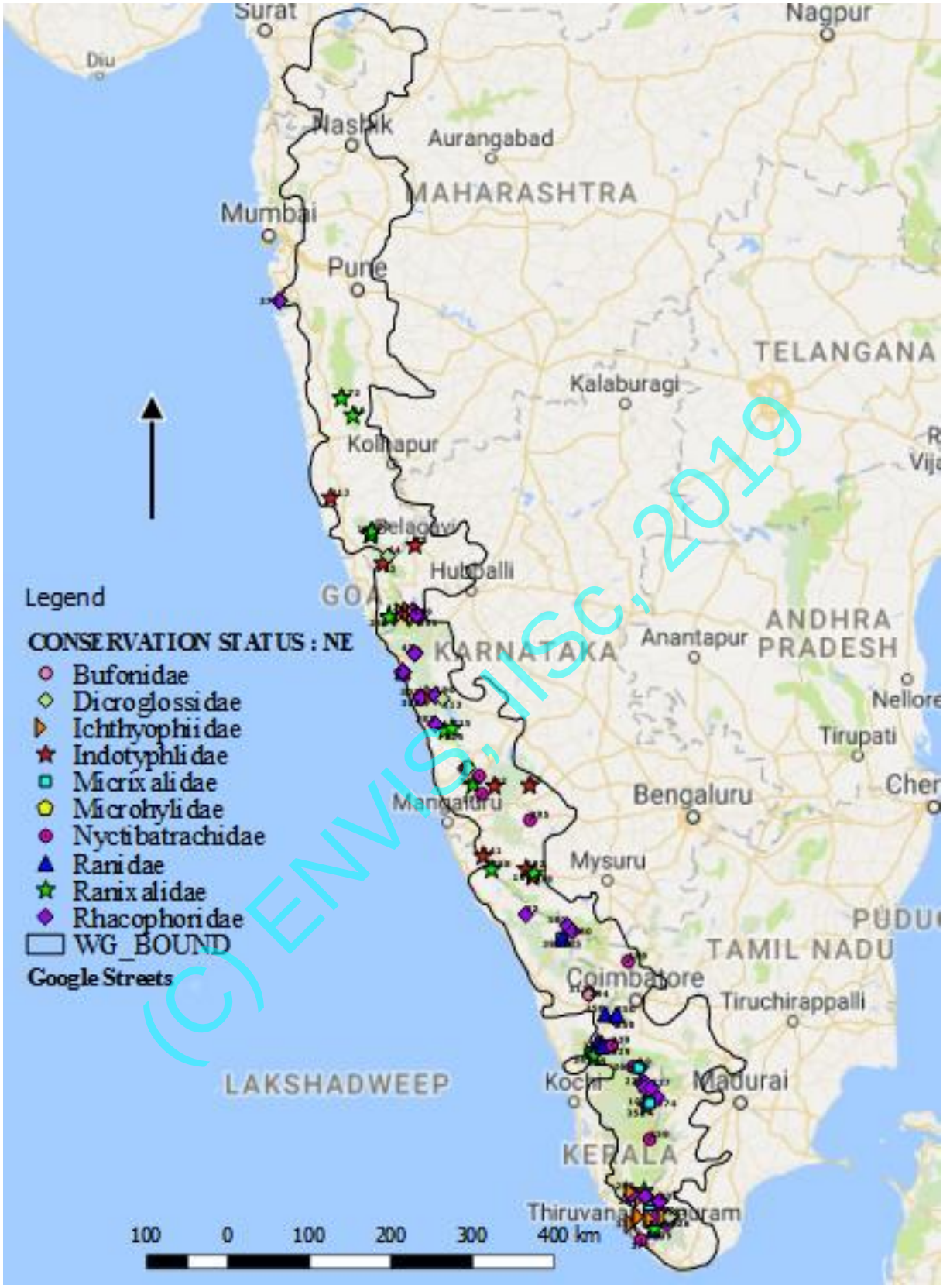


Fig. 6.3.26. Spatial distribution of the Not Evaluated Amphibian species.

6.4. REPTILES

Reptiles are tetrapod animals belongs to the kingdom Animalia, phylum Chordata, subphylum Vertebrata and class Reptilia. They are cold-blooded animals with low metabolic rate and poor body insulation. Reptiles are known as true friends of farmer. There are more than 8200 species of reptiles present in the world. Class Reptilia includes 4 major orders, Testudines, which includes turtles, order Crocodylia includes crocodiles, alligators, and gharials, order Squamata including snakes and lizards and order Rhynchocephalia includes tuatara (Dodd, 2016).

Western Ghats has 197 species of Reptiles across 165 locations as per the reviewed literature. The study sites include Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamilnadu state portions of WG region (Fig. 6.4.1). As per reviewed literature, 186 species has identified up to species level and 11 has identified only up to genera level.WG region has 19 families of reptiles. The families are Agamidae, Boidae, Chamaeleonidae, Colubridae, Crocodylidae, Elapidae, Gekkonidae, Geoemydidae, Gerrhopilidae, Lacertidae, Pythonidae, Scincidae, Testudinidae, Trionychidae, Typhlopidae, Uropeltidae, Varanidae, Viperidae, and Xenodermidae. Among these 19 reptilian families present in the WG, Colubridae is the largest family with 43 species. Chamaeleonidae, Crocodylidae, Pythonidae, and Varanidae are the smallest reptilian families present in the WG region (Fig. 6.4.2). As per the review, Elapidae, Pythonidae and Viperidae are the widely distributed families, reported from the WG regions of all the states. Agamidae, Boidae, Colubridae, Gekkonidae, Scincidae, Trionychidae, and Varanidae are reported from all states except Goa. Chamaeleonidae, Typhlopidae, Uropeltidae shows higher distribution in Gujarat, Maharashtra, Kerala and Tamilnadu region of WG. Geoemydidae and Gerrhopilidae show the higher distribution in the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu. And the families, Crocodylidae, Lacertidae, Testudinidae, and Xenodermidae show the higher distribution in the Central and Southern WG region.

Distribution based on the family

Agamidae is the reptilian family which includes lizards. *Calotes andamanensis, C. calotes, C. elliotti, C. grandisquamis, C. nemoricola, C. rouxii, C. versicolor, C. sp, Draco dussumieri, Otocryptis beddomii, Psammophilus blanfordanus, P. dorsalis, Psammophis longifrons, Sitanalaticeps, S. ponticeriana, Salea horsfieldi* and *Salea anamallayana* are the Agamidae species present in the WG region (Fig. 6.4.3). These species show distribution across the WG regions of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu. Most of the Agamidae species show higher distribution towards the central and Southern regions of WG. *Psammophis*

longifrons and *Sitana laticeps* show higher distribution in the Maharashtra region of Western Ghtas. As per the review, *Otocryptis beddomii*, *Salea anamallayana* and *Salea horsfieldi* are the species which shows distribution only in the Southern WG. *Calotes rouxii*, *C. versicolor* and *Sitana ponticeriana* show distribution in the Gujarat region of WG. *Calotes andamanensis* shows distribution only in the Tamil Nadu regions of WG. *Calotes elliotti*, *C. grandisquamis*, *C. nemoricola*, *C. rouxii*, *Draco dussumieri*, *Otocryptis beddomii*, *Salea anamallayana* and *Salea horsfieldi* are the members of Agamidae family endemic to the WG. According to the IUCN red list, *Otocryptis beddomii* is the only species in Agamidae family categorized as endangered species.

Boidae is a reptilian family consists of non-venomous snakes. Eryx is the only genus of Boidae family reported from the WG. As per the review, *Eryx whitakeri*, *E.conica*, *E. johnii* and an unidentified *Eryx* species are distributed across the WG regions of Maharashtra, Karnataka, and Tamilnadu (Fig. 6.4.4). Among the 4 species, *Eryx conia* and *E. johnii* show a wide distribution in the WG region. *Eryx whitakeri* is the only endemic species of Boidae family and it shows higher distribution across the WG region of Maharashtra and Karnataka. *Eryx whitakeri* is a protected species, which is protected by including in the Schedule IV of Indian Wildlife Protection Act 1972.

Chamaeleonidae is one of the smallest reptilian families present in the WG. *Chamaeleo zeylanicus* is the only species of the Chamaeleonidae family distributed across the WG region of Gujarat, Maharashtra, Kerala, and Tamilnadu (Fig. 6.4.4). *Chamaeleo zeylanicus* is commonly known as the Asian Chameleon or Indian Chameleon and it is considered as the least concern species by IUCN.

Colubridae is the largest snake family present in the WG region. The family consists of 43 species and it is distributed across WG regions of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.4.5a & Fig. 6.4.5b). As per the reviewed literature, *Argyrogena fasciolatus*, *Coluber gracilis*, *Coronella brachyuran*, *Lycodon flavomaculatus*, *Lycodon striatus* and *Sibynophis subpunctatus* show distribution only in the Northern WG especially in the Maharashtra region. While other species shows distribution across the WG region. Ganesh et al (2013) reported 24 Colubridae species, *Ahaetulla cf nasuta*, *A. pulverulenta*, *Amphiesma beddomei*, *A. monticola*, *A. stolata*, *Atretium schistosum*, *Boiga beddomei*, *B. ceylonensis*, *B. forsteni*, *B. nuchalis*, *B. trigonata*, *Chrysopelea ornate*, *Coelognathus helena monticollaris*, *Dendrelaphis ashoki*, *D. chairecacos*, *D. girii*, *D. grandoculis*, *Lycodon aulicus*, *L.*

travancoricus, Macropisthodon plumbicolor, Oligodon affinis, Ptyas mucosus, Rhabdopsolivaceus and *Xenochrophis piscator* from the Karnataka region of central WG. Colubridae family shows highest endemism (18 species), *Ahaetulla dispar, A. perroteti, Amphiesma beddomei, A. monticola, Boiga nuchalis, Coelognathus helena helena, Coelognathus helena monticollaris, Dendrelaphis ashoki, D. chairecacos, D. girii, D. grandoculis, Liopeltis calamaria, Oligodon affinis, O. brevicauda, O. taeniolatus, O. travancoricus, O. venustus* and *Rhabdops olivaceus* are endemic species. According to the IUCN conservation status, *Ahaetulla perroteti* and *Dendrelaphis chairecacos* are categorized as endangered species, *Oligodon brevicauda*is considered as vulnerable species and *Ahaetulla dispar* and *Ptyas mucosus* as near threatened species. The species, *Ahaetulla dispar, A. nasuta, A. pulverulenta, Amphiesma stolata, Argyrogena fasciolatus, Atretium schistosum, Boiga beddomei, B. ceylonensis, B. forsteni, B. nuchalis, B. trigonata, Chrysopelea ornate, Coelognathus helena helena, Coelognathus helena monticollaris, Coluber gracilis, Coronella brachyuran, Dendrelaphis ashoki, D. girii, D. grandoculis, D. tristis, Lycodon aulicus, L. flavomaculatus, L. striatus, L. travancoricus, Oligodon affinis, O. arnensis, O. brevicauda, O. travancoricus, O. venustus, Ptyas mucosus, Rhabdops olivaceus, Sibynophis subpunctatus* and *Xenochrophis piscator* are legally protected under Indian Wildlife Protection Act 1972 in the Schedule IV.

Elapidae family is the family of venomous snakes. It is one of the highly distributed families in WG. *Bungarus caeruleus, B. sindanus, Calliophis beddomei, C. bibroni, C. castoe, C. melanurus, C. nigrescens, Naja naja, Ophiophagus Hannah and Serpentes sp.* are the Elapidae species and have distributed across the WG regions of Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamilnadu (Fig. 6.4.6). As per the review, *Ophiophagus hannah* and *Naja naja* are the only Elapidae species reported from the WG region of Goa (Crook et al., 2015). Amit Sayyed reported *Bungarus sindanus* from the Satara district of Maharashtra (Amit Sayyed, 2016). Ganesh et al (2013) reported *Calliophis beddomei* from the WG region of Karnataka. *Calliophis beddomei, Calliophis bibroni,* and *Calliophis nigrescens* are the species which are endemic to the WG. *Ophiophagus hannah* commonly known as King Cobra is categorized as a vulnerable species by IUCN conservation status. The species *Bungarus caeruleus, Calliophis bibroni, C. castoe, C. melanurus, Naja naja* and *Ophiophagus hannah* are legally protected by including in the Schedule II and *Calliophis nigrescens* and *C. beddomei* are listed in the Schedule IV of Indian Wildlife Protection Act 1972.

Crocodylidae is the family of crocodiles. As per the reviewed literatures, WG has only one species of crocodile, *Crocodylus palustris*. It shows higher distribution in the WG regions, such as Kerala and Maharashtra (Fig. 6.4.6). *Crocodylus palustris* is commonly known as Broad-snouted Crocodile or Marsh Crocodile and it is categorized as a vulnerable species by IUCN conservation status.

Gekkonidae is the reptilian family which includes geckos. Gujarat, Maharashtra, Karnataka, Kerala and Tamilnadu regions of WG has 35 species of Geckos (Fig. 6.4.7a & 6.4.7b). Mirza et al (2014) discovered *Cnemaspis girii*, a new Gekkonidae species from the Satara region of Maharashtra. Cyriac and Umesh, 2014 discovered a new species, *Cnemaspis kottiyoorensis* from the Kannur district of Kerala and *Hemidactylus parvimaculatus* is discovered by Chandramouli and Ganesh, (2011) from WG region of Kerala. As per the review, *Cnemaspis heteropholis, C. indraneildasii, Geckoella albofasciatus, Hemidactylus cf brookii, H. prashadi* and *H. frenatus* shows higher distribution in the Karnataka region of WG (Ganesh et al, 2013). *Cnemaspis girii, Hemidactylus gracilis, H. flaviviridis* and *H. sataraensis* shows higher distribution in the northern WG. *Geckoella collegalensis, Hemidactylus brooki, H. flaviviridis* and *H. leschenaulti* are the Gekkonidae species reported from the WG region of Gujarat (Raju Vyas, 2004). *Cnemaspis beddomei, C. gracilis, C. heteropholis, C. indica, C. indraneildasii, C. littoralis, C. mysoriensis, C. nairi, C. nilagirica, C. ornata, C. sisparensis, C. wynadensis, Geckoella albofasciatus, G. deccanensis, Hemidactylus anamallensis, H. maculates, H. prashadi* and *H. sataraensis* are the endemic species present in the WG region. According to the IUCN conservation status, *Cnemaspis indica, C. indraneildasii,* and *Hemidactylus sataraensis* are categorized as vulnerable and *Cnemaspis wynadensis* is categorized as endangered species.

Geoemydidae is the family of turtles. As per the review, WG has 3 Geoemydidae species; *Melanochelys trijuga, Melanochelys trijugacoronata* and *Vijayachelys silvatica*. These species are reported from the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.4.8). *Melanochelys trijuga coronate,* commonly known as Indian pond terrapin is reported from the Kannur district of Kerala (Sreedharan, T.P, 2004). *Vijayachelys silvatica* is the only Geoemydidae species which is endemic to WG region. It is categorized as endangered species and it is legally protected under Schedule 1 of Indian Wildlife Protection Act 1972 and CITES.

Gerrhopilidae is the family of blindsnakes. As per the review, *Gerrhopilus thurstoni, Typhlops beddomii, Typhlops tindalli* and an unidentified *Typhlops species* are present across the WG

region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.4.8). Palot, 2015 reported *Gerrhopilus thurstoni* from the WG region of Kerala. *Typhlops beddomii* shows higher distribution in the WG region of Maharashtra (Sayyed, 2016). Daniels, 1993 reported *Typhlops tindalli* from the Central and Southern WG. All the Gerrhopilidae species present in the WG region, except the unidentified species are endemic to WG. *Typhlops beddomii* and *Typhlops tindalli* are legally protected under the Schedule IV of Indian Wildlife Protection Act 1972.

Lacertidae are the family of wall lizards or true lizards. Only one genus, *Ophisops* has reported from the WG region. *Ophisops beddomei, Ophisops jerdonii* and *Ophisops leschenaultia* are the Lacertidae species reported from the WG. These species shows higher distribution in the Karnataka and Maharashtra regions (Fig. 6.4.9). Ganesh et al, 2007 reported *Ophisops leschenaultia*, commonly known as Leschenault's Lacerta from the WG region of Karnataka. From the review, *Ophisops jerdonii* show higher distribution in the Maharashtra region (Sayyed, 2016).

Pythonidae is one of the smallest families present in the WG. Indian rock python, *Python molurus* is the Pythonidae species present in the WG. It is reported from the WG region of Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.4.9). According to the IUCN conservation status, *Python molurus* is categorized under the vulnerable category and it is legally protected by including in the Schedule I of Indian Wildlife Protection Act, 1972.

Scincidae is the reptilian family which includes skinks. It is one of the most diverse reptilian families present in the WG. WG has 26 Scincidae species across the regions of Gujarat, Maharashtra, Karnataka, Kerala and Tamilnadu (Fig. 6.4.10). As per the review, *Lygosoma lineata* and *Mabuya trivittata* are reported from the WG region of Maharashtra (Sayyed, 2016). Murthy, 1983 reported *Kaestlea bilineata, Kaestlea laterimaculata, Kaestlea travancorica, Ristella beddomii, Scincella palnica* and *Sphenomorphus dussumieri* from the WG region of Tamilnadu. Harikrishnan et al, (2012) reported Barred tree skink, *Dasia johnsinghi* from the Tamilnadu regions of WG. *Dasia subeaeruleum, Kaestlea beddomii, K. bilineata, K. laterimaculata, K. palnica, K. travancorica, Mabuya beddomii, M. clivicola, M. gansi, Ristella beddomii, Ristella guentheri, Ristella rurkii* and *Sphenomorphus dussumieri* are the Scincidae species endemic to WG. IUCN conservation status categorized *Dasia subeaeruleum* and *Mabuya clivicola* as endangered species and *Kaestlea laterimaculata* as vulnerable species.

Testudinidae are the Tortoises family, WG has 3 Testudinidae species, *Geochelone elegans, Indotestudo forstenii* and *Indotestudo travancoria*. These species have distributed across the

WG region of Karnataka, Kerala, and Tamilnadu (Fig. 6.4.11). Ullas Karanth and Krithi Karanth, (2007) reported *Indotestudo forstenii* from the WG region of Karnataka and is legally protected by including in Appendix II of CITES. *Indotestudo travancoria* is the endemic Testudinidae species, which is legally protected by including in the Schedule IV of Indian Wildlife Protection Act 1972 and CITES. According to IUCN conservation, *Geochelone elegans* and *Indotestudo travancoria* are categorized as vulnerable species and *Indotestudo forstenii* is categorized as endangered species.

Trionychidae is the family of Soft-shelled turtles. As per the review, WG has 2 Trionychidae species; *Lissemys punctata* and *Nilssonia leithii*. These species have distributed across the WG region of Gujarat, Maharashtra, Karnataka, Kerala and Tamilnadu (Fig. 6.4.11). IUCN conservation status categorized *Nilssonia leithii* as vulnerable species and it is commonly distributed in the Satara regions of Maharashtra.

The reptilian family **Typhlopidae** includes blindsnakes. *Ramphotyphlops braminus* and *Rhinotyphlops acutus* are the Typhlopidae species present in the WG. These species show wide distribution in the WG regions of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.4.12).

Xenodermidae family includes snake species. Xenodermidae species, *Xylophis stenorhynchus*, *Xylophis captaini* and *Xylophis perroteti* are distributed across the WG region of Kerala and Tamilnadu (Fig. 6.4.12). As per the report, *Xylophis captaini* shows higher distribution in Kerala (Subramanian et al, 2015). Palot, (2015) reported *Xylophis stenorhynchus* and *Xylophis perroteti* from the WG regions of Kerala. All the three Xenodermidae species present in the WG shows endemism and are legally protected by including in the Schedule IV of Indian Wildlife Protection Act 1972.

Uropeltidae is the family of non-venomous shield-tailed snakes. WG regions of Maharashtra, Karnataka, Kerala and Tamilnadu consists 31 different types of Uropeltidae species (Fig. 6.4.13a & 6.4.13b) Palot, (2015) reported *Uropeltis woodmasoni, U. smithi, U. rubromaculatus, U. rubrolineata, U. petersi, U. ocellatus, U. myhendrae, U. macrorhyncha, U. liura, U. beddomii, U. arcticeps madurensis, U. pulneyensis, U. maculates, Teretrurus sanguineus, Rhinophis travancoricus, R. sanguineus, Plecturus guentheri, P. perroteti, Platyplectrurus trilineatus, Platyplectrurus madurensis, Melanophidium wynaudense, M. punctatum, M. bilineatum* and *Brachyophidium rhodogaster* from the WG region of Kerala. Chandramouli and Ganesh, (2011) reported *Uropeltis dindigalensis* from the WG region of

Tamil Nadu. Among the 31 Uropeltidae species present in WG, 28 species are endemic. *Brachyophidium rhodogaster, Melanophidium bilineatum, M. punctatum, M. wynaudense,Platyplectrurus madurensis, Platyplectrurus trilineatus, Plectrurus canaricus, Plectrurus perroteti , P. guentheri, Rhinophis sanguineus, R. travancoricus, Teretrurus sanguineus, Uropeltes maculates, U. pulneyensis, U. arcticeps madurensis, U. beddomii, U. ceylanica, U. dindigalensis, U. elliotti, U. liura, U. macrolepis, U. macrorhyncha, U. myhendrae, U. ocellatus, U. petersi, U. phipsonii, U. rubrolineata, U. rubromaculatus, U. smithi* and *U. woodmasoni* are the endemic species. According to the IUCN conservation status, *Melanophidium bilineatum* and *Uropeltis phipsonii* are considered as vulnerable, and *Rhinophis travancoricus* and *Platyplectrurus madurensis* are considered as endangered species. The legally protected Uropeltidae species are *Brachyophidium rhodogaster, Melanophidium bilineatum, M. punctatum, M. wynaudense, Platyplectrurus madurensis, Platyplectrurus trilineatus, Plectrurus canaricus, P. perroteti, P. guentheri, Rhinophis sanguineus, Teretrurus sanguineus, Uropeltis arcticeps madurensis, U. beddomii, U. ceylanica, U. dindigalensis, U. elliotti, U. liura, U. myhendrae, U. ocellatus, U. petersi, U. phipsonii, U. rubromaculatus, U. smithi* and *U. woodmasoni*, these species are included in the Schedule IV of Indian Wildlife Protection Act 1972.

Viperidae is the family of venomous snakes. There are 7 Viperidae species; *Daboia russelii, Echiscarinatus, Hypnalehypnale, Trimeresurus gramineus, Trimeresurus macrolepis, Trimeresurus malabaricus* and *Trimeresurus strigatus* has been reported from the WG region of Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.4.14). As per the review, Echis carinatus shows higher distribution in the northern WG (Yadav and Yankanchi, 2014; Sayyed, 2016). Sawant et al, (2010) reported *Hypnale hypnale, Trimeresurus gramineus* and *Trimeresurus malabaricus* from the WG region of Goa. Khairnar, (2009) reported the distribution of *Daboia russelii* in the Nashik region of Maharashtra. *Trimeresurus macrolepis, T. malabaricus* and *T. strigatus* are endemic to WG. *Daboia russelii* and *Echis carinatus* are included in Schedule II of Indian Wildlife Protection Act. *Trimeresurus gramineus, T. macrolepis, T. malabaricus* and *T. strigatus* are included in the Schedule IV of Indian Wildlife Protection Act.

Varanidae is one of the smallest reptilian families present in the WG. This family includes carnivorous lizards. WG has only one Varanidae species, *Varanus bengalensis*. It is commonly known as Bengal Monitor Lizard or Common Indian Monitor. It is distributed across the WG region of Gujarat, Maharashtra, Karnataka, Kerala and Tamil Nadu (Fig. 6.4.14).

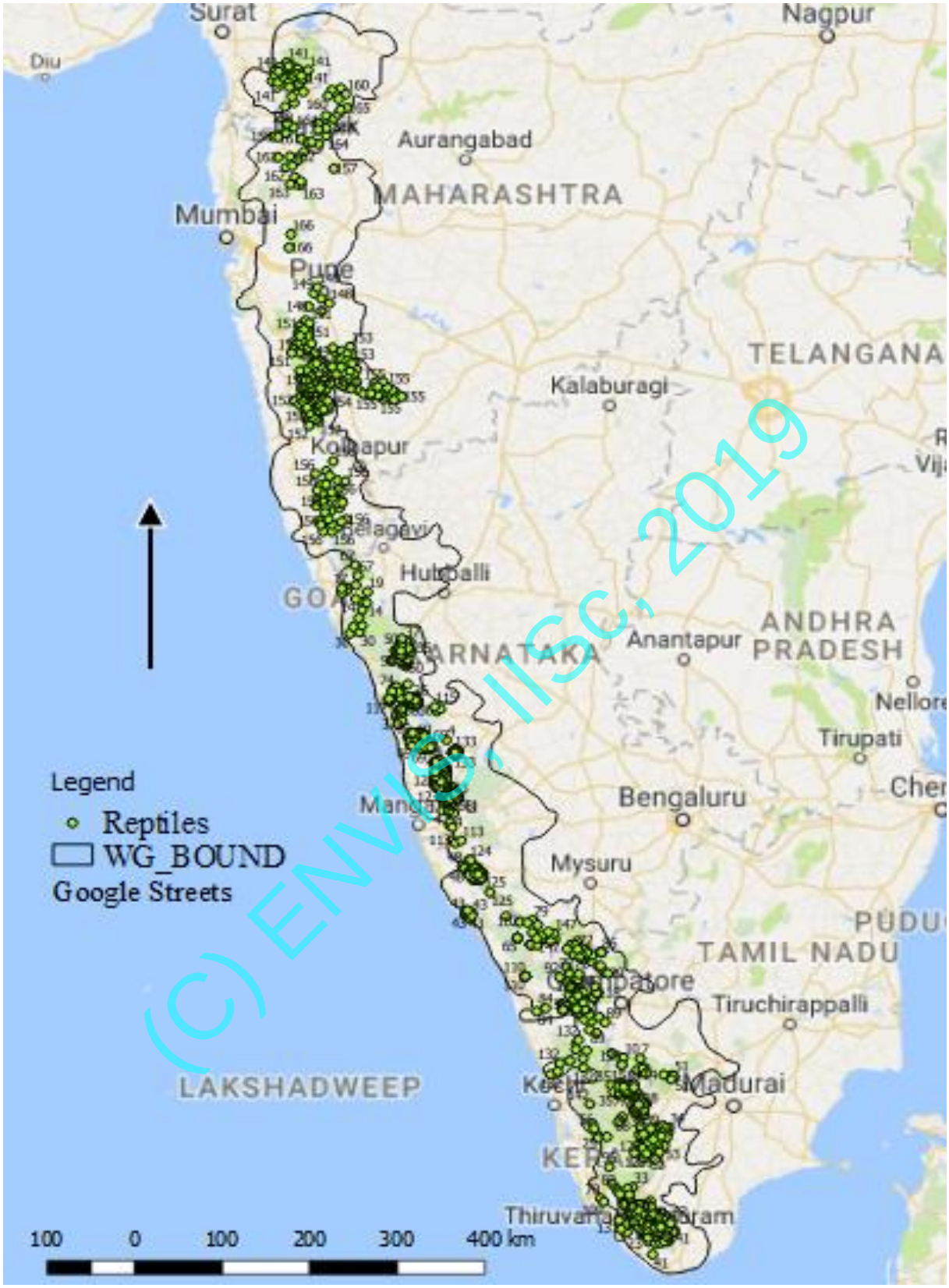


Fig. 6.4.1. Spatial distribution of Reptiles in the WG.

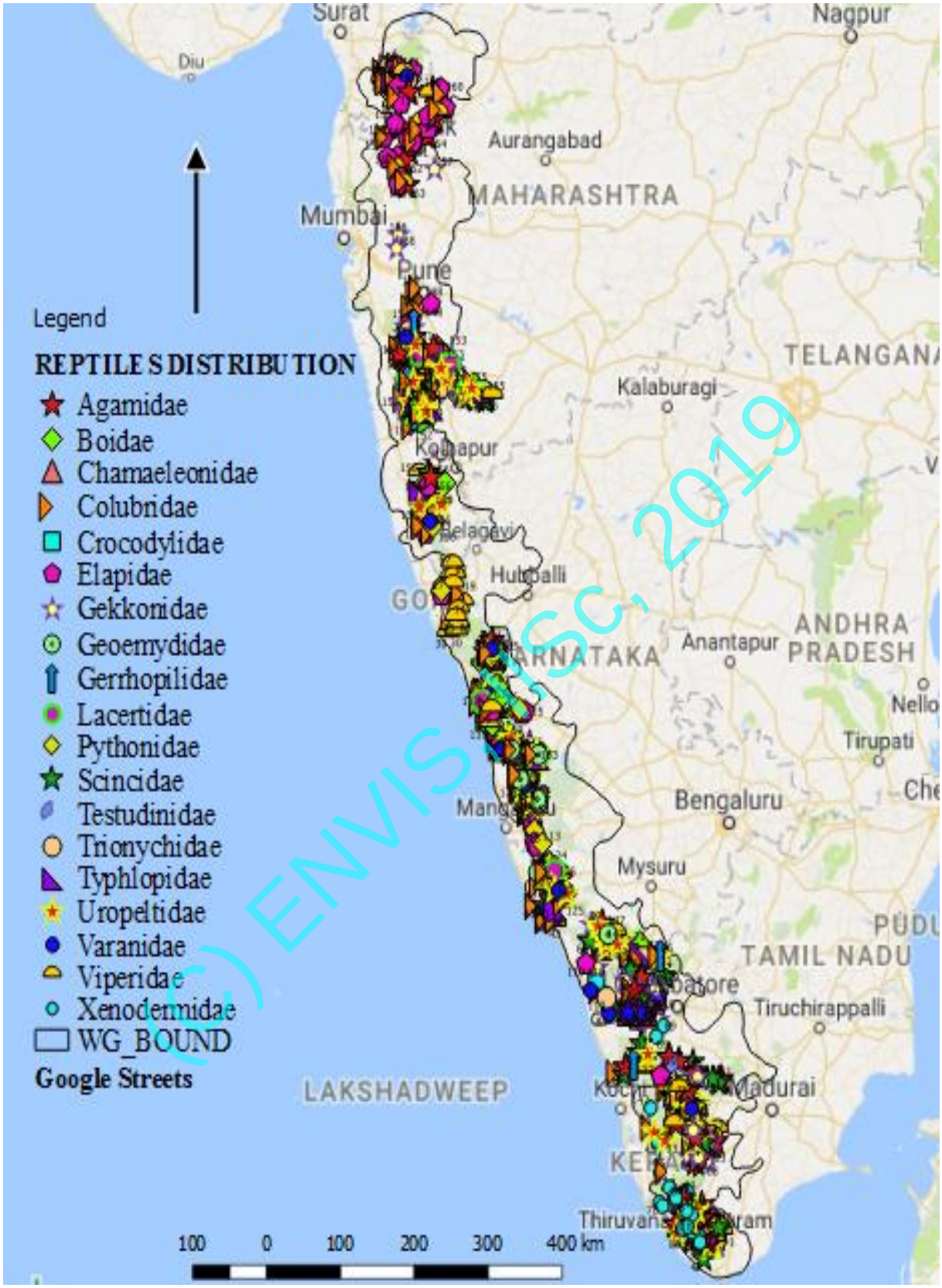


Fig. 6.4.2. Spatial distribution of Reptilian families in WG.

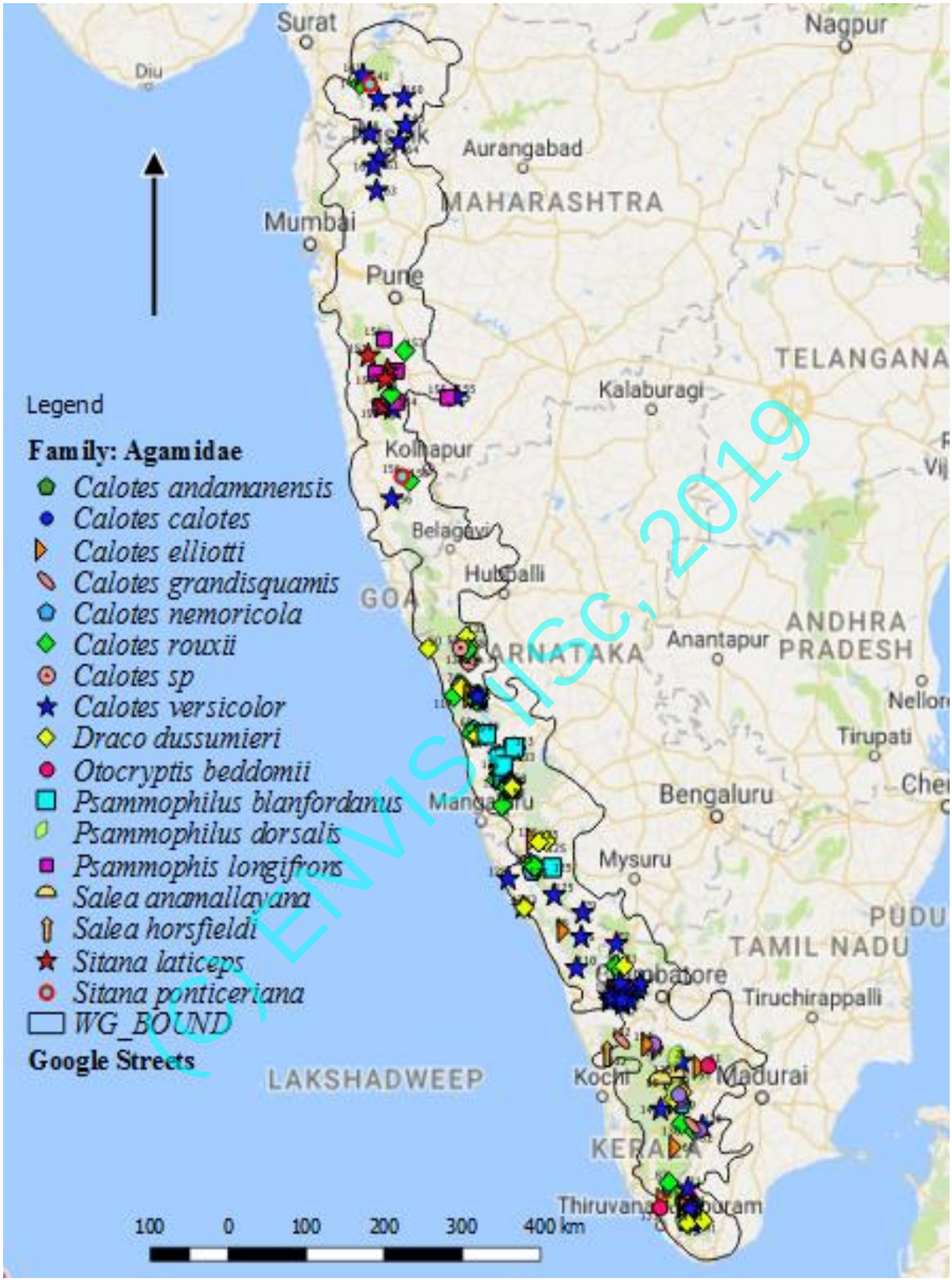


Fig. 6.4.3. Spatial distribution of the Agamidae family.

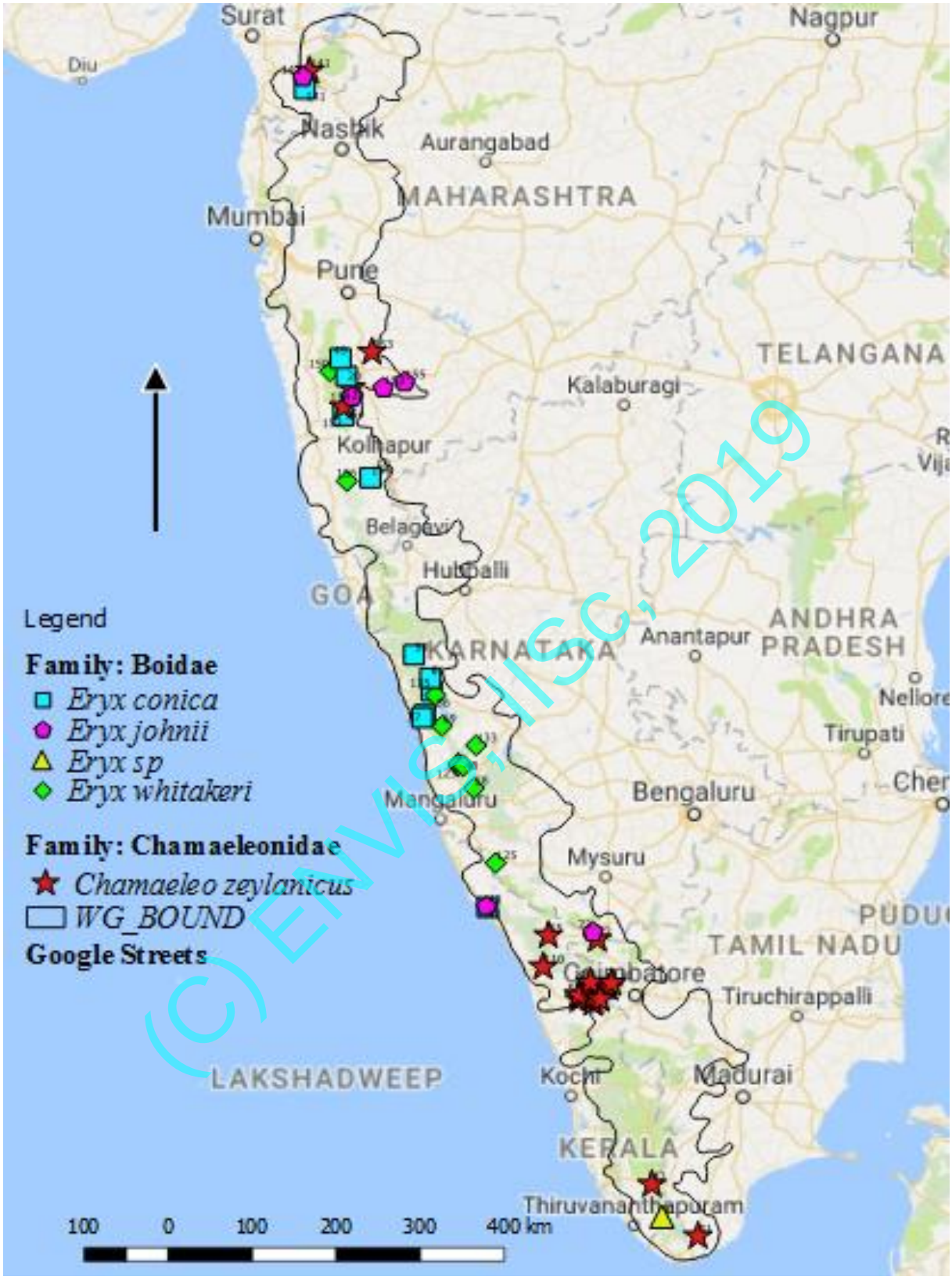


Fig. 6.4.4. Spatial distribution of the Boidae and Chamaeleonidae families.

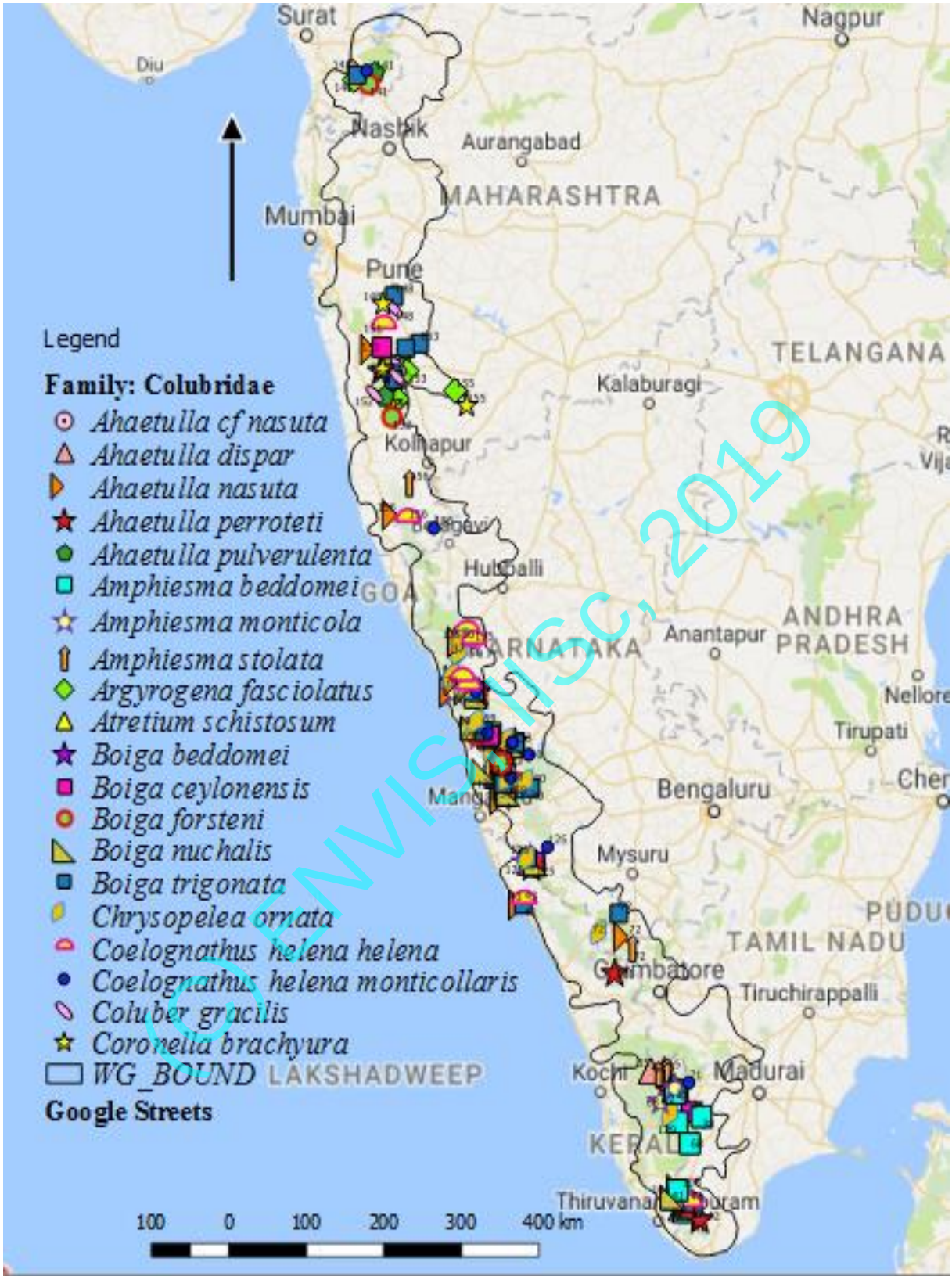


Fig. 6.4.5a Spatial distribution of the Colubridae family.

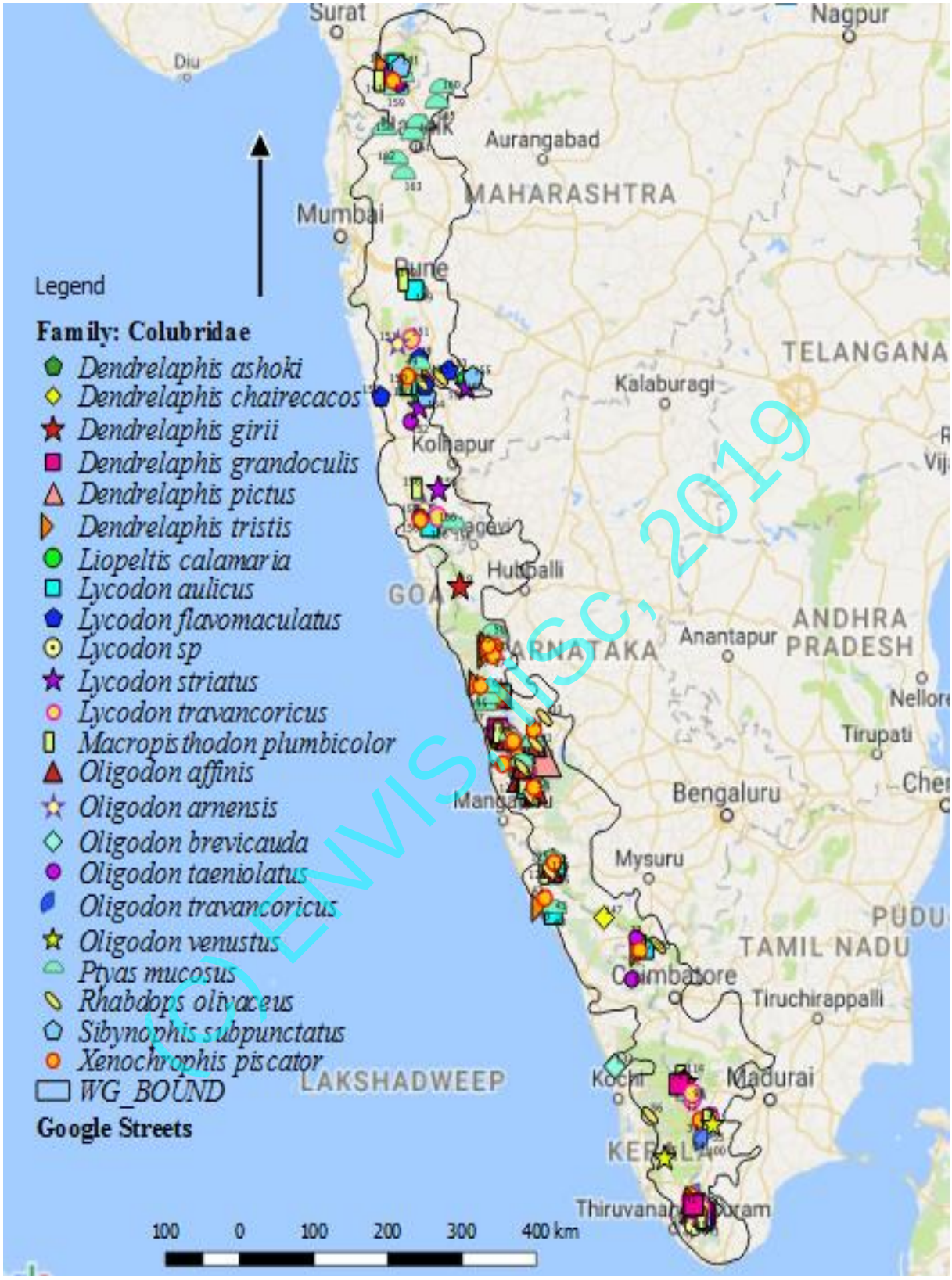


Fig. 6.4.5b Spatial distribution of the Colubridae family.

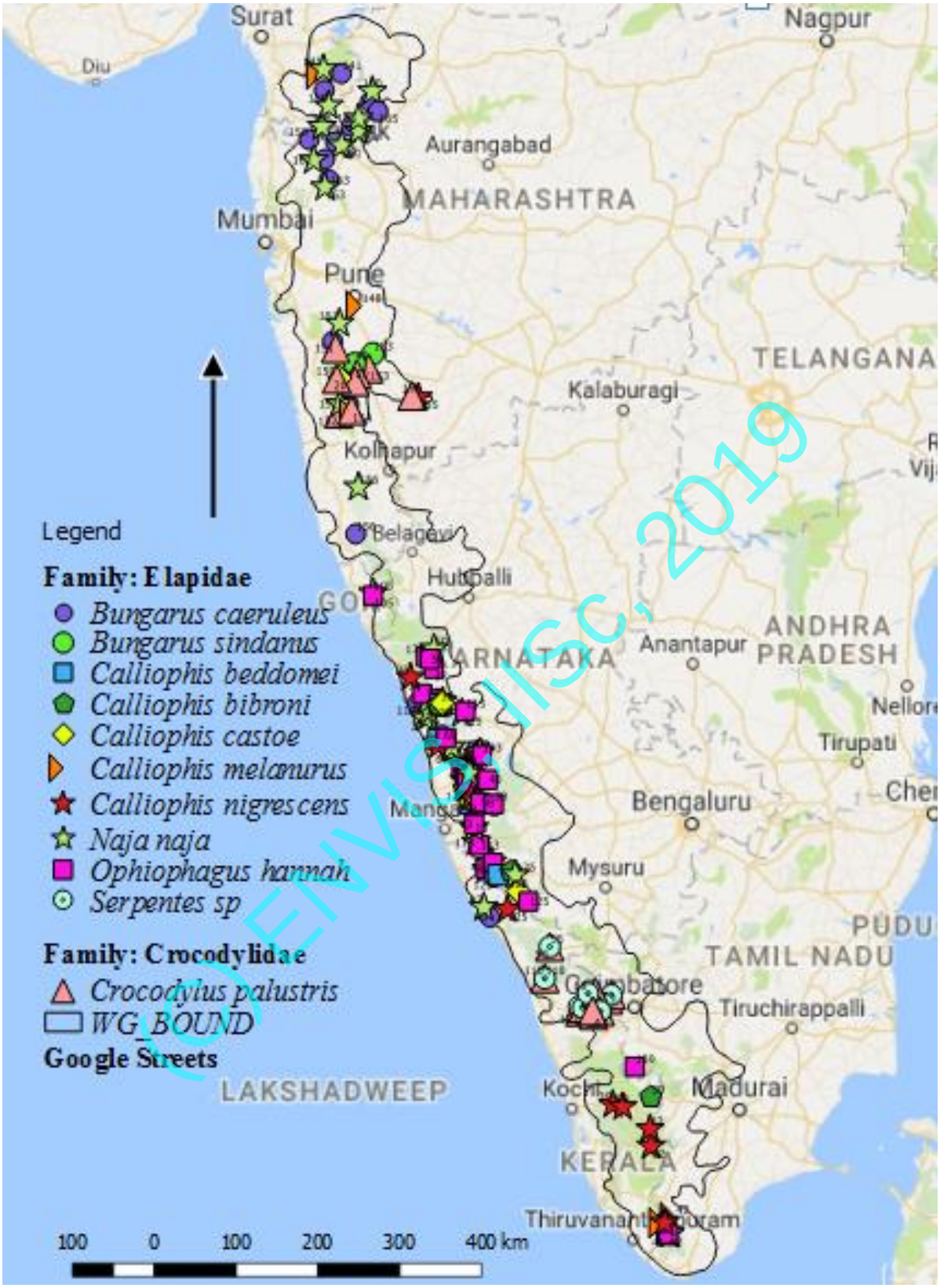


Fig. 6.4.6. Spatial distribution of the Elapidae and Crocodylidae families.

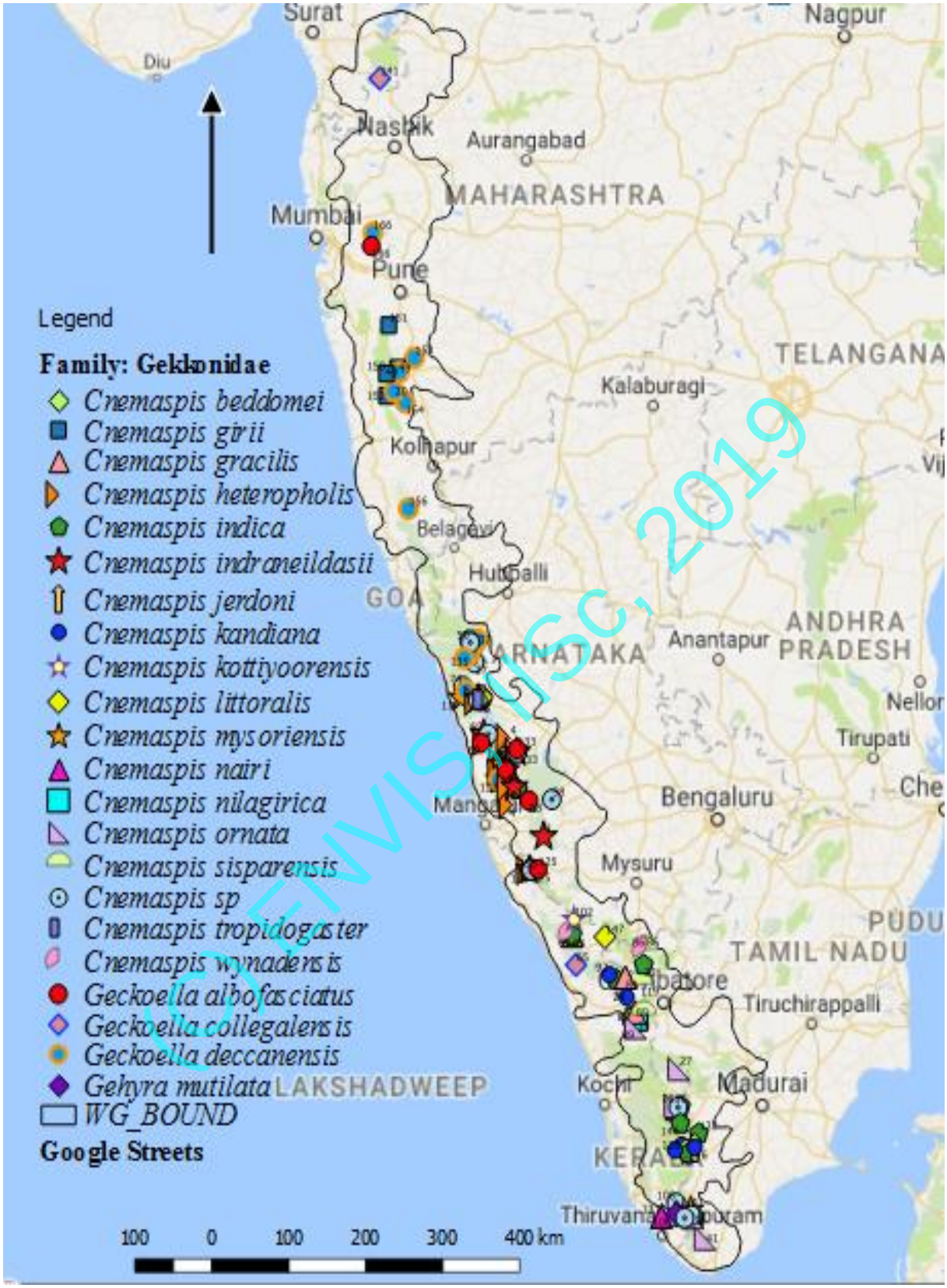


Fig. 6.4.7a. Spatial distribution of the Gekkonidae family.

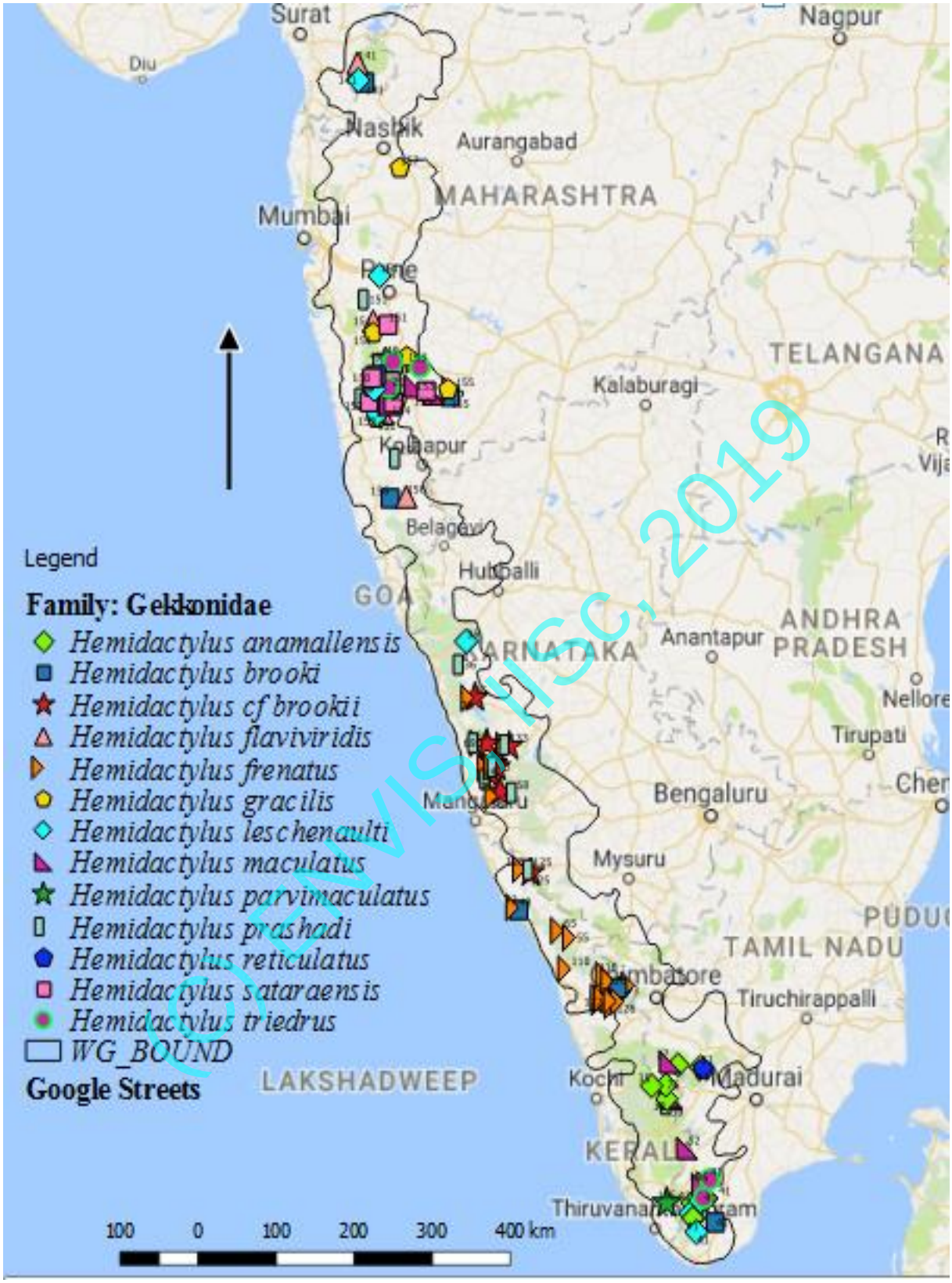


Fig. 6.4.7b. Spatial distribution of the Gekkonidae family.

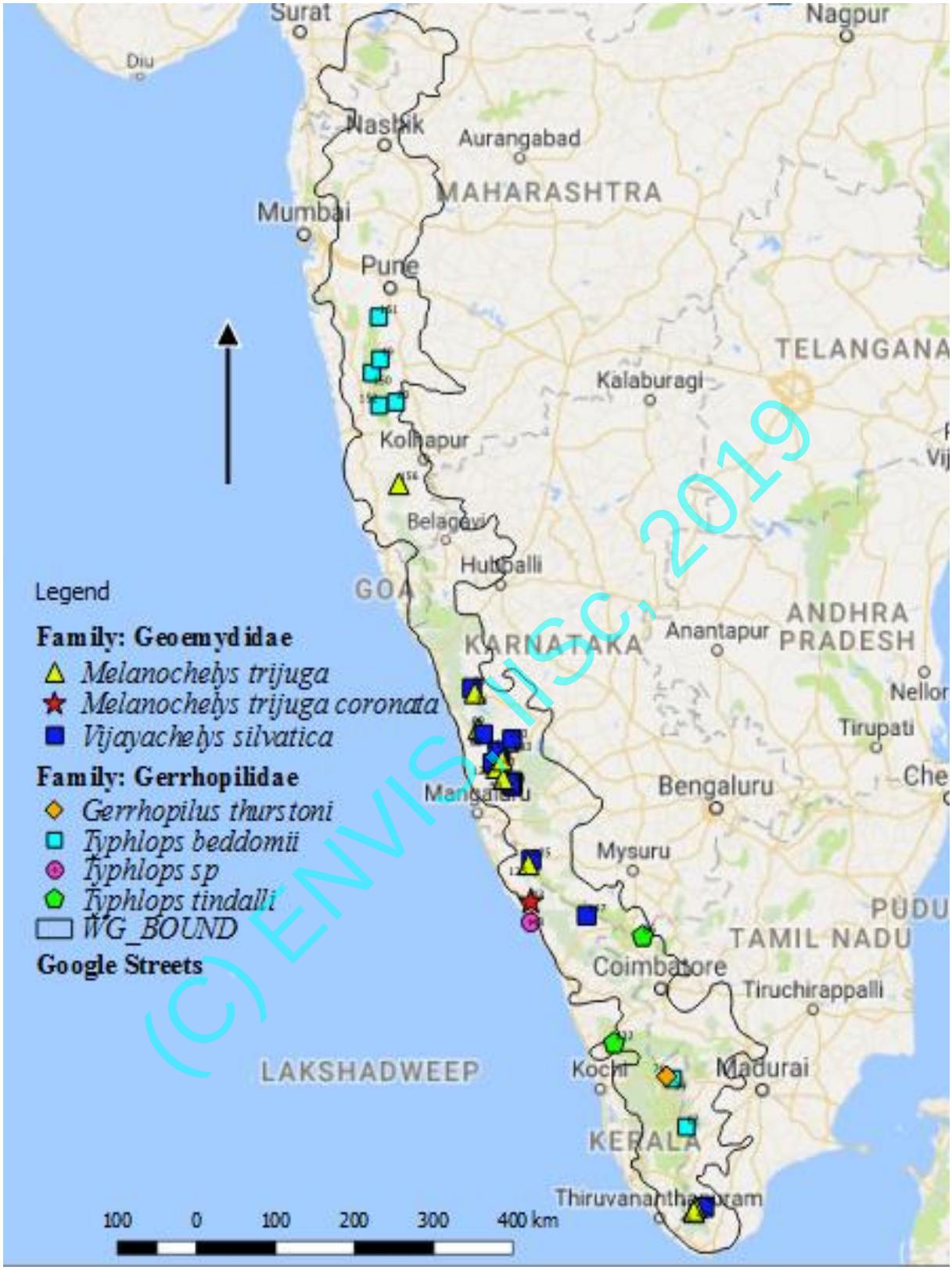


Fig. 6.4.8. Spatial distribution of the Geoemydidae and Gerrhopilidae families.

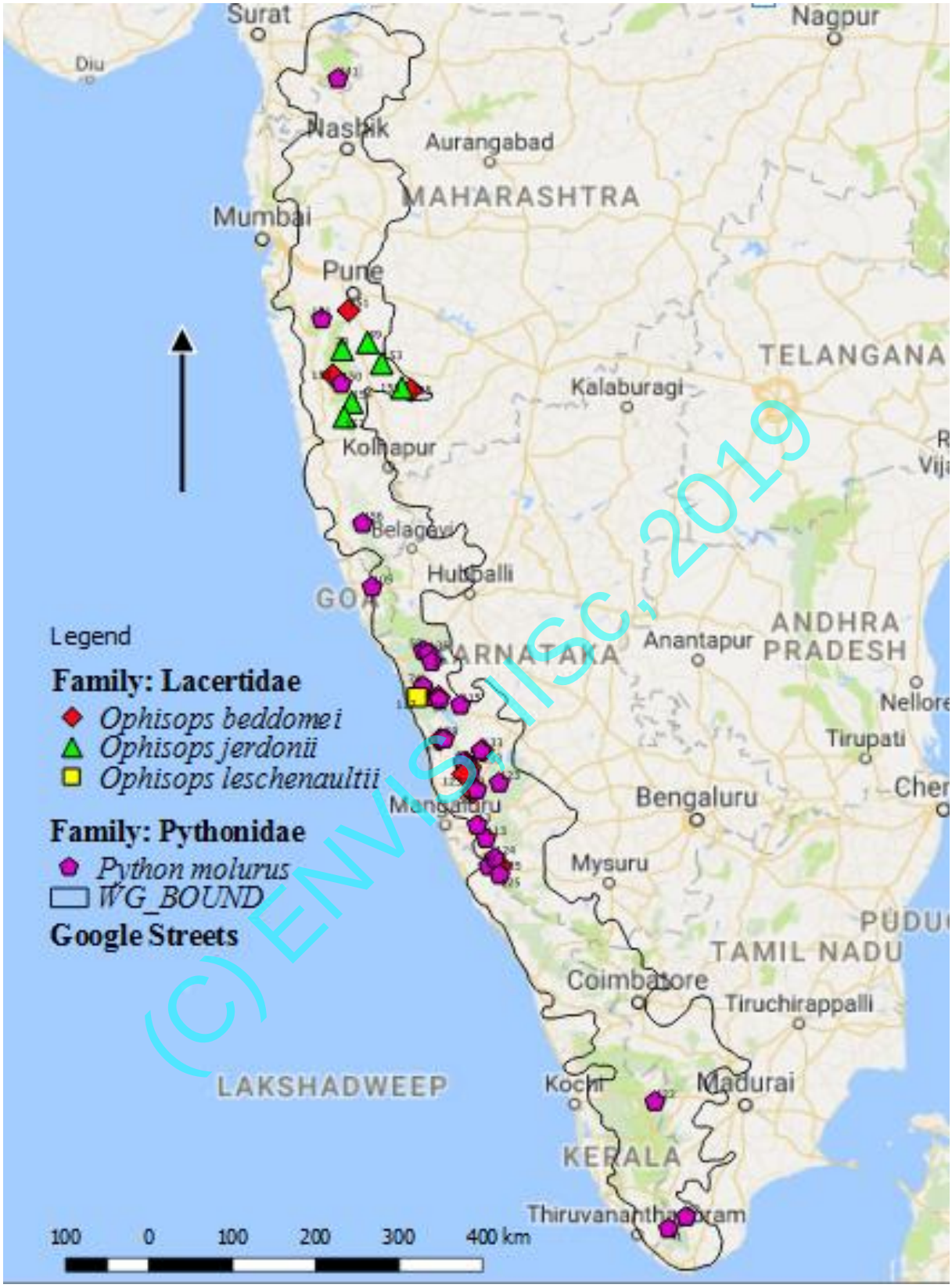


Fig. 6.4.9. Spatial distribution of the Lacertidae and Pythonidae families.

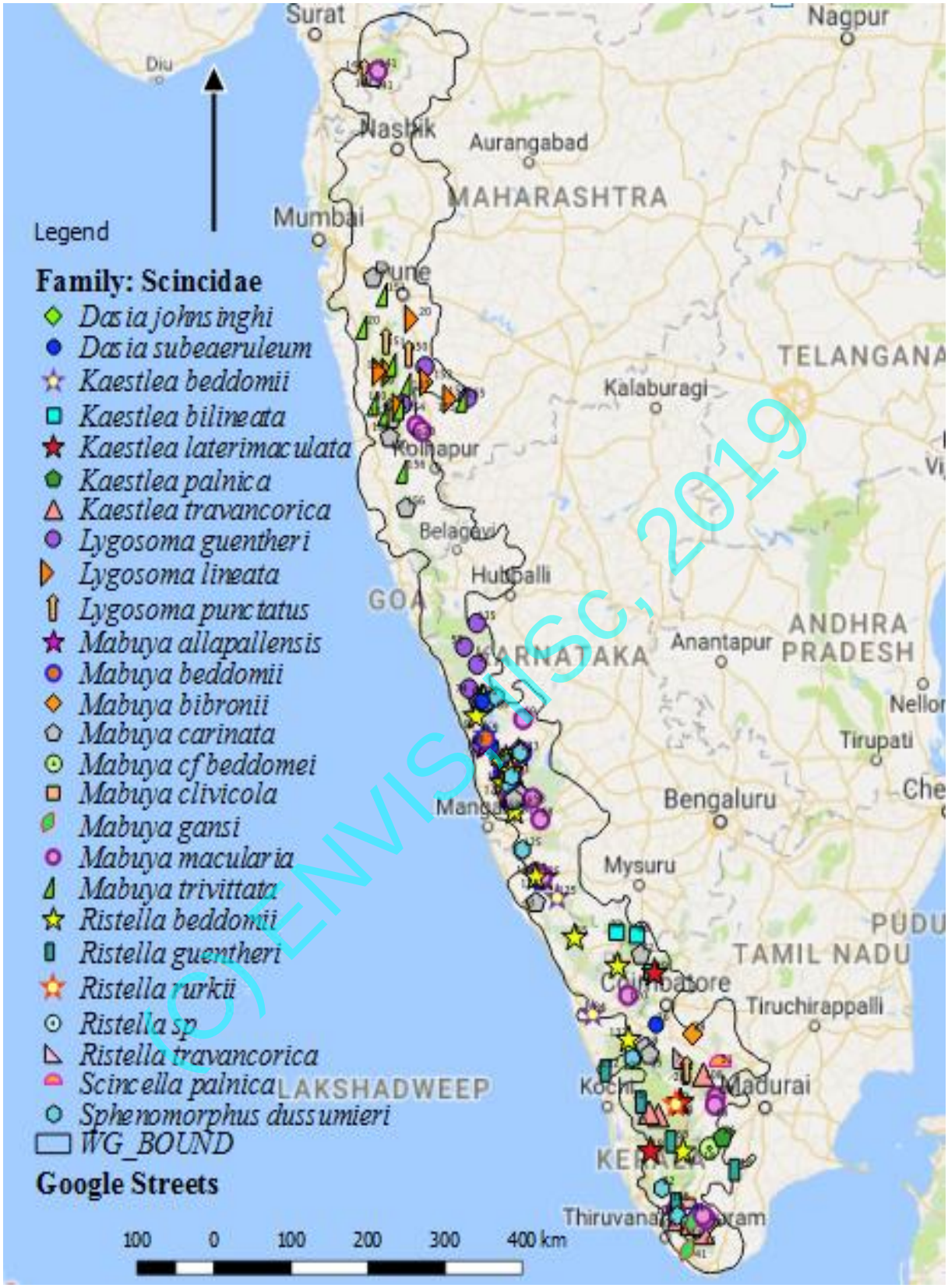


Fig. 6.4.10. Spatial distribution of the Scincidae family.

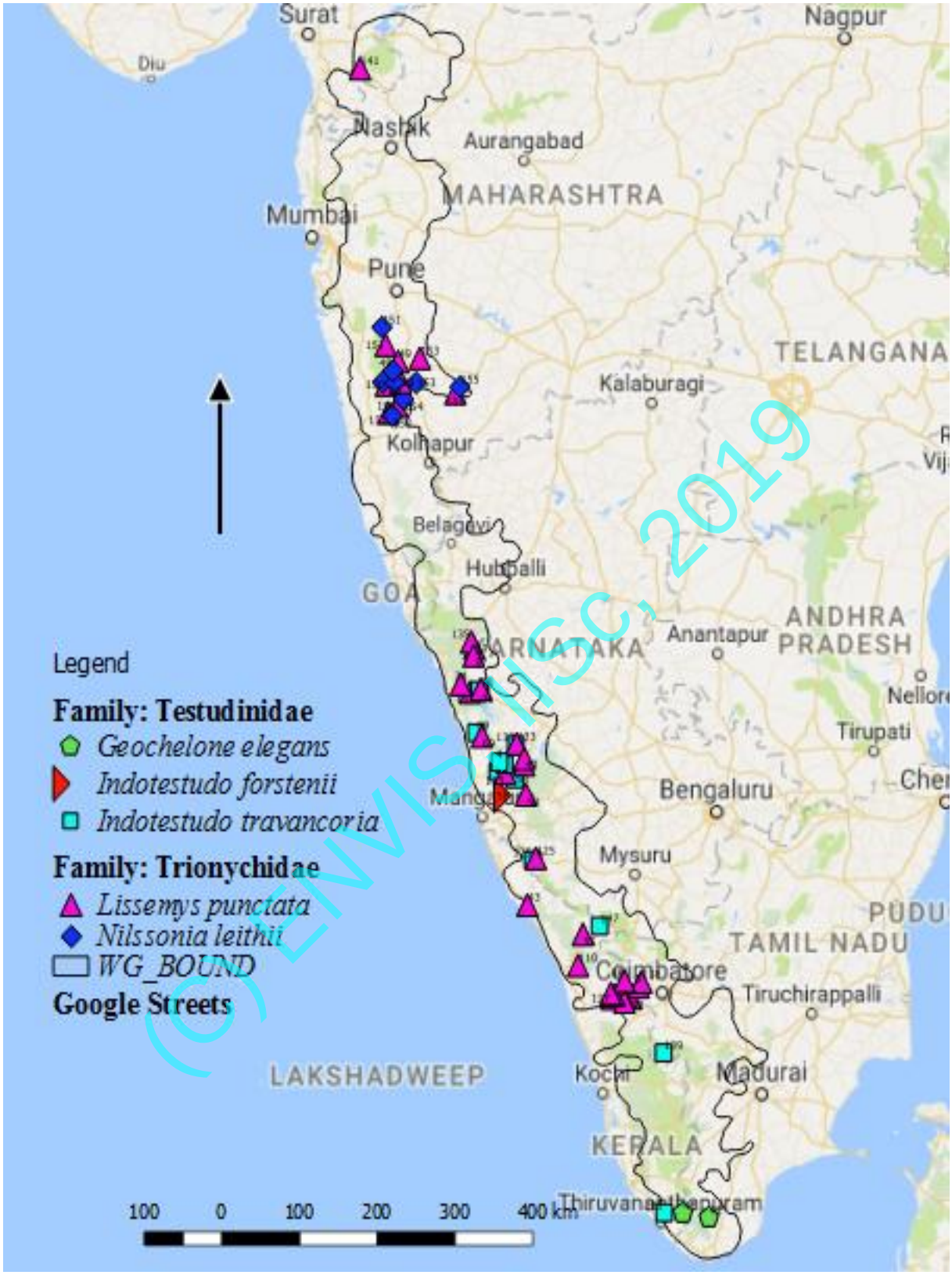


Fig. 6.4.11. Spatial distribution of the Testudinidae and Trionychidae families.

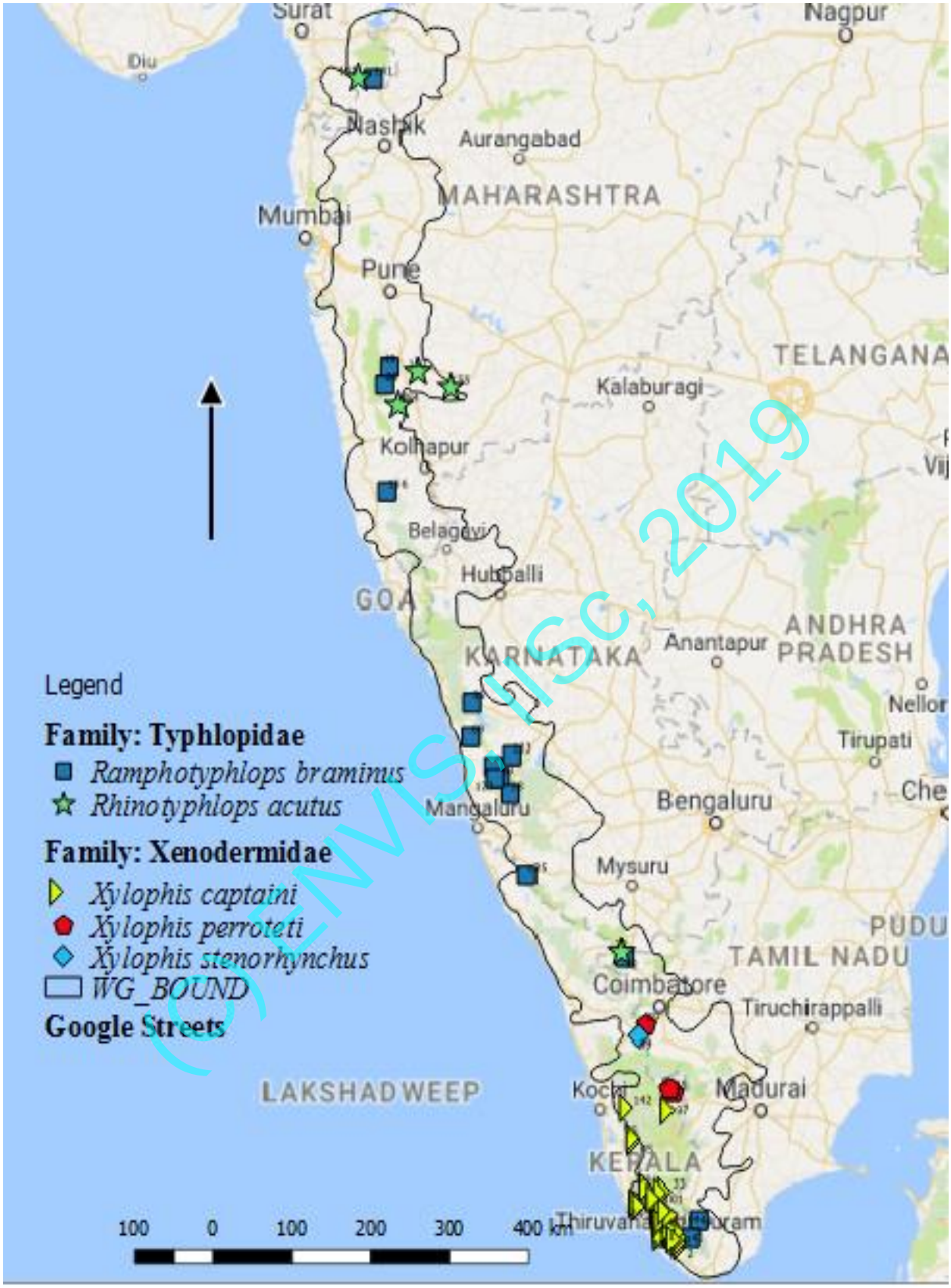


Fig. 6.4.12. Spatial distribution of the Typhlopidae and Xenodermidae families.

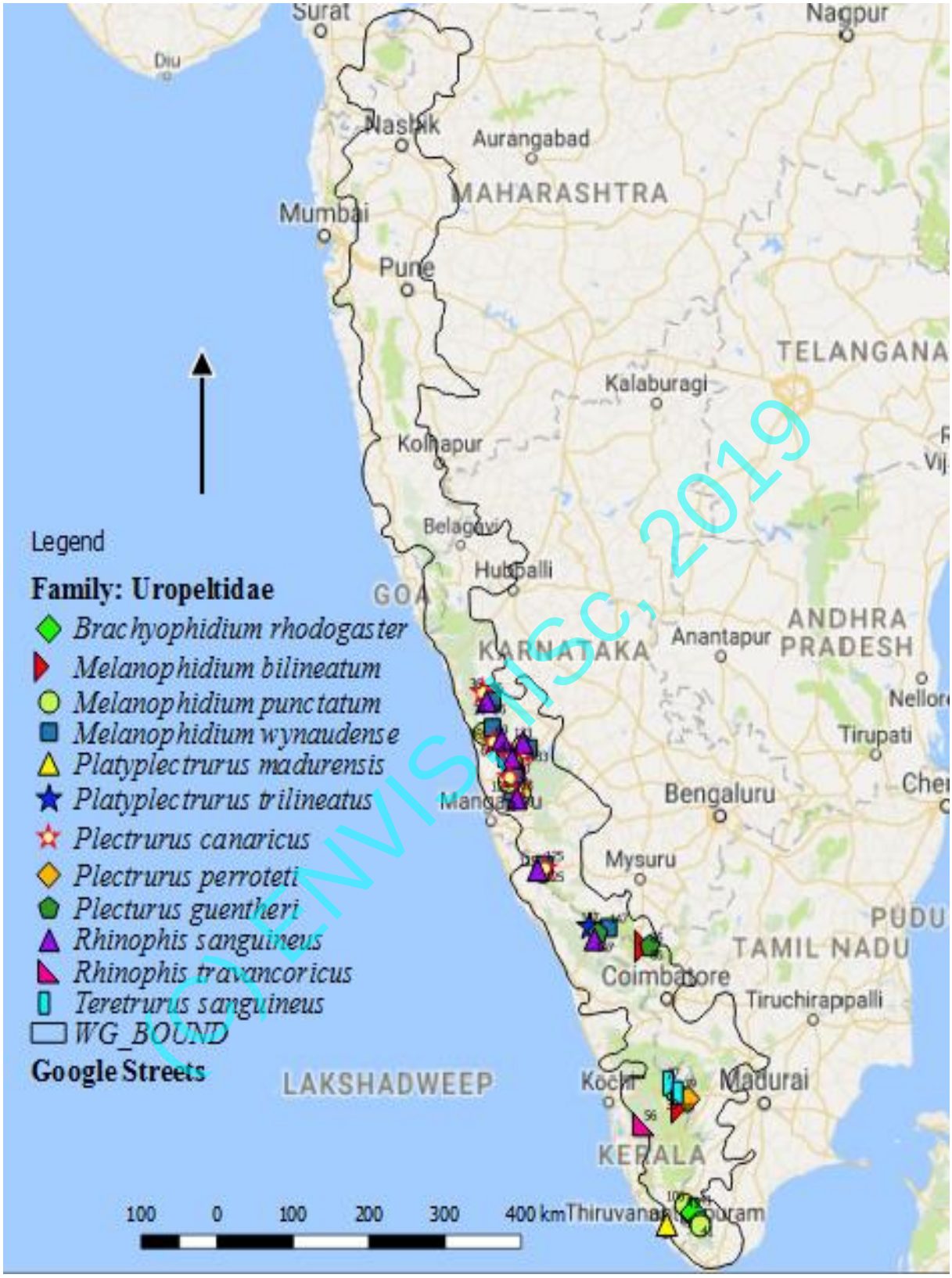


Fig. 6.4.13a. Spatial distribution of the Uropeltidae family.

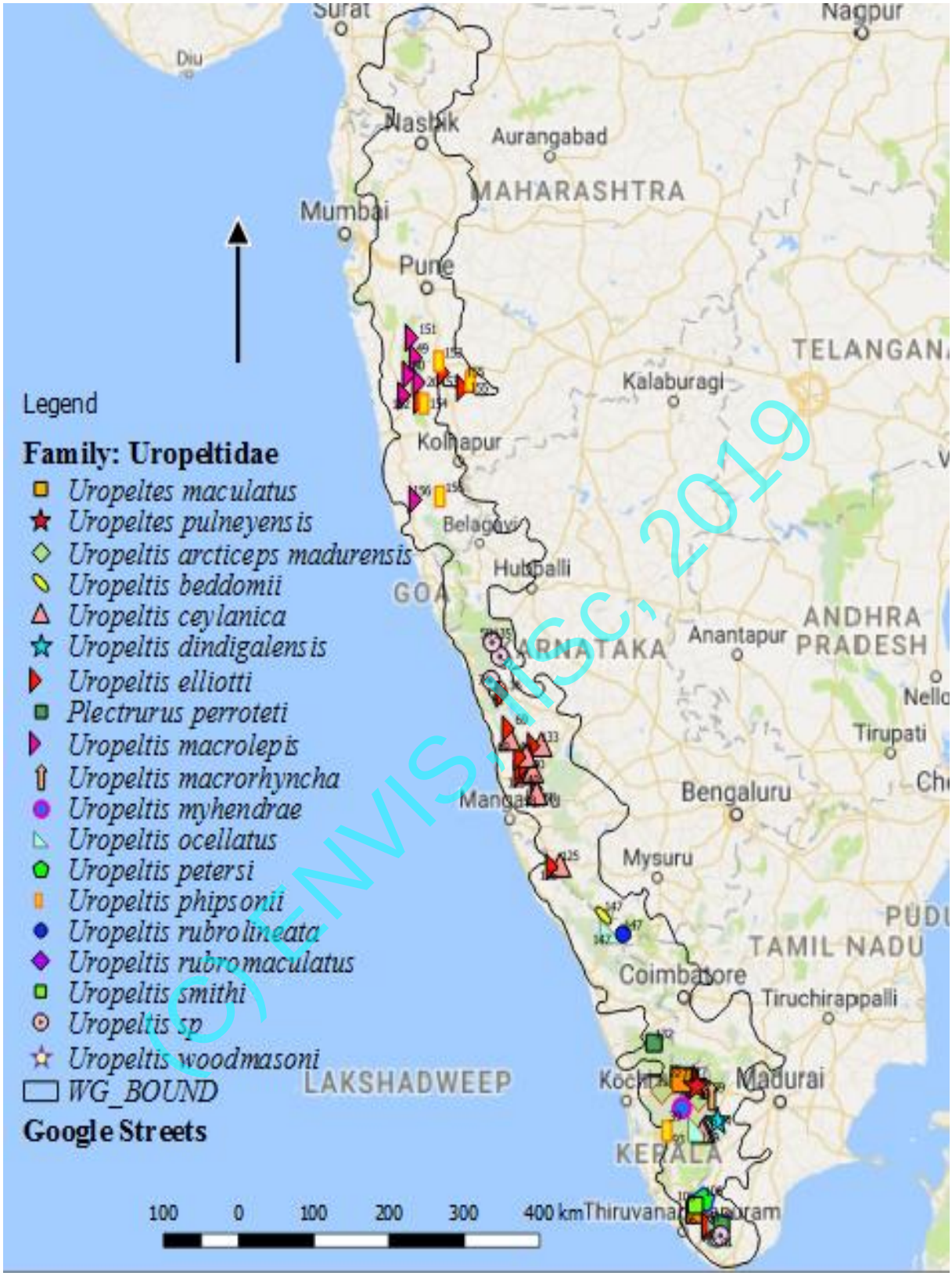


Fig. 6.4.13b. Spatial distribution of the Uropeltidae family.

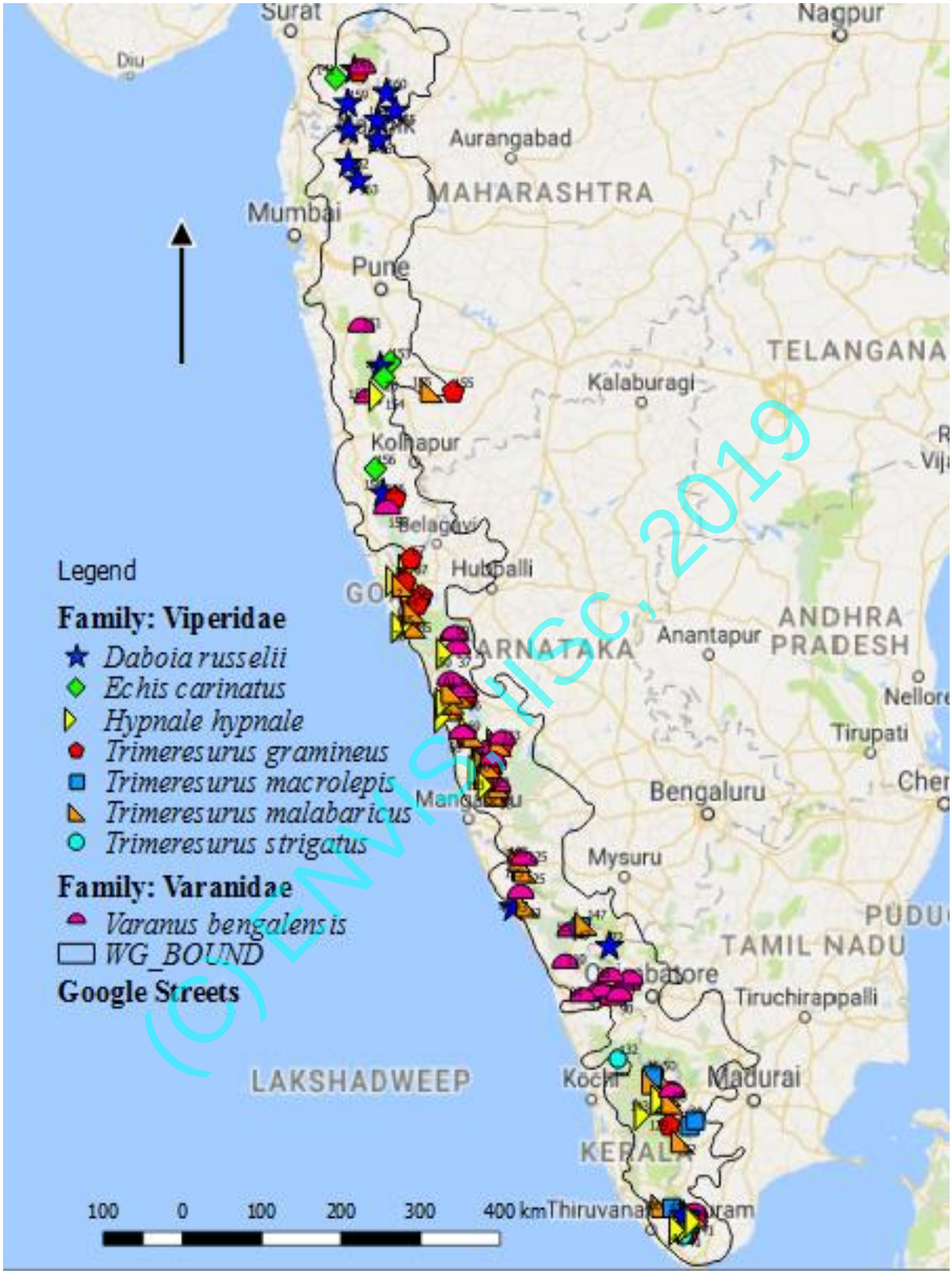


Fig. 6.4.14. Spatial distribution of the Viperidae and Varanidae families.

Distribution of endemic species

Among the 197 species of reptiles, 102 species (52%) are endemic to WG (Fig. 6.4.15 & Fig. 6.4.16). Among the 19 reptilian families present in the WG, 12 families are endemic (Fig. 6.4.17).

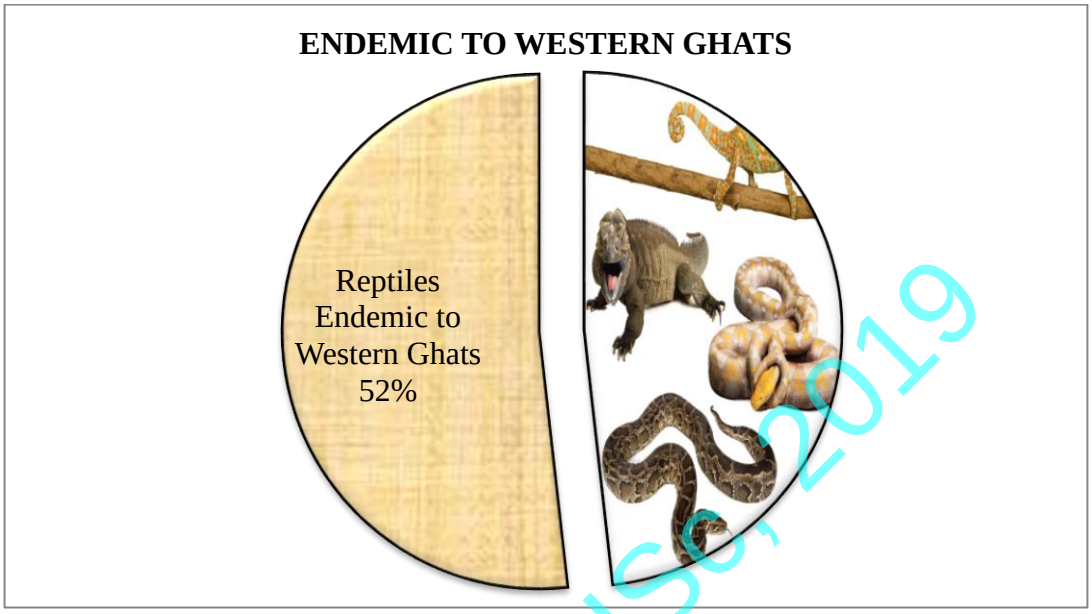


Fig. 6.4.15. Pie chart showing Endemism of Reptiles in WG.

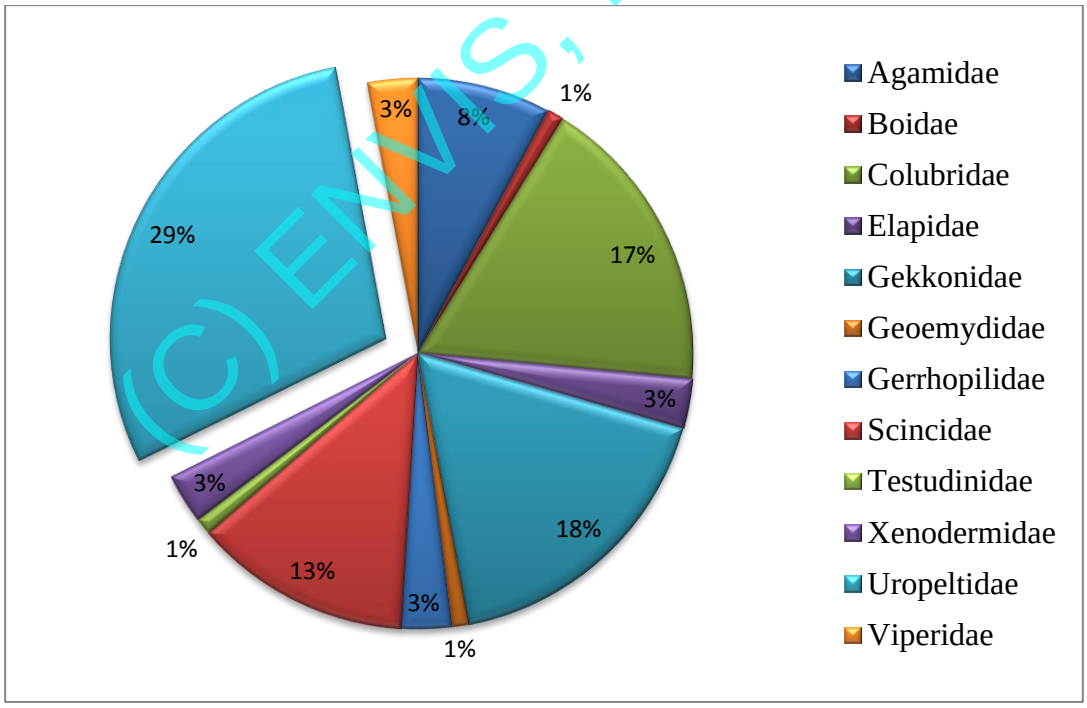


Fig. 6.4.17. Pie chart showing Endemic Reptilian families.

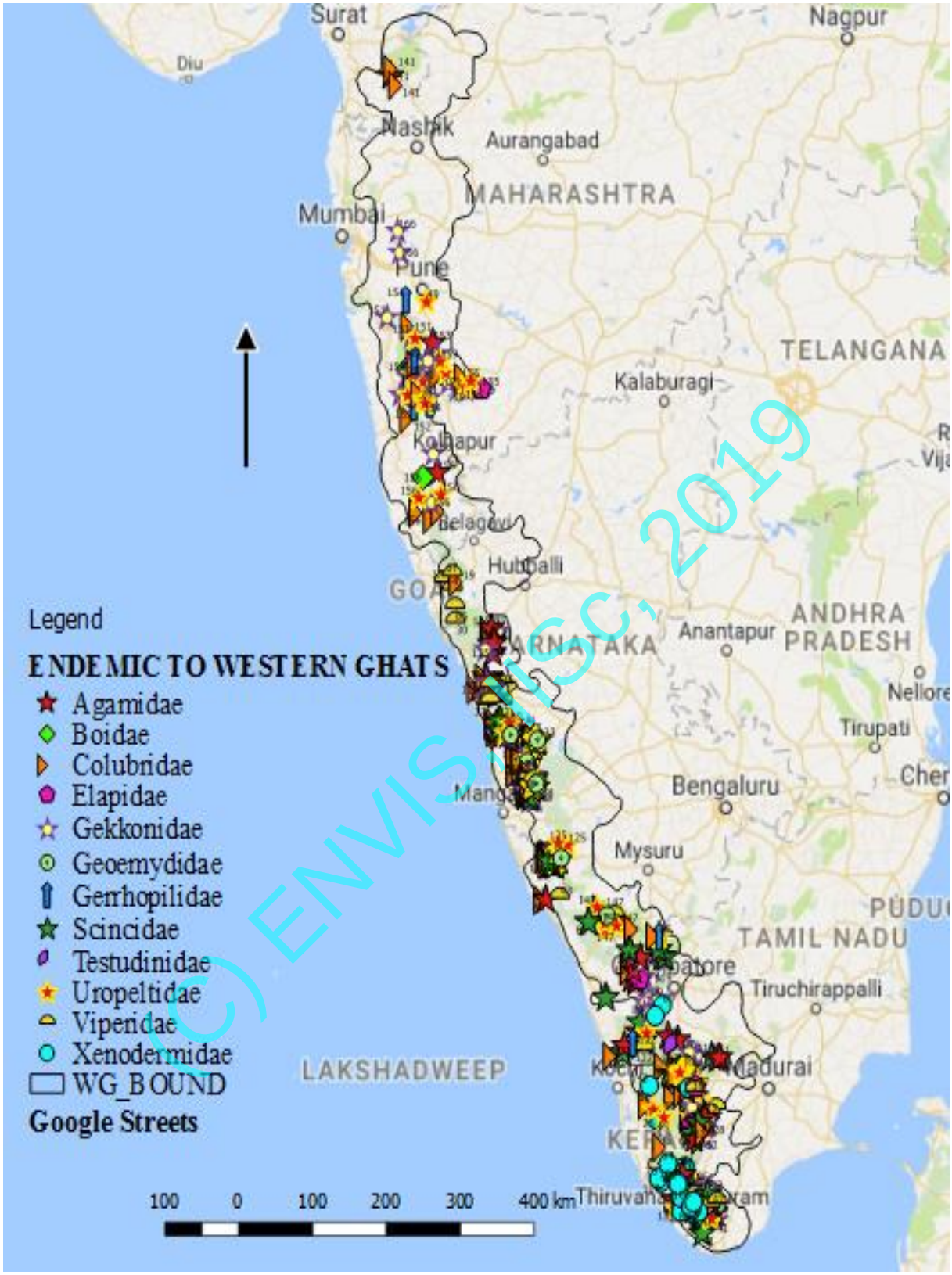


Fig. 6.4.16. Spatial distribution of the Reptilian families endemic to WG.

Distribution based on conservation status

According to the IUCN red data list, all reptilian species present in the WG are grouped as Endangered, Vulnerable, Near Threatened, Least Concern, Data Deficient and Not Evaluated

on the basis of their threat status (Fig. 6.4.18). Among the 197 Reptiles present in the WG region, 10 species were categorized as Endangered (EN). 13 species were considered as Vulnerable (VU). 11 species comes under the category Near Threatened (NT). 78 species were categorized under the Least Concern category. 23 species were categorized under the category Data Deficient (DD). Conservation Status of 62 species of reptiles was not evaluated (Fig. 6.4.19).

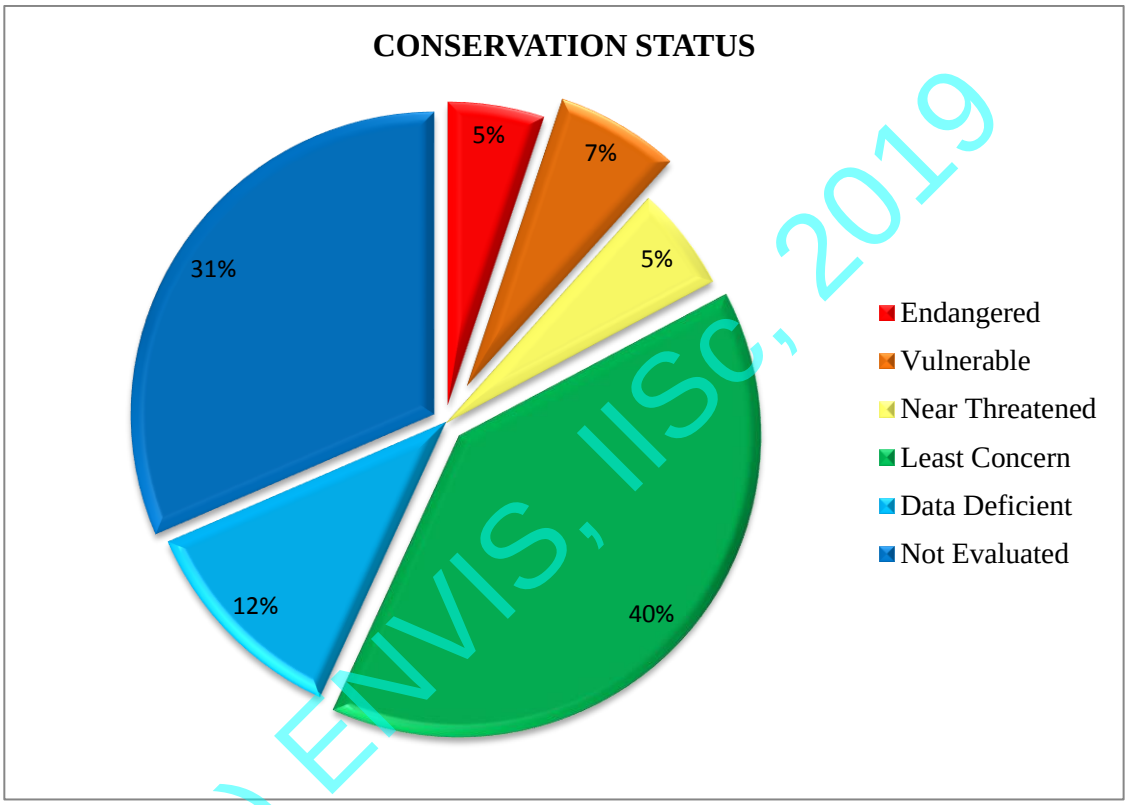


Fig. 6.4.19. Pie chart showing conservation status of reptiles in WG.

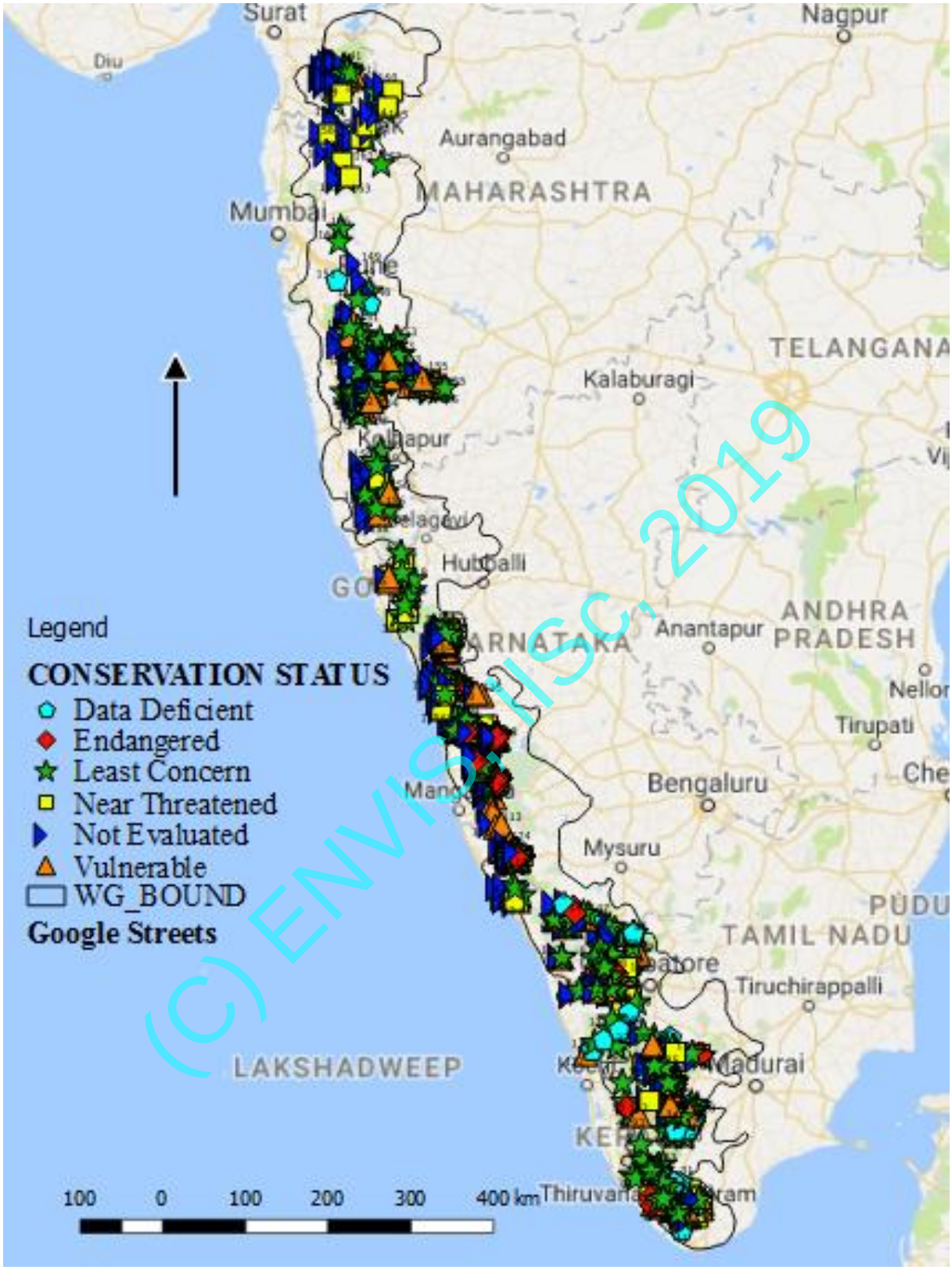


Fig. 6.4.18. Spatial distribution of the Reptilian families according to IUCN status.

According to the IUCN conservation status, 13 species from 7 reptilian families are categorized as endangered species. *Otocryptis beddomii, Ahaetulla perroteti, Dendrelaphis chairecacos, Cnemaspis wynadensis, Vijayachelys silvatica, Dasia subeaeruleum, Mabuya clivicola,*

Platyplectrurus madurensis, *Rhinophis travancoricus* and *Indotestudo forstenii* are the endangered reptilian species present in WG. As per the review, these species are distributed in the central and southern regions of WG (Fig. 6.4.20). It comprises 5% of the total reptilian population present in the WG.

WG has 13 vulnerable reptilian species under 9 families. The vulnerable species include, *Oligodon brevicauda*, *Cnemaspis indica*, *Cnemaspis indraneildasii*, *Hemidactylus sataraensis*, *Kaestlea laterimaculata*, *Indotestudo travancoria*, *Melanophidium bilineatum*, *Uropeltis phipsonii*, *Crocodylus palustris*, *Ophiophagus hannah*, *Python molurus*, *Nilssonia leithii* and *Geochelone elegans*. These species show distribution in the WG regions of Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamil Nadu (Fig. 6.4.21). It shows that 7% of the total reptilian population in the WG is vulnerable. As per the review, *Cnemaspis indraneildasii* is reported from the WG region of Karnataka. *Nilssonia leithii* and *Hemidactylus sataraensis* are reported only in Maharashtra region and *Geochelone elegans* is reported from Tamilnadu region.

WG has 11 near threatened reptilian species. These species include *Ahaetulla dispar*, *Cnemaspis heteropholis*, *Cnemaspis nairi*, *Cnemaspis ornata*, *Cnemaspis sisparensis*, *Hemidactylus anamallensis*, *Uropeltis smithi*, *Ptyas mucosus*, *Melanochelys trijuga*, *Typhlops sp* and *Hypnale hypnale*. The species shows distribution across the WG regions of Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu (Fig. 6.4.22). As per the review, *Cnemaspis heteropholis* is reported from the WG region of Karnataka. According to the IUCN conservation status, 78 reptilian species present in the WG comes under the category least concern. The least concern species are reported from entire WG (Fig. 6.4.23). The least concern species are from the families Agamidae, Chamaeleonidae, Colubridae, Elapidae, Gekkonidae, Lacertidae, Scincidae, Trionychidae, Uropeltidae, Varanidae, Viperidae, and Xenodermidae. Most of the reptilian species (70%) present in WG comes under this category. IUCN categorize 23 reptilian species present in the WG under the category data deficient. It comprises 12% of the total reptilian population present in WG. Data Deficient species belong to the families Colubridae, Elapidae, Gekkonidae, Gerrhopilidae, Scincidae, Uropeltidae, and Xenodermidae (Fig. 6.4.24). Conservation Status of 62 species of reptiles has not evaluated, that comprises almost 31% of the total number of species present in the WG (Fig. 6.4.25). The conservation status of the reptiles from the families Agamidae, Colubridae, Gekkonidae, Geoemydidae, Scincidae, Testudinidae, and Uropeltidae are not evaluated. These species show distribution across the WG regions of Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamil Nadu.

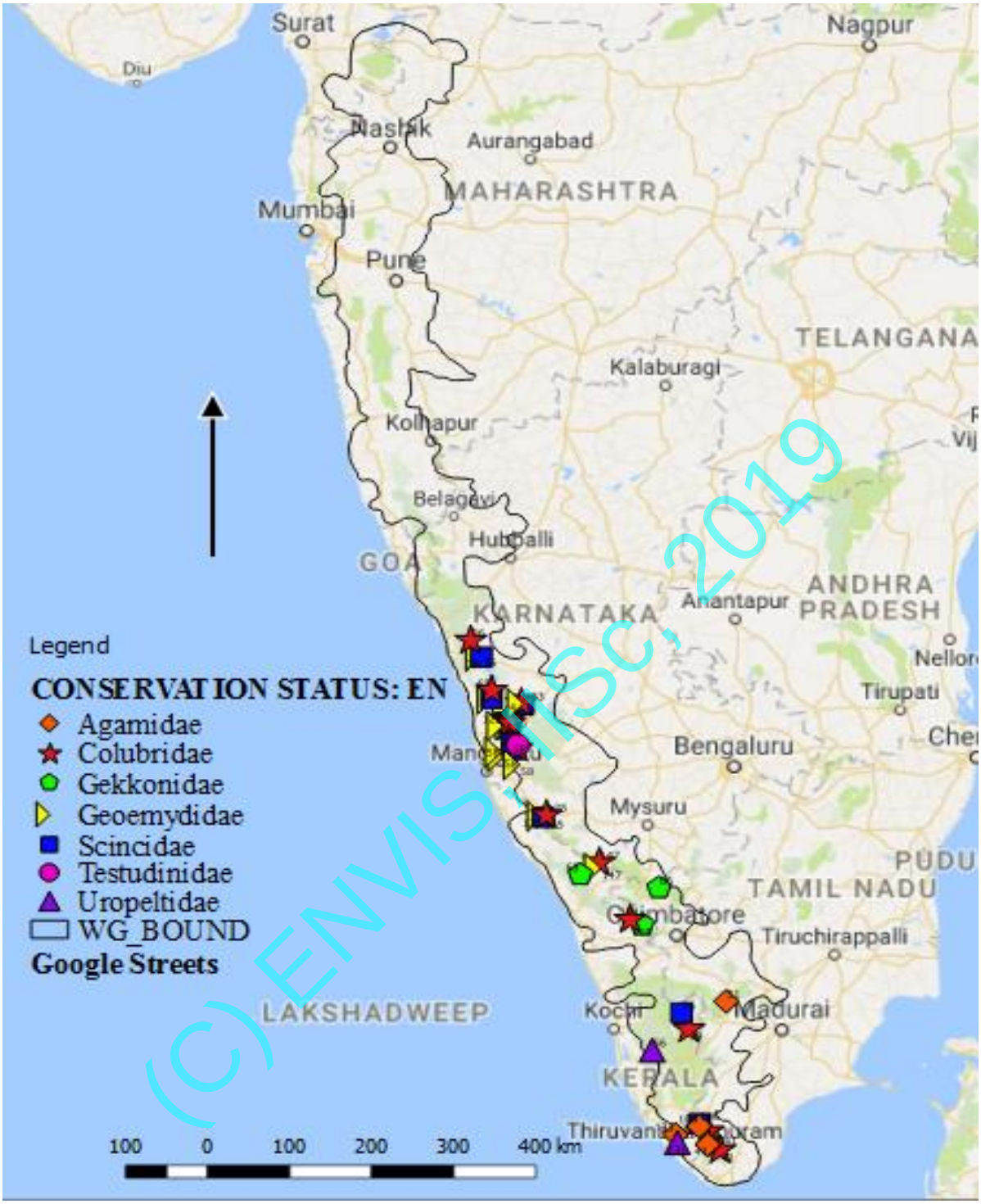


Fig. 6.4.20. Spatial distribution of the Endangered Reptilian species.

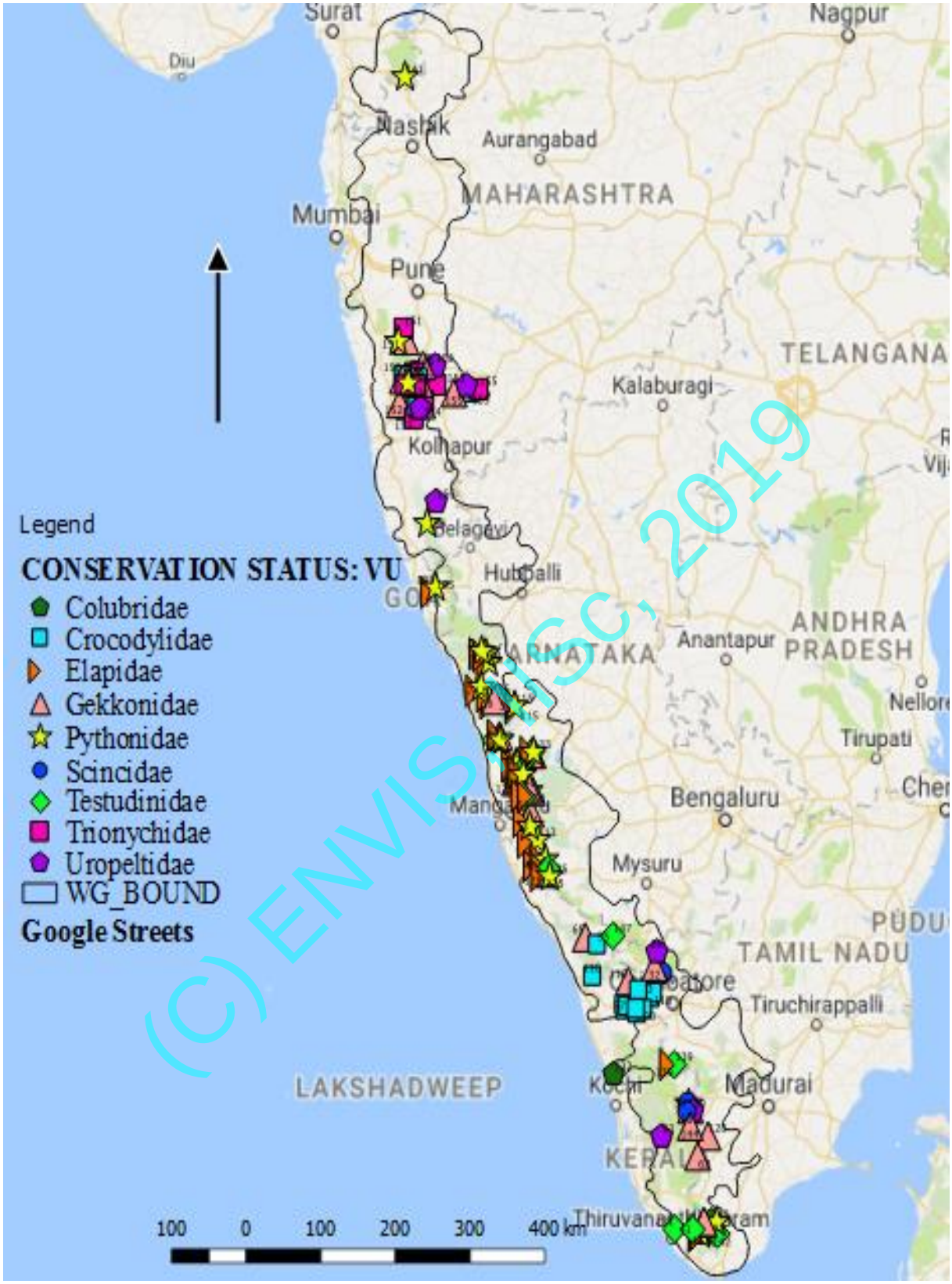


Fig. 6.4.21. Spatial distribution of the Vulnerable Reptilian species.

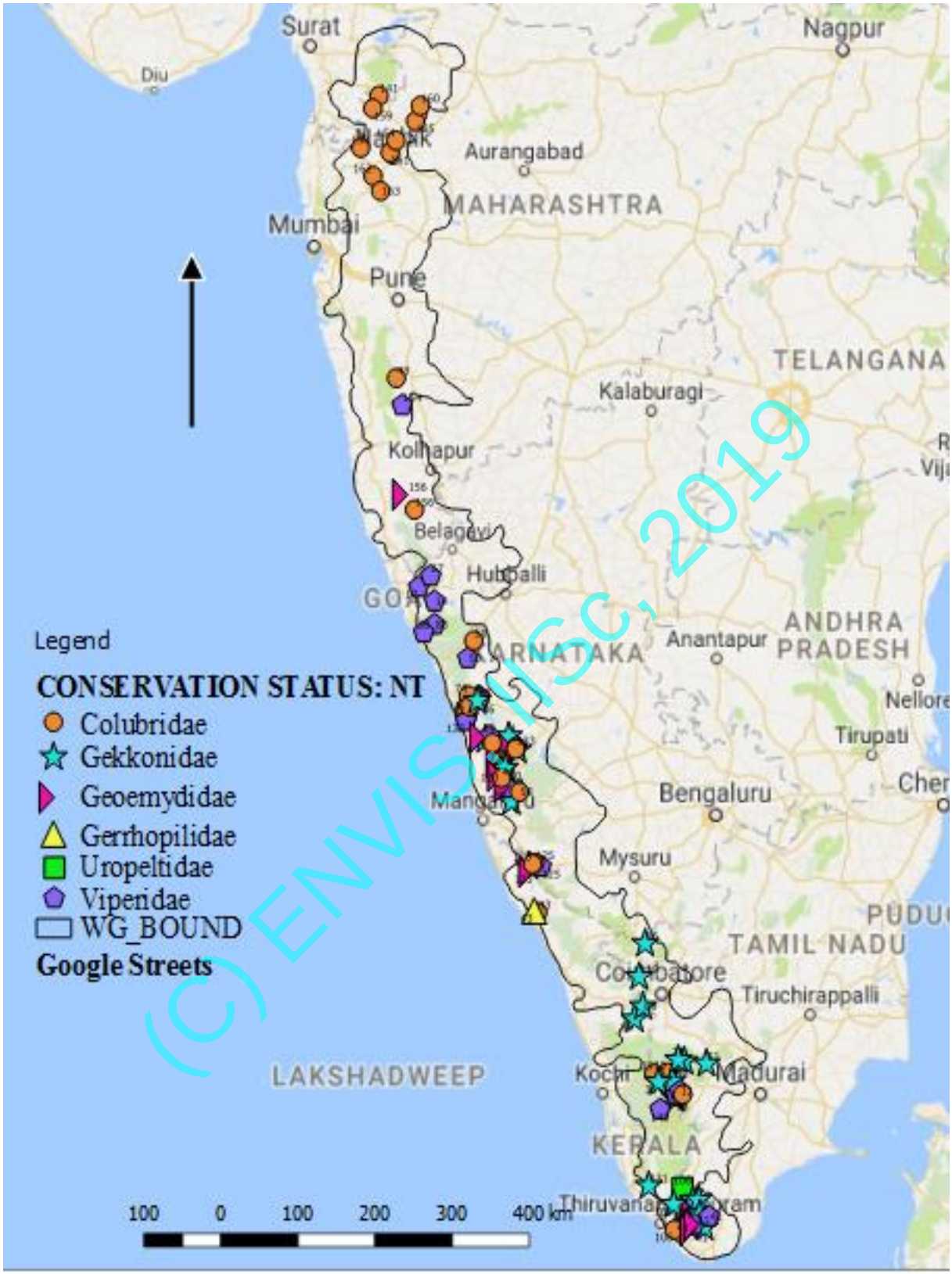


Fig. 6.4.22. Spatial distribution of the Near Threatened Reptilian species.

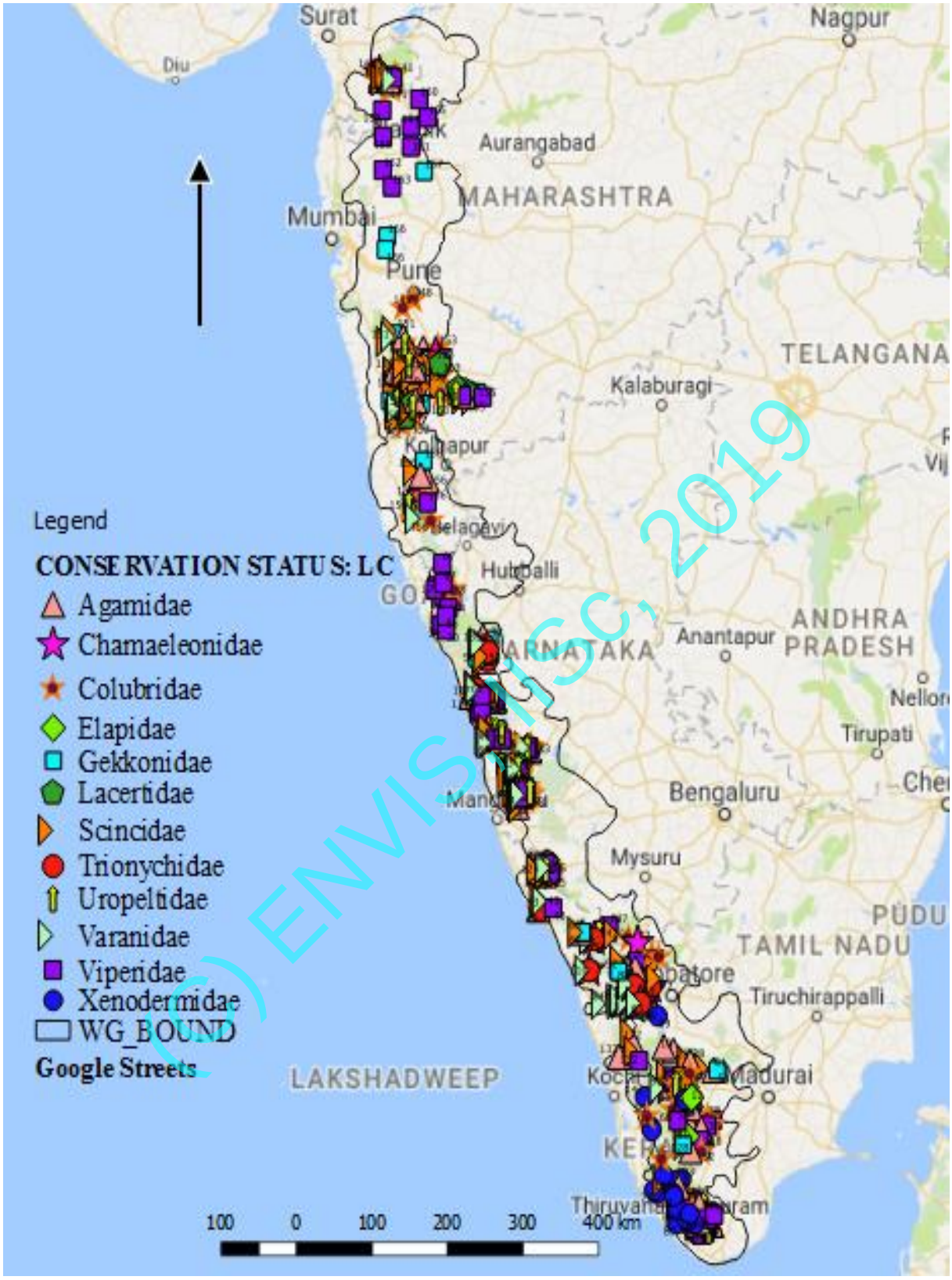


Fig. 6.4.23. Spatial distribution of the Least Concern Reptilian species.

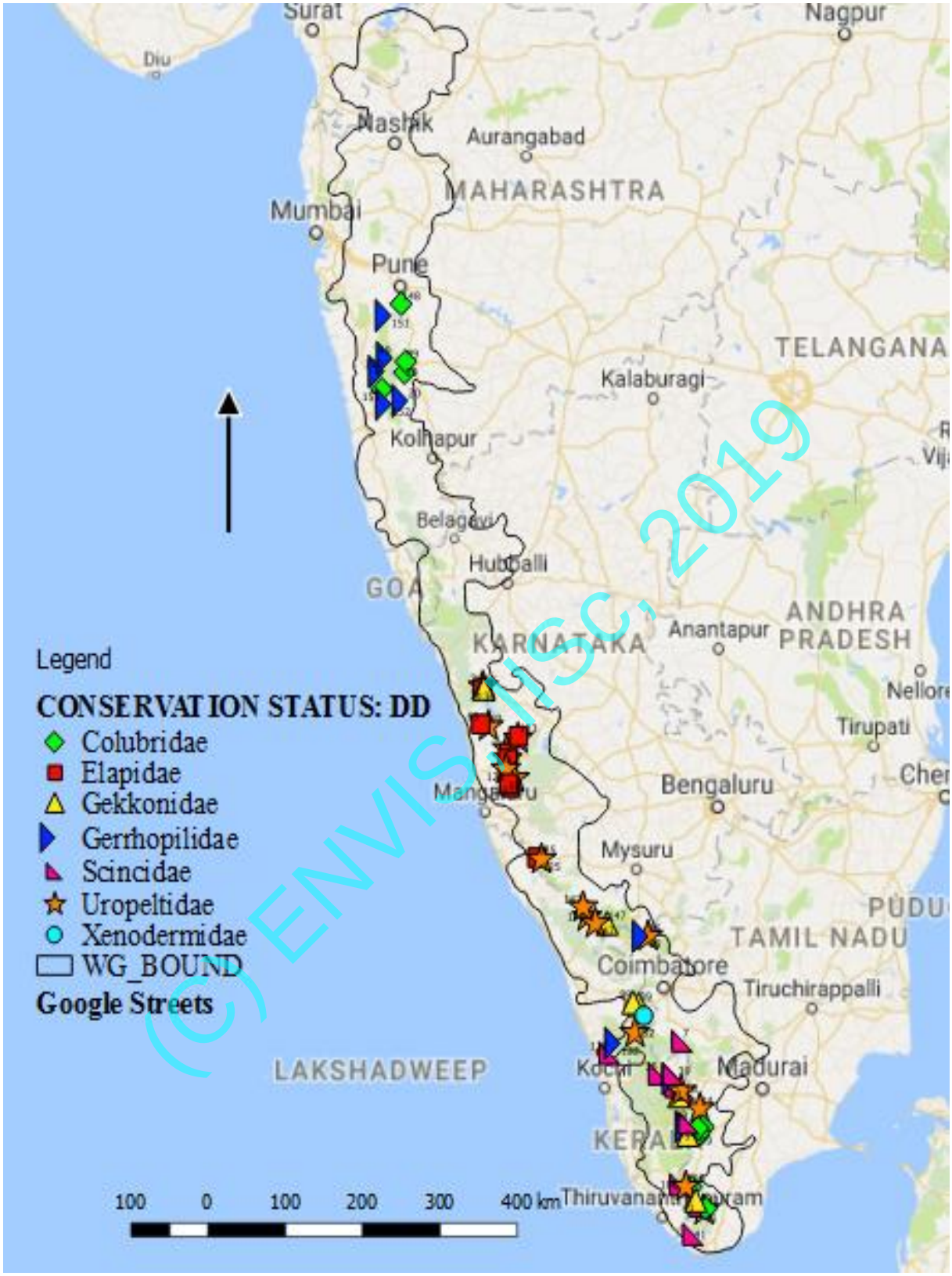


Fig. 6.4.24. Spatial distribution of the Data Deficient Reptilian species.

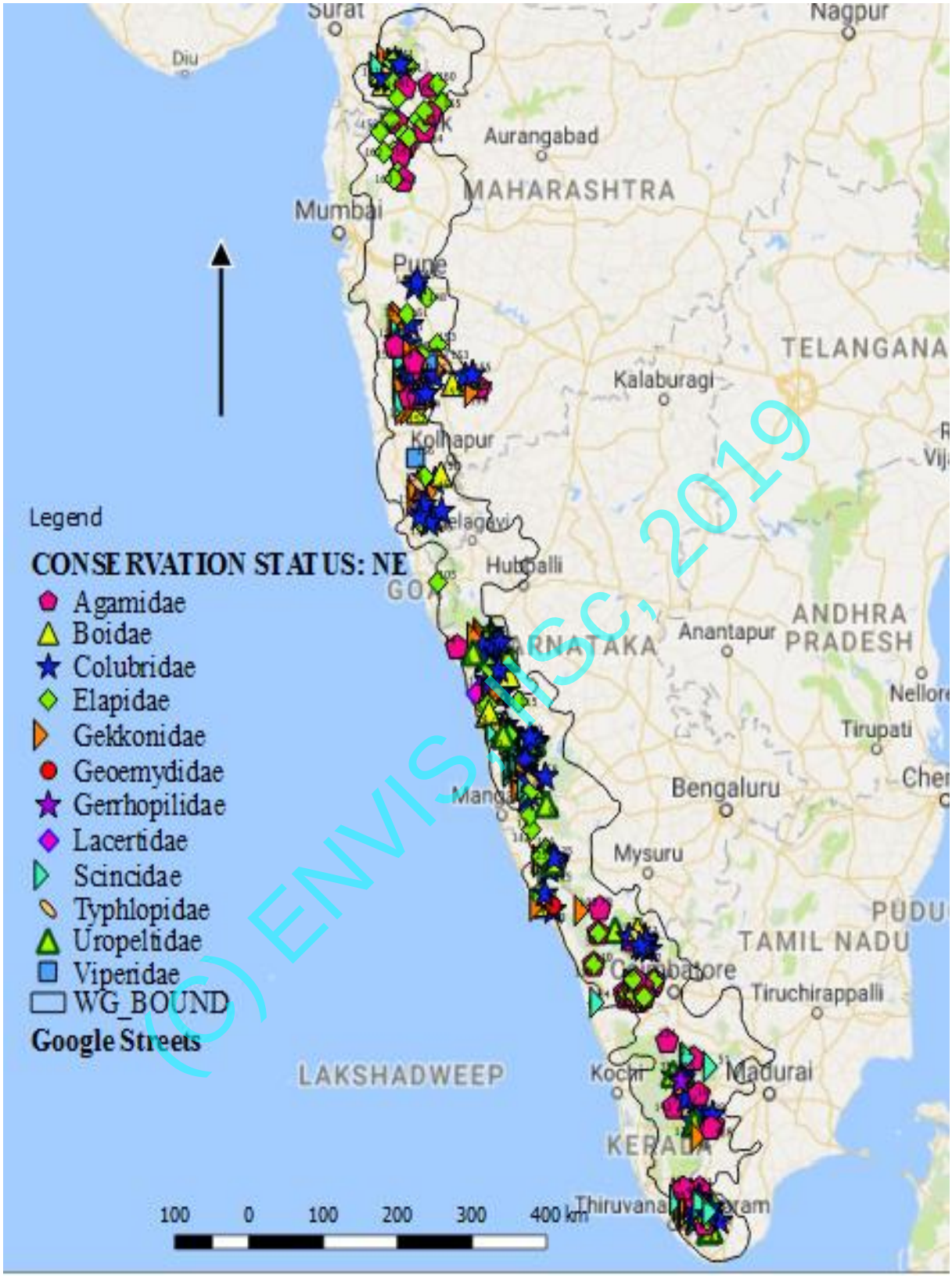


Fig. 6.4.25. Spatial distribution of the Not Evaluated Reptilian species.

6.5. BIRDS

Birds are a group of endothermic vertebrates belongs to the Kingdom Animalia, Phylum Chordata, Subphylum Vertebrata and Class Aves. Their characteristic features include the

presence of feathers, toothless beaked jaws, hard-shelled eggs, four-chambered heart and lightweight skeleton. There are 9702 bird species identified across the globe (Sreedharan, 2004).

As per the reviewed literature, Western Ghats has 529 species of Bird species across 119 locations. The study sites include Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu state portions of Western Ghats (WG) region (Fig. 6.5.1). The review highlights studies have identified 528 species up to species level and one species, *Gallinago sp* has identified only up to genera level. WG region has 85 avian families. Among these, Accipitridae is the largest family consists of 43 species and has many small families which consist of only one species (Fig. 6.5.2a & 6.5.2b). As per the literature, the majority of the avian families are distributed across the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu. The families like Emberizidae, Glareolidae, Gruidae, Phoenicopteridae, Pteroclidae, and Rostratulidae are reported from the WG region of Maharashtra. Dromadidae and Stercorariidae are observed in the Karnataka region. Cathartidae and Pelecanidae are the avian families reported from the Kerala and Tamilnadu regions of WG respectively.

Distribution based on the family

Accipitridae is the largest avian family present in the WG. This family comes under the order Accipitriformes and consists of birds with strongly hooked bills such as eagles. WG region has 43 species of Accipitridae family and shows distribution across the regions of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.3a & 6.5.3b). As per the review, *Ictinaetus malayensis* is the widely distributes Accipitridae species in WG. *Aegypius monachus*, commonly known as Cinereous vulture or Eurasian black vulture is reported from the WG region of Maharashtra (Kasambe & Khan, 2015). Pawar et al (2010) reported *Aquila clanga, Aquila heliaca, Aquila nipalensis, Aquila pomarina, Milvus migrans govinda* and *Milvus migranslineatus* from the Maharashtra region. *Aviceda jerdoni, Buteo buteo japonicus* and *Sarcogyps calvus* are reported from Tamilnadu regions of WG (Johnsingh, 2001). Aravind et al (2001) reported the sightings of *Circus cyaneus* from Karnataka regions of WG. Praveen & Nameer (2009) reported the sightings of *Buteo buteo* and *Ichthyophaga humilis* in Kerala regions. According to the IUCN red data list, *Sarcogyps calvus, Gyps indicus* and *G. bengalensis* are categorized as critically endangered species, *Neophron percnopterus* and *Aquila nipalensis* are classified as endangered species, *Haliaeetus leucoryphus, Aquila heliaca*

and *Aquila clanga* as vulnerable species and *Ichthyophaga ichthyaetus, Ichthyophaga humilis, Circus macrourus* and *Aegypius monachus* as near threatened species.

Acrocephalidae are a family of oscine passerine birds and the members are commonly known as warblers. *Acrocephalus aedon, Acrocephalus bistrigiceps, Acrocephalus dumetorum, Acrocephalus stentoreus* and *Hippolais caligata* are the Acrocephalidae species reported from the WG and it has distributed across Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.4). The review shows that Blyth's Reed Warbler (*Acrocephalus dumetorum*) is the widely distributed species of this family. *Acrocephalus aedon* is highly distributed in southern WG. *Acrocephalus bistrigiceps* commonly known as Paddy field warbler or Black-browned reed warbler is reported from the WG region of Maharashtra (Ramchandra, 2013).

Aegithinidae is one of the smallest avian families, which includes the bird iora. Common Iora, *Aegithina tiphia* is the only Aegithinidae species present across Maharashtra, Karnataka, Kerala, and Tamilnadu regions of WG (Fig. 6.5.4).

Alaudidae is the family of birds comes under the order Passeriformes. WG has 11 Alaudidae members and they are commonly called as Larks. *Alauda arvensis, Alauda gulgula, Ammomanes phoenicura, Calandrella raytal, Eremopterix grisea, Galerida cristata, Galerida deva, Galerida malabarica, Mirafra affinis, Mirafra cantillans* and *Mirafra erythroptera* are the species present across the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.4). *Alauda arvensis* is reported from Tamilnadu regions of WG (Johnsingh, 2001). Ramchandra, 2013, reported *Calandrella raytal* and Tuljapurkar et al (2013) reported *Galerida deva* from the Maharashtra region of WG. *Galerida cristata* is highly distributed in the WG region of Karnataka (Sowmya & Jayappa, 2016).

Alcedinidae are Kingfisher family comes under the order Coraciiformes. WG has 8 species of Alcedinidae birds, they are *Alcedo atthis, Alcedo meninting, Ceryle rudis, Ceyx erithacus, Halcyon coromanda, Halcyon pileata, Halcyon smyrnensis* and *Pelargopsis capensis*.These species show distribution across the WG regions of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.5). *Halcyon coromanda* (White-breasted Kingfisher or Ruddy Kingfisher) is reported from the WG region of Maharashtra (Pawar et al, 2010). *Halcyon smyrnensis* is the widely distributed Alcedinidae species. All the species are listed under the least concern category.

Anatidae is the avian family which includes ducks, swans, and geese. *Anas acuta, A. clypeata, A. crecca, A. penelope, A. platyrhynchos, A. poecilorhyncha, A. querquedula, A. strepera, Anser indicus, Aythya ferina, Aythya fuligula, Dendrocygna javanica, Nettapus coromandelianus, Sarkidiornis melanotos* and *Tadorna ferruginea* are the 15 species distributed across the Maharashtra, Karnataka, Kerala, and Tamilnadu regions of WG (Fig. 6.5.5). Majority of the Anatidae species *Anas clypeata, A.penelope, A. querquedula, A. strepera, Aythya ferina, Aythya fuligula, Sarkidiornis melanotos* and *Tadorna ferruginea* shows higher distribution in Maharashtra region (Tuljapurkar et al, 2013; Pawar et al, 2010). As per review, *Dendrocygna javanica* shows wide distribution.

Anhingidae is a family of waterbirds commonly known as Darters or snake-birds. Oriental Darter (*Anhinga melanogaster*) is the only species reported from the central and southern WG (Fig. 6.5.6). According to IUCN conservation status, it is categorized as near threatened species.

Apodidae is the family comes under the order Apodiformes and the members are commonly known as Swifts. *Apus affinis, A. apus, A. pacificus, Chaetura gigantea, Chaetura sylvatica, Collocalia unicolor, Tachymarptis melba* and *Zoonavena sylvatica* are reported from the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.6). As per the review, Karuthedathu et al (2014) reported *Apus apus* from the Kasargod district of Kerala. *Chaetura gigantea* and *Chaetura sylvatica* shows higher distribution in WG region of Kerala (Radhakrishnan, 2002).

Bucerotidae are the family of Hornbills. The species *Anthracoceros coronatus, Buceros bicornis, Ocyceros birostris* and *Ocyceros griseus* are observed from the WG regions of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.6). Malabar Pied Hornbill (*Anthracoceros coronatus*) is commonly seen in Karnataka and Kerala regions. *Ocyceros birostris* commonly known as Indian Grey Hornbill is reported from the regions of Karnataka and Maharashtra. *Ocyceros griseus* (Malabar grey hornbill) is an endemic species and shows distribution across WG regions of Maharashtra, Goa, Karnataka, Kerala and Tamilnadu. IUCN conservation status categorized *Buceros bicornis* and *Anthracoceros coronatus* as near threatened species.

Ardeidae are the family of herons. *Ardea alba, A. cinerea, A. goliath, A. purpurea, Ardeola grayii, Botaurus stellaris, Bubulcus coromandus, Bubulcus ibis, Butorides striatus, Dupetor flavicollis, Egretta garzetta, E. gularis, E. intermedia, Gorsachius melanolophus, Ixobrychus*

cinnamomeus, I. minutuis, I. sinensis, Mesophoyx intermedia and *Nycticorax nycticorax* are the species distributed across the WG regions of Maharashtra, Karnataka, Kerala and Tamilnadu (Fig. 6.5.7). *Ardea goliath* is reported from the WG region of Maharatra (Ramchandra, 2013). Among 19 species, *Ardea alba, Ardeola grayii, Bubulcus ibis, Butorides striatus* and *Egretta garzetta* shows higher distribution in WG. *Ixobrychus minutuis, I. sinensis,* and *I. cinnamomeus* show higher distribution in WG region of Maharashtra.

Artamidae is the family of passerine birds. *Artamus fuscus* is the only Artamidae species reported from the WG region. It is also known as ashy woodswallow and has distributed across the Central and Southern WG (Fig. 6.5.7).

Burhinidae family consists of birds which are commonly known as thick-knees or stone curlews. These species are usually found in dry, tropical climates. *Burhinus indicus, Burhinus oedicnemus, Esacus magnirostris* and *Esacus recurvirostris* are the Burhinidae species present WG region of Maharashtra, Karnataka, and Tamilnadu (Fig. 6.5.8). *Burhinus indicus, Esacus magnirostris,* and *Esacus recurvirostris* show higher distribution in WG region of Maharashtra. The species *Burhinus oedicnemus* is endemic to WG and has higher distribution in Karnataka and Tamilnadu.

Campephagidae is a family of songbirds commonly known as shrikes. *Coracina macei, Coracina melanoptera, Pericrocotus cinnamomeus, Pericrocotus divaricatus, Pericrocotus ethologus, Pericrocotus flammeus* and *Pericrocotus roseus* are the species reported from the WG region across the states, Maharashtra, Karnataka, Kerala and Tamilnadu (Fig. 6.5.8). *Pericrocotus divaricatus* and *Pericrocotus ethologus* show higher distribution in WG region of Maharashtra. Rosy Minivet (*Pericrocotus roseus*) shows higher distribution in Karnataka region.

Caprimulgidae is the family consists of nocturnal birds such as nightjars. WG has 5 species of Nightjars; they include *Caprimulgus affinis, C. asiaticus, C. atripennis, C. indicus* and *C. macrurus*. These species are distributed across the WG region of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.8). *Caprimulgus affinis* and *Caprimulgus atripennis* show higher distribution in the WG regions of Maharashtra and Karnataka respectively. All the Caprimulgidae species present in the WG region are categorized as least concern.

Cathartidae is the family of vultures. *Coragyps atratus* is the Cathartidae species present in WG, commonly known as American black vulture. As per the review, this species has distributed across the Kerala region of WG (Fig. 6.5.9). IUCN conservation status listed this species under least concern category.

Charadriidae is the avian family which includes plovers, dotterels, and lapwings. *Charadrius alexandrinus, C. dubius, C. mongolus, Pluvialis squatarola, Vanellus gregarious, V. indicus* and *Vanellus malabaricus* are the species present across the WG regions of Maharashtra, Karnataka, Kerala and Tamilnadu (Fig. 6.5.9). As per the review, *Charadrius mongolus* and *Pluvialis squatarola* show higher distribution in the WG region of Karnataka. *Vanellus gregarius* is a critically endangered species reported from the Maharashtra region.

Chloropseidae is the family of small passerine birds commonly known as leafbirds. *Chloropsis aurifrons, C. cochinchinensis* and *C. jerdoni* are the leafbirds reported from the WG region of Maharashtra, Karnataka, Kerala and Tamilnadu (Fig. 6.5.9). According to IUCN Red data list, *Chloropsis cochinchinensis* is categorized as near threatened species and *Chloropsis aurifrons* and *Chloropsis jerdoni* as least concern species.

Ciconiidae is the avian family consists of storks. *Anastomus oscitans, Ciconia ciconia, Ciconia episcopus* and *Mycteria leucocephala* are the stork species present in the WG regions of Maharashtra, Karnataka, Kerala and Tamilnadu (Fig. 6.5.10). As per the literatures, *Ciconia ciconia* and *Ciconia episcopus* shows higher distribution in Karnataka and Maharashtra regions of WG. IUCN conservation status categorized the species *Ciconia ciconia* (White Stork) and *Ciconia episcopus* (Woolly-necked Stork) as vulnerable species, *Mycteria leucocephala* (Painted Stork) as near threatened species and *Anastomus oscitans* as least concern species.

Cisticolidae is the family of small passerine birds. WG has 7 Cisticolidae species; includes *Cisticola juncidis, Orthotomus sutorius, Prinia gracilis, P. hodgsonii, P. inornata, P. socialis* and *P. sylvatica*. These species have distributed across the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.10).

Coraciidae is the avian family comes under the order Coraciiformes. *Coracias benghalensis* and *Eurystomus orientalis* are the species present in WG. These least concern species are distributed across the regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.10). As per the review, *Coracias benghalensis* (Indian roller) is the widely distributed Coraciidae species, while *Eurystomus orientalis* shows higher distribution in southern WG.

Columbidae is the family of doves and pigeons. *Chalcophaps indica, Columba elphinstonii, Columba livia, Ducula aenea, Ducula badia, Spilopelia chinensis, Spilopelia senegalensis, Streptopelia decaocto, Streptopelia orientalis, Streptopelia chinensis, Streptopelia tranquebarica, Treron affinis, T. bicinctus, T. phoenicopterus* and *T. pompadora* are the Columbidae species present in the WG. These species have distributed across the region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.11). As per the review, *Streptopelia orientalis* and *Streptopelia tranquebarica* show higher distribution in the WG region of Maharashtra (Padhye et al, 2007; Goodale et al, 2014). Barve and Warrier (2013) reported *Treron bicinctus* from the WG region of Karnataka. *Columba elphinstonii* and *Treron affinis* are the endemic species and it is categorized as vulnerable and least concern species respectively.

Dromadidae is the avian family which consists of Crab-plovers. *Dromas ardeola* is the only Dromadidae species present in WG. It shows distribution in the WG region of Karnataka (Sowmya & Jayappa, 2016) (Fig. 6.5.11).

Corvidae is the avian family which consists of crows, rooks, magpies, treepies etc. *Corvus macrorhynchos, Corvus splendens, Dendrocitta leucogastra* and *Dendrocitta vagabunda* are the Corvidae species widely present across the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.12). *Dendrocitta leucogastra* commonly known as Southern Treepie is an endemic species present in the WG. It is a least concern species and it is protected by including in Schedule IV of Indian Wildlife Protection Act, 1972.

Dicruridae is the family of Drongos. WG has 7 species of drongos, they are, *Dicrurus adsimilis, Dicrurus aeneus, Dicrurus caerulescens, Dicrurus hottentottus, Dicrurus leucophaeus, Dicrurus macrocercus* and *Dicrurus paradiseus*. These Dicruridae species are distributed across Gujarat, Maharashtra, Karnataka, Kerala and Tamilnadu regions of WG (Fig. 6.5.12). *Dicrurus hottentottus* (gray drongo) shows higher distribution in Karnataka regions of WG. All the Dicruridae species present in WG are categorized under least concern category.

Emberizidae is the family of seed-eating passerine birds commonly known as buntings. *Emberiza bruniceps, Emberiza buchanani, Emberiza lathami* and *Emberiza melanocephala* are the species present in WG. As per the review, these least concern species are highly distributed in Maharashtra region of WG (Fig. 6.5.12).

Cuculidae is the family of cuckoos comes under the order Cuculiformes. *Cacomantis passerines, Cacomantis sonneratii, Centropus bengalensis, Centropus chlororhynchos, Centropus sinensis, Centropus toulou, Clamator coromandus, Clamator jacobinus, Cuculus canorus, Cuculus micropterus, Cuculus poliocephalus, Cuculus sparverioides, Eudynamys scolopaceus, Hierococcyx sparverioides, Hierococcyx varius, Phaenicophaeus leschenaultii, Phaenicophaeus pyrrhocephalus, Phaenicophaeus tristis, Phaenicophaeus viridirostris* and *Surniculus lugubris* are the species present across the WG regions of Maharashtra, Karnataka, Kerala and Tamilnadu regions of WG (Fig. 6.5.13). As per the review, *Centropus bengalensis* is reported from Maharashtra of WG (Ramchandra, 2013). *Centropus chlororhynchos, Cuculus sparverioides,* and *Phaenicophaeus pyrrhocephalus* show higher distribution in WG regions of Karnataka (Aravind et al, 2001). *Centropus toulou* and *Cacomantis passerinus* has higher distribution in Southern WG (Radhakrishnan, 2002) and *Hierococcyx sparverioides* was reported from Tamilnadu region of WG (Johnsingh, 2001).

Dicaeidae is the family which includes flowerpeckers. This family consists of two genera, Prionochilus and Dicaeum. Dicaeum is the only genera reported from the WG region, it includes the species; *Dicaeum agile, D. concolor, D. erythrorhynchos* and *D. minullum*. These Dicaeidae species are distributed across the regions of Maharashtra, Karnataka, Kerala and Tamilnadu regions of WG (Fig. 6.5.13). All the species comes under the least concern category and shows wide distribution.

Estrildidae family includes small passerine birds. WG has 7 Estrildidae species, *Amandava amandava, Lonchura atricapilla, L. kelaarti, L. malabarica, L.malacca, L. punctulata* and *L. striata*. These species show distribution in the WG areas of Maharashtra, Karnataka, Kerala and Tamilnadu regions of WG (Fig. 6.5.14). The literatures show that, majority of this species shows higher distribution in Karnataka and Maharashtra. *Lonchura atricapilla* is reported from the WG region of Karnataka (Sowmya & Jayappa, 2016).

Falconidae is the avian family comes under the order Falconiformes. *Falco chicquera, F. jugger, F. naumanni, F. peregrinus, F. peregrinus calidus, F. peregrinus perigrenator, F. subbuteo* and *F. tinnunculus* are the Falconidae species present in the WG. These species are distributed in the WG areas of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.14). As per the literatures, *Falco chicquera* is commonly known as Red-headed falcon (Tuljapurkar et al, 2013) and *Falco peregrinus calidus* and *Falco peregrinus perigrenator* are reported from the WG region of Maharashtra (Kasambe & Khan, 2015). Johnsingh (2001) reported *Falco*

jugger from WG region of Tamilnadu regions. According to the IUCN conservation status, *Falco naumanni* is categorized as vulnerable species and *Falco chicquera* and *Falco jugger* are categorized as near threatened species.

Fringillidae is the family which includes finches. The only one Fringillidae species reported from the WG is *Carpodacus erythrinus*. It is a least concern species commonly known as common rosefinch and it is seen in Maharashtra, Karnataka, Kerala, and Tamilnadu regions of WG (Fig. 6.5.14).

Hirundinidae are the family of swallows and martins. WG has10 Hirundinidae species, it includes *Delichon urbica, Hirundo concolor, H. daurica, H. domicola, H. fluvicola, H. rupestris, H. rustica, H. smithii, H. tahitica* and *Riparia chinensis*. These species show distribution across the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu and all these species are categorized as least concern (Fig. 6.5.15). As per the literatures, *Delichon urbica* reported from the WG region of Tamilnadu (Johnsingh, 2001). Balakrishnan (2010) reported *Hirundo domicola* from the WG region of Kerala and *Riparia chinensis* is from Maharashtra (Tuljapurkar et al, 2013).

Jacanidae is the avian family which contains jacanas. *Hydrophasianus chirurgus* and *Metopidius indicus* are the two Jacanidae species present in WG, across the regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.15). As per the literatures, *Hydrophasianus chirurgus* shows higher distribution in Maharashtra regions. IUCN red data list listed these species in the least concern category.

Hemiprocnidae are the family of Treeswifts. *Hemiprocne coronata* is the Hemiprocnidae species reported from the WG region of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.15). It is commonly known as Crested Treeswift and categorized under the least concern group.

Laniidae is the family of carnivorous passerine birds commonly known as shrikes. *Lanius cristatus, L. isabellinus, L. meridionalis, L. schach, L. schach erythronotus* and *L. vittatus* are the Laniidae species present across the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.16). As per the review, *Lanius cristatus* and *Lanius schach* are the widely distributed species in WG region. *Lanius schach erythronotus* commonly known as Rufous-backed Long-tailed Shrike is reported from the Maharashtra region of WG (Kasambe & Khan, 2015).

Laridae family comes under the order Charadriiformes and it includes Gulls and Terns. There are 11 species from Laridae family were reported from the WG region. *Chlidonias hybrida, Gelochelidon nilotica, Larus brunnicephalus, Larus heuglini, Onychoprion anaethetus, Sterna aurantia, Sterna dougallii, Sterna hirundo, Thalasseus bengalensis, Thalasseus bergii* and *Xema sabini* are the species which has distributed across the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.16). As per the literatures reviewed, *Gelochelidon nilotica* and *Larus brunnicephalus* are reported from Maharashtra region of WG (Tuljapurkar et al, 2013). Majority of the Laridae species such as *Larus heuglini, Sterna dougallii, Thalasseus bengalensis, Thalasseus bergii, Xema sabini* and *Onychoprion anaethetus* shows higher distribution in Karnataka region.

Glareolidae is the family of water birds. *Cursorius coromandelicus* is the only Glareolidae species commonly known as Indian Courser present in the WG region of Maharashtra (Fig. 6.5.16).

Leiothrichidae is the avian family consists of old world passerine birds. It commonly includes Babblers and laughing thrushes. WG has 12 species from the family Leiothrichidae, it includes *Garrulax cachinnans, G. delesserti, G. jerdoni, G. jerdoni fairbanki, Trochalopteron fairbanki, Turdoides affinis, T. caudata, T. malcolmi, T. striatus, T. subrufa, T. subrufus hyperythrus* and *T. subrufus subrufus.* These species show distribution across the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.17). The species *Garrulax cachinnans, G. delesserti, G. jerdoni fairbanki, Trochalopteron fairbanki, Turdoides subrufa, Turdoides subrufus hyperythrus* and *Turdoides subrufus subrufus* are endemic to WG. As per the review, many of the Leiothrichidae species such as *Garrulax cachinnans, Garrulax jerdoni, Garrulax jerdoni fairbanki* and *Turdoides subrufus hyperythrus* show higher distribution in southern WG. *Turdoides malcolmi* is reported from the WG region of Maharashtra (Tuljapurkar et al, 2013). According to IUCN conservation status, *Garrulax jerdoni fairbanki* and *Trochalopteron fairbanki* are categorized as near threatened species.

Locustellidae is an avian family consists of small insectivorous songbirds. *Chaetornis striata, Locustella naevia* and *Schoenicola platyura* are the species which has distributed across the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.17). As per the review, *Chaetornis striata* is reported from the Tamilnadu regions of WG (Kanagavel et al, 2014). IUCN red data list grouped the species *Chaetornis striata* and *Schoenicola platyura* as vulnerable species. *Schoenicola platyura* is the species which is endemic to WG.

Irenidae is the family of small passerine birds. *Irena puella* (Asian fairy bluebird) is the Irenidae species present in the WG. It is a least concern species and has distributed across the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.17).

Megalaimidae is the avian family consists of Asian barbets. Megalaima is the only genera of the family Megalaimidae present in the WG and it consists of 6 species, *Megalaima asiatica, M. haemacephala, M. malabarica, M. rubricapilla, M. viridis* and *M. zeylanica*. These species show distribution in the WG regions of Gujarat, Maharashtra, Karnataka, Kerala and Tamilnadu (Fig. 6.5.18). As per the literatures, *Megalaima asiatica* is reported from the WG of Maharashtra. *Megalaima haemacephala* and *Megalaima malabarica* are the endemic species present in WG.

Meropidae is the family of Bee-eaters. *Merops leschenaulti, M. orientalis, M. persicus, M. philippinus* and *Nyctyornis athertoni* are the Meropidae species present across the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.18). *Merops leschenaulti* and *Merops philippinus* are the widely distributed species. *Merops persicus* commonly known as Blue-cheeked Bee-eater is distributed in the WG of Maharashtra and Blue-beared Bee-eater (*Nyctyornis athertoni*) is highly distributed in Karnataka region.

Monarchidae is the avian family of passerine birds which commonly includes paradise flycatchers, larks, and shrikebills. *Hypothymis azurea* and *Terpsiphone paradisi* are the two Monarchidae species present in WG. These species have distributed across the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.18). These species are commonly known as Black-naped Monarch and Asian paradise flycatcher and are categorized as least concern species.

Motacillidae is the family of small passerine birds with long tails. *Anthus campestris, A. hodgsoni, A. nilghiriensis, A. rufulus, A. similis, A. trivalis, Dendronanthus indicus, Dendronanthus indicus, Motacilla alba dukhunrnsis, M. caspica, M. cinerea, M. citreola, M. flava, M. flava melanogrisea* and *M. maderaspatensis* are the members of Motacillidae family present in the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.19). As per the review, *Anthus campestris, Motacilla alba dukhunrnsis, Motacilla flava melanogrisea* and *Motacilla citreola* are reported from the Maharashtra region. *Anthus trivalis* shows higher distribution in Karnataka and Maharashtra and *Anthus similis* shows higher distribution in Karnataka and Kerala regions of WG. Radhakrishnan (2002) reported *Motacilla caspica* from

the Idukki regions of Kerala. *Anthus nilghiriensis* commonly known as Nilgiri pipit is an endemic species present in WG and it is classified as near threatened species by IUCN.

Gruidae is the family birds with long legs and long necks, commonly known as cranes. This family comes under the order Gruiformes. *Grus virgo* is the only Gruidae species reported from the WG. This least concern species is commonly known as Demoiselle crane and shows higher distribution across the WG region of Maharashtra (Fig. 6.5.19).

Muscicapidae is one of the largest and diverse families present in WG. There are 36 Muscicapidae species were reported from the entire WG region (Fig. 6.5.20). As per the review, *Brachypteryx major albiventris* and *Brachypteryx major major*, commonly known as White-bellied Shortwing shows higher distribution in southern WG. *Eumyias sordida* is highly distributed in the WG region of Karnataka (Barve & Warrier, 2013). *Ficedula albicilla*, commonly known as Red-throated flycatcher and *Ficedula superciliaris* (White-browed Blue Flycatcher) are reported from Maharashtra region (Kasambe & Khan, 2015). Ramchandra 2013, reported *Oenanthe oenanthe* from WG region of Maharashtra. *Phoenicurus fuliginosus* is the only Muscicapidae species reported from WG region of Goa (Vannur & Hiragond, 2016). Radhakrishnan (2002) reported *Turdus merula bourdilloni* from the Kerala region of WG and *Turdus merula simillimus* is reported from Karnataka region (Aravind et al, 2001). *Brachypteryx major albiventris, Brachypteryx major major, Cyornis pallipes, Eumyias albicaudatus* and *Ficedula nigrorufa* are the Muscicapidae species which are endemic to WG region. According to IUCN conservation status, *Brachypteryx major albiventris, Brachypteryx major major* and *Ficedula subrubra* are categorized as vulnerable species and *Eumyias albicaudatus, Eumyias sordida,* and *Ficedula nigrorufa* as near threatened species.

Nectariniidae is family of passerine birds includes sunbirds and spiderhunters. WG has 8 species of Nectariniidae family, they include *Aethopyga siparaja, Aethopyga vigorsii, Arachnothera longirostra, Cinnyris asiaticus, Cinnyris lotenius, Leptocoma minima, Leptocoma zeylonica* and *Nectarinia asiatica*. These species are distributed across Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu regions of WG (Fig. 6.5.21). As per the review, *Aethopyga siparaja* shows higher distribution in northern WG. *Aethopyga vigorsii* and *Leptocoma minima* are the endemic species present in WG.

Oriolidae is the family of passerine birds. Oriolus is the only genera present in WG. *Oriolus chinensis, O. kundoo, O. oriolus, O. tenuirostris* and *O. xanthornus* are the species present the WG of Maharashtra, Karnataka, Kerala, and Tamilnadu regions of WG (Fig. 6.5.21). As per

the review, *Oriolus oriolus* shows higher distribution towards the Central and Southern WG. Aravind et al (2001) reported *Oriolus tenuirostris*, commonly known as Slender-billed oriole from the WG region of Karnataka.

Otididae is the avian family which includes Bustards. *Ardeotis nigriceps* and *Sypheotides indicus* are the two Otididae species present in WG. These species show distribution in Maharashtra and Karnataka regions of WG (Fig. 6.5.21). Tuljapurkar et al (2013) reported a critically endangered species, *Ardeotis nigriceps* from the WG region of Maharashtra. *Sypheotides indicus* has distributes across the WG region of Karnataka. It is categorized as an endangered species.

Paridae is the avian family comes under the order Passeriformes and it generally includes Tits. *Parus aplonotus, P. cinereus, P. major, P. nuchalis* and *P. xanthogenys* are the Paridae members present in WG. These species are distributed in the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu regions of WG (Fig. 6.5.22). The literatures show that, *Parus aplonotus* and *Parus cinereus* are highly distributed in WG region of Maharashtra. *Parus nuchalis* is a vulnerable species which is highly distributed in the Karnataka region of WG.

Passeridae family includes sparrows. WG has 2 types of Passeridae species, *Passer domesticus* and *Petronia xanthocollis*. These are least concern species and has distributed across Maharashtra, Karnataka, Kerala, and Tamilnadu regions of WG (Fig. 6.5.22).

Pandionidae is the family of Osprey. *Pandion haliaetus* is the species reported from the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.22). It is a least concern species observed near shallow waters, suburban and urban environments.

Pelecanidae is the family of large water birds commonly known as Pelicans. *Pelecanus philippensis* is the Spot-billed pelican or Grey pelican reported from the Tamilnadu regions of WG (Fig. 6.5.22). According to IUCN status, it is categorized as near threatened species.

Pellorneidae is the family of ground babblers. *Alcippe poioicephala, Graminicola bengalensis* and *Pellorneum ruficeps* are the Pellorneidae species present in the WG. These species have distributed across the regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.23). The review shows that *Graminicola bengalensis* is reported from Maharashtra region of WG (Ramachandra, 2013). All the species are categorized as least concern.

Phalacrocoracidae is the family of aquatic birds commonly known as cormorants and shags. *Microcarbo niger, Myophonus caeruleus, Phalacrocorax carbo* and *Phalacrocorax fuscicollis* are the species present in the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.23). As per the review, *Microcarbo niger, Myophonus caeruleus* and *Phalacrocorax carbo* shows the wide distribution in the WG. *Myophonus caeruleus* (whistling thrush) *and Phalacrocorax fuscicollis* (great cormorant) show higher distribution in WG region of Karnataka.

Phylloscopidae is a new avian family consists of insectivorous birds. This family contains two genera, Seicercus and Phylloscopus. WG region has only one genus, Phylloscopus and the species includes are *Phylloscopus griseolus, P. affinis, P. collybita, P. collybita tristis, P. magnirostris, P. nitidus, P. occipitalis, P. trochiloides* and *P. tytleri*. These species show distribution in the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.23). As per review, *Phylloscopus griseolus* and *Phylloscopus collybita* show higher distribution in WG regions Maharashtra and Karnataka. *Phylloscopus humei* (Hume's Leaf-warbler), *Phylloscopus nitidus* (bright-green warbler) are reported from Maharashtra region. *Phylloscopus tytleri* is a near threatened species which shows higher distribution towards southern WG.

Phasianidae is the avian family of heavy ground-living birds. It generally includes junglefowl, pheasants etc. WG has 14 species of Phasianidae family; they are *Coturnix chinensis, C. coromandelica, C. coturnix, Francolinus pictus, Francolinus pondicerianus, Galloperdix lunulata, Galloperdix spadicea, Gallus gallus domesticus, Gallus sonneratii, Pavo cristatus, Pavo muticus, Perdicula argoondah, Perdicula asiatica* and *Perdicula erythrorhyncha*. These species are distributed across Gujarat, Maharashtra, Karnataka, Kerala and Tamilnadu regions of WG (Fig. 6.5.24). As per the review, *Coturnix chinensis, Coturnix coromandelica, Francolinus pictus* and *Perdicula argoondah* are the species which shows higher distribution in Maharashtra region, while *Gallu gallus domesticus* shows higher distribution in southern WG. *Pavo muticus* (Ramchandra, 2013) is an endangered species which is reported from the WG region of Maharashtra.

Phoenicopteridae is a wading bird family which includes flamingos. *Phoenicopterus roseus* is the species present in the WG region of Maharashtra (Fig. 6.5.24). It is a least concern species commonly known as Greater flamingo.

Pittadae is one of the smallest avian families present in WG. *Pitta brachyura* commonly known as Indian Pitta is reported from the WG regions of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.24). According to IUCN red data list, *Pitta brachyura* is categorized as a least concern species.

Picidae is the family of woodpeckers. WG has 15 species of the family Picidae they are *Campephilus imperialis, Chrysocolaptes festivus, Chrysocolaptes guttacristatus, Chrysocolaptes lucidus, Dendrocopos maharattensis, Dendrocopos nanus, Dinopium benghalense, Dinopium javanense, Dryocopus javensis, Hemicircus canente, Jynx torquilla, Micropternus brachyurus, Picumnus innominatus, Picus chlorolophus* and *Picus xanthopygaeus*. These species show distribution in the areas of Gujarat, Maharashtra, Karnataka, Kerala and Tamilnadu (Fig. 6.5.25). As per the literatures, *Campephilus imperialis* shows higher distribution Kerala region of WG. *Chrysocolaptes festivus* and *Dendrocopos maharattensis* show higher distribution in Maharashtra region. According to IUCN conservation status, *Campephilus imperialis*, commonly known as Imperial woodpecker is categorized as critically endangered species. The Picidae species, *Picus xanthopygaeus, Picumnus innominatus, Dryocopus javensis* and *Dendrocopos nanus* are legally protected by including in Schedule IV of Indian Wildlife Protection Act, 1972.

Ploceidae is an avian family comes under the order Passeriformes. *Ploceus benghalensis, P.megarhynchus,* and *P. philippinus* are the three Ploceidae species present in WG. Distribution of these species has been reported from Maharashtra, Karnataka, and Tamilnadu (Fig. 6.5.25). *Ploceus megarhynchus* and *Ploceus benghalensis* are reported from the WG of Maharashtra (Ramchandra, 2013). *Ploceus megarhynchus* is commonly known as Himalayan Baya Weaver or yellow weaver and it is considered as a vulnerable species.

Podargidae is the family of nocturnal birds, commonly known as frogmouths. *Batrachostomus moniliger* is the only Podargidae species reported in WG. it is distributed across the regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.25). This species is categorized as least concern and it is also known as Sri Lanka Frogmouth or Ceylon frogmouth.

Psittacidae is the avian family which includes parakeets. *Loriculus vernalis, Psittacula columboides, P. cyanocephala, P. eupatria* and *P. krameri* are the species present in the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.26). According to IUCN conservation status, *Psittacula eupatria* is considered as near threatened species and the

reviews show that it is highly distributed in Karnataka and Maharashtra region WG. *Psittacula columboides* is the endemic species present in WG.

Podicipedidae is the family comes under the order Podicipediformes and its members are generally known as grebes. *Tachybaptus ruficollis* is the only Podicipedidae species present in the WG region. This species has distributed across the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.26). *Tachybaptus ruficollis* is a least concern species commonly known as little grebe and seen in small and shallow wetlands.

Pteroclidae is an avian family comes under the order Pteroclidiformes and its members are commonly called as Sandgrouse. *Pterocles exustus* is the only species present in WG region of Maharashtra (Fig. 6.5.26). It is commonly known as Indian Sandgrouse or Chestnut-bellied Sandgrouse. These least concern species are generally seen in barren plains, dry stubbles, and sun-baked ploughed lands.

Rallidae is a large family of ground-living birds. *Amaurornis phoenicura, Fulica atra, Gallicrex cinerea, Gallinula chloropus, Porphyrio porphyrio, Rallina euryzonoides* and *Rallus striatus* are the Rallidae species reported from the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.26).

Pycnonotidae is the family of Bulbuls. WG has 13 species of bulbuls across the regions of Maharashtra, Karnataka, Kerala, and Tamilnadu. The species are, *Acritillas indica, Alophoixus flaveolus, Hypsipetes ganeesa, Hypsipetes leucocephalus, Hypsipetes madagascariensis, Pycnonotus cafer, Pycnonotus gularis, Pycnonotus jocosus, P. leucotis, P. luteolus, P. melanicterus, P. priocephalus* and *P. xantholaemus* (Fig. 6.5.27). As per the review, *Acritillas indica* is widely distributed in the WG region. *Alophoixus flaveolus,* White-browed Bulbul reported from the WG region of Karnataka (Barve & Warrier, 2013) and *Hypsipetes madagascariensis* is reported from Kerala region (Radhakrishnan, 2002). *Pycnonotus leucotis* is reported from the Maharashtra region of WG. *Pycnonotus priocephalus* and *Pycnonotus gularis* are endemic to WG. Some of the Pycnonotidae species, *Pycnonotus gularis, Pycnonotus leucotis* and *Pycnonotus luteolus* present in the WG are protected by Schedule IV of Indian Wildlife Protection Act, 1972. According to the IUCN status, *Pycnonotus xantholaemus*is classified as vulnerable species and *Pycnonotus priocephalus* is categorized as near threatened species.

Recurvirostridae is the bird family comes under the order Charadriiformes. *Himantopus himantopus* is the only Recurvirostridae species present in the WG region. It is commonly known as Black-winged stilt and has distributed in the WG regions of Maharashtra, Karnataka, and Tamilnadu (Fig. 6.5.27). It prefers shores of large inland water bodies and estuarine or coastal habitats and it is also categorized as least concern species.

Rhipiduridae is the avian family that includes fantails. Rhipidura is the only one genus of this family present in WG region and the species are *Rhipidura albicollis, R. albogularis, R. aureola*and *R. hypoxantha*. These species are distributed across the WG region of Gujarat, Maharashtra, Karnataka, and Tamilnadu (Fig. 6.5.27). The literature shows that *Rhipidura albogularis* (White-spotted fantail) and *Rhipidura hypoxantha* (White-throated fantail or Yellow-bellied fantail) are reported from the WG region of Maharashtra (Kasambe & Khan, 2015; Ramchandra, 2013).

Scolopacidae is one of largest avian families present in the WG. *Actitis hypoleucos, Calidris ferruginea, C. minuta, C. pugnax, Gallinago gallinago, G. nemoricola, G. sp, G. stenura, Limosa lapponica, Limosa limosa, Scolopacidae rusticola, Tringa erythropus, T. glareola, T. nebularia, T. ochropus, T. stagnatilis, T. totanus* and *Xenus cinereus* are Scolopacidae species present across the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.28). As per the review, *Calidris ferruginea* and *Xenus cinereus* are highly distributed in Karnataka region (Sowmya &Jayappa, 2016). *Calidris minuta, Calidris pugnax, Tringa glareola, Tringa stagnatilis,* and *Limosa lapponica* show higher distribution in Maharashtra region. *Gallinago nemoricola* is reported from Kerala region of WG (Radhakrishnan, 2002). Aravind et al (2001) *Gallinago stenura* and *Scolopacidae rusticola* are reported from Karnataka. According to IUCN Red data list, *Gallinago nemoricola* is grouped as vulnerable species and *Calidris ferruginea, Limosa lapponica* and *Limosa limosa* are categorized as near threatened species.

Rostratulidae is the family of wader birds commonly painted-snipes. *Rostratula benghalensis* is the only Rostratulidae species present WG. It is reported from the Maharashtra region of WG (Fig. 6.5.28). *Rostratula benghalensis* is commonly known as greater snipe and it is sighted in pond sides, shrubby vegetations and muddy patches.

Strigidae is the family of true owls. *Asio flammeus, Athene brama, Bubo bengalensis, Bubo bubo, Bubo coromandus, Bubo nipalensis, Glaucidium radiatum, Heteroglaux blewitti, Ketupa zeylonensis, Ninox obscura, Ninox scutulata, Otus bakkamoena, Otus lettia, Otus sunia, Strix leptogrammica* and *Strix ocellata* are the Strigidae species present across the WG region of

Gujarat, Maharashtra, Karnataka, Kerala and Tamilnadu (Fig. 6.5.29). As per the review, *Asio flammeus* and *Bubo bengalensis* show higher distribution in WG region of Maharashtra, *Heteroglaux blewitti* shows higher distribution towards northern WG. Sidhu et al (2010) reported *Ninox obscura* commonly known as Hume's hawk owl or Hume's bookbook from WG region of Kerala. IUCN conservation status categorized *Heteroglaux blewitti* as critically endangered species and all other Strigidae species were categorized as least concern.

Sittidae family includes small passerine birds commonly known as Nuthatch. Sitta is the genus present in WG region and species are *Sitta castanea* and *Sitta frontalis*. They are commonly known as Chestnut-bellied nuthatch and Velvet-fronted nuthatch. These least concern species are distributed in the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.29).

Sturnidae is the family of small to medium-sized passerine birds consisting of the starlings and mynas. WG has 10 species of Sturnidae family; they are *Acridotheres fuscus, A. ginginianus, A. tristis, Gracula indica, Gracula religiosa, Gracupica contra, Sturnia blythii, Sturnia malabarica, Sturnia pagodarum* and *Sturnus roseus*. These species are distributed in the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.30). *Acridotheres fuscus, Acridotheres tristis* and *Sturnia malabarica* are highly distributed species. *Gracula indica* and *Graculareligiosa*, commonly known as Common hill Myna or Southern hill Myna shows higher distribution in Karnataka, Kerala, and Tamilnadu. *Acridotheres ginginianus* is highly distributed in Maharashtra and the species, *Gracupica contra* is reported from WG region of Maharashtra (Kasambe & Khan, 2015). Barve and Warrier (2013), reported an endemic species, *Sturnia blythii* from the WG region of Karnataka.

Stercorariidae is the family of seabirds, it mainly includes Skuas. *Stercorarius parasiticus* and *Stercorarius pomarinus* are the two Stercorariidae members present in WG. These species has mainly distributed across the WG region of Karnataka (Fig. 6.5.30). *Stercorarius parasiticus* and *Stercorarius pomarinus* are commonly known as Arctic Skua and Pomarine Skua respectively. These species are categorized as least concern species.

Stenostiridae is a family of small passerine birds such as flycatchers. *Culicicapa ceylonensis*, commonly known as Grey-headed flycatcher and it has distributed across the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.30).

Sylviidae members are known as old world Warblers. *Chrysomma sinense, Sylvia curruca, Sylvia curruca halimodendri* and *Sylvia hortensis* are the Sylviidae species present in WG regions Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.31). *Sylvia curruca halimodendri* is reported from the WG region of Maharashtra (Tuljapurkar et al, 2013).

Tephrodornithidae is the avian family comes under the order Passeriformes. WG has 4 species of Tephrodornithidae family; they are *Hemipus picatus, Tephrodornis gularis, T. pondicerianus* and *T. sylvicola*. These species are distributed across Gujarat, Maharashtra, Karnataka, Kerala and Tamilnadu region of WG (Fig. 6.5.31). *Hemipus picatus* is the widely distributed species. *Tephrodornis gularis* and *Tephrodornis sylvicola* show higher distribution in WG region of Karnataka, Kerala, and Tamilnadu. *Tephrodornis sylvicola* commonly known as Malabar woodshrike is an endemic species present in WG.

Threskiornithidae is the family which includes wading birds. *Platalea leucorodia, Plegadis falcinellus, Pseudibis papillosa* and *Threskiornis melanocephalus* are the Threskiornithidae species present in WG. These species are distributed across the region of Maharashtra, Karnataka, and Tamilnadu (Fig. 6.5.31). *Threskiornis melanocephalus* is near threatened species widely found in the Maharashtra, Karnataka and Kerala regions of WG.

Timaliidae is the avian family which includes old world passerine birds. *Dumetia hyperythra, Macronous gularis, Pomatorhinus horsfieldii* and *Rhopocichla atriceps* are the 4 Timaliidae species present in the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.32). *Macronous gularis* commonly known as Yellow-breasted babbler is reported from the WG of Maharashtra (Ramchandra, 2013). All other Timaliidae species are widely distributed in the WG region.

Trogonidae is the family of the order Trogoniformes and it consists of Trogons. WG has two Trogonidae species, *Cypsiurus balasiensis* and *Harpactes fasciatus* commonly known as Asian palm swift and Malabar Trogon respectively. These are least concern species and shows distribution in WG regions of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.32).

Turdidae are the family of Thrushes. *Geokichla citrina, Geokichla wardii, Turdus merula, Turdus simillimus* and *Zoothera dauma* are the members of Turdidae family present in WG. The species are distributed across Maharashtra, Karnataka, Kerala, and Tamilnadu regions of WG (Fig. 6.5.32). As per the review, *Geokichla citrina* and *Turdus merula* are the highly

distributed species. *Turdus simillimus* shows higher distribution in WG region of Karnataka and Maharashtra. *Zoothera dauma* and *Geokichla wardii* are highly distributed in southern WG region.

Turnicidae is the avian family which includes Buttonquails. *Turnix suscitator*, *Turnix sylvaticus*, and *Turnix tanki* are the species present in WG region. Members of this family has distributed across the WG region of Maharashtra, Karnataka, and Tamilnadu (Fig. 6.5.32). All the species are categorized as least concern by IUCN red data list.

Tytonidae is the avian family which includes Barn owls and Bay owls. WG has 3 species from Tytonidae family, it includes *Phodilus badius*, *Tyto alba*, and *Tyto capensis*. This family has distributed across Maharashtra, Karnataka, Kerala and Tamilnadu regions of WG (Fig. 6.5.33). As per review, *Phodilus badius* and *Tyto capensis* show higher distribution in southern WG. *Tytoalba* commonly known as Barn owl is the highly distributed Tytonidae species.

Upupidae is the family of Hoopoes. *Upupa epops* is the only Upupidae species present in WG. It is generally known as Eurasian Hoopoe or Common Hoopoe and it has distributed across the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.33).

Zosteropidae is an avian family which includes the passerine birds commonly known as White-eyes. *Zosterops palpebrosus* (Oriental White-eye) is present in the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.33). It is a least concern species commonly seen in open landscapes and interior forests.

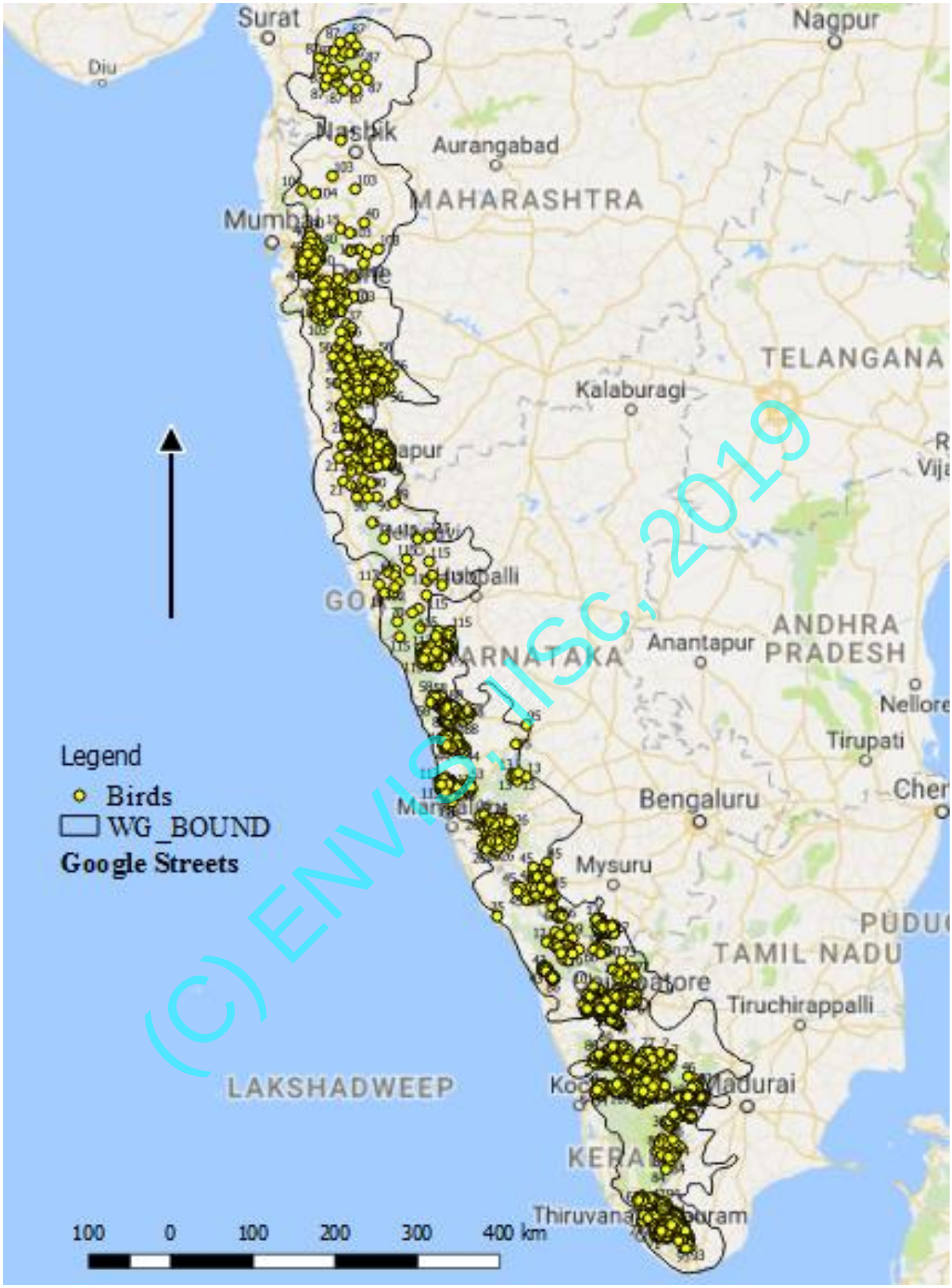


Fig. 6.5.1. Spatial distribution of Birds in the WG.

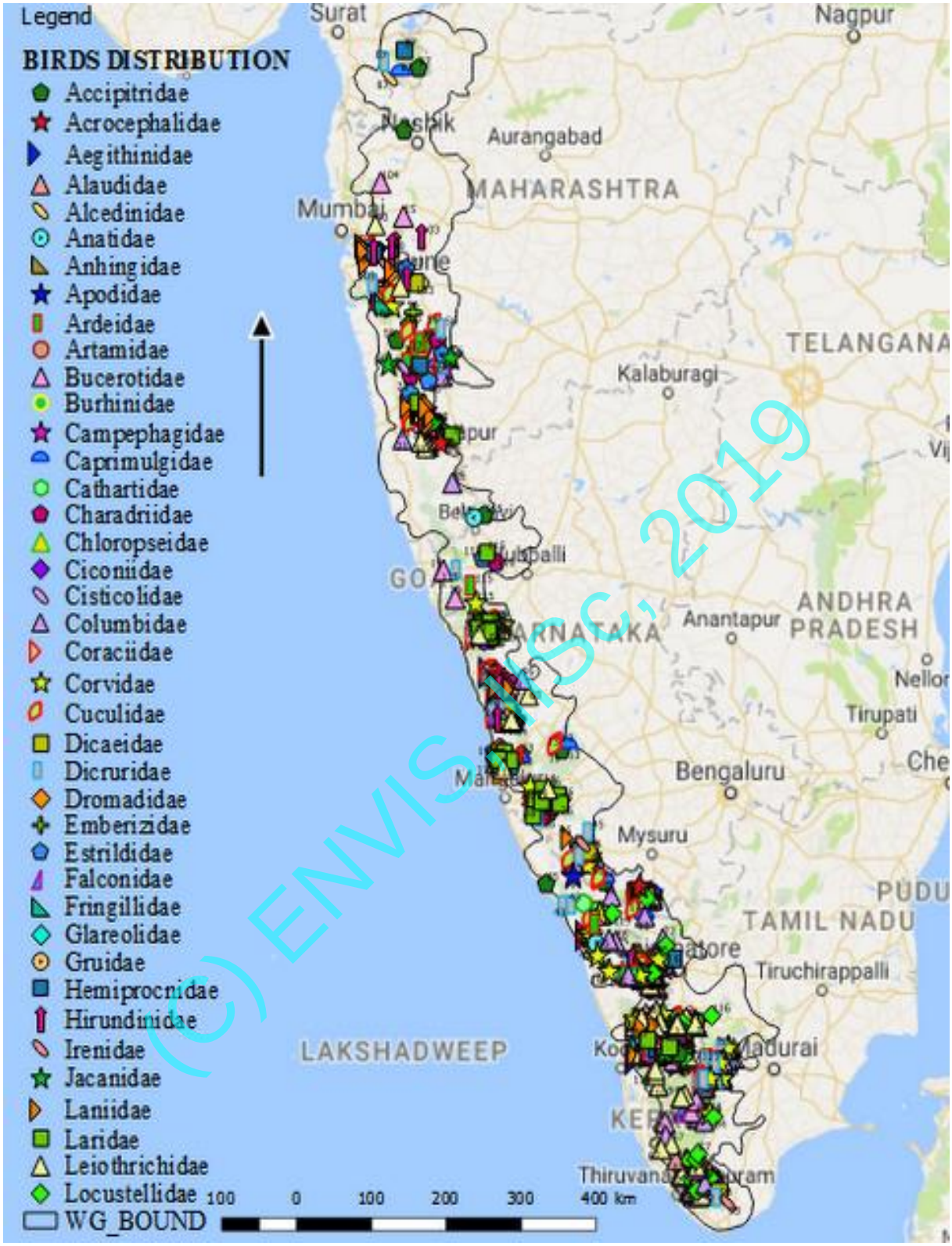


Fig. 6.5.2a. Spatial distribution of Bird families in WG.

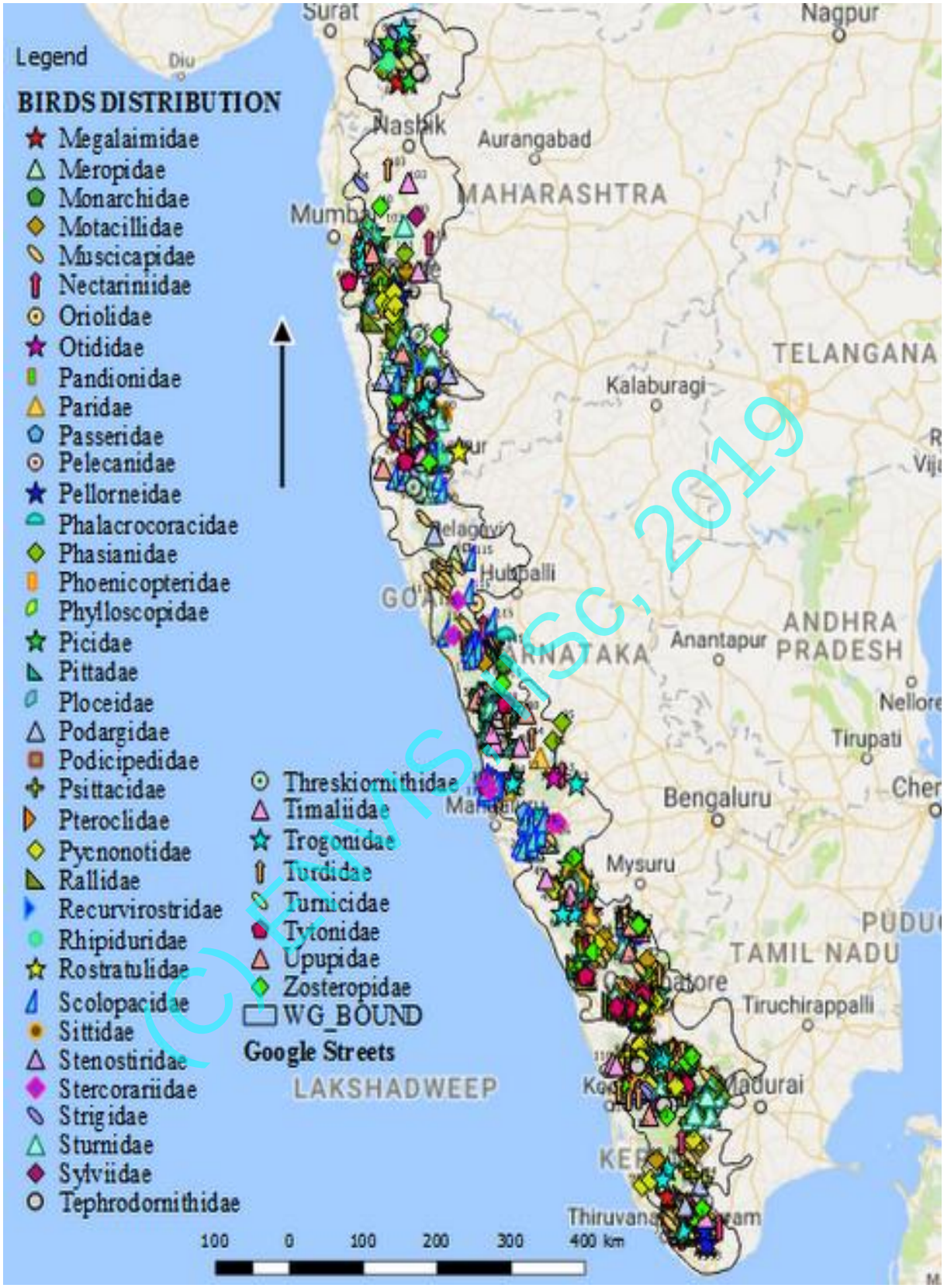


Fig. 6.5.2b. Spatial distribution of Bird families in WG.

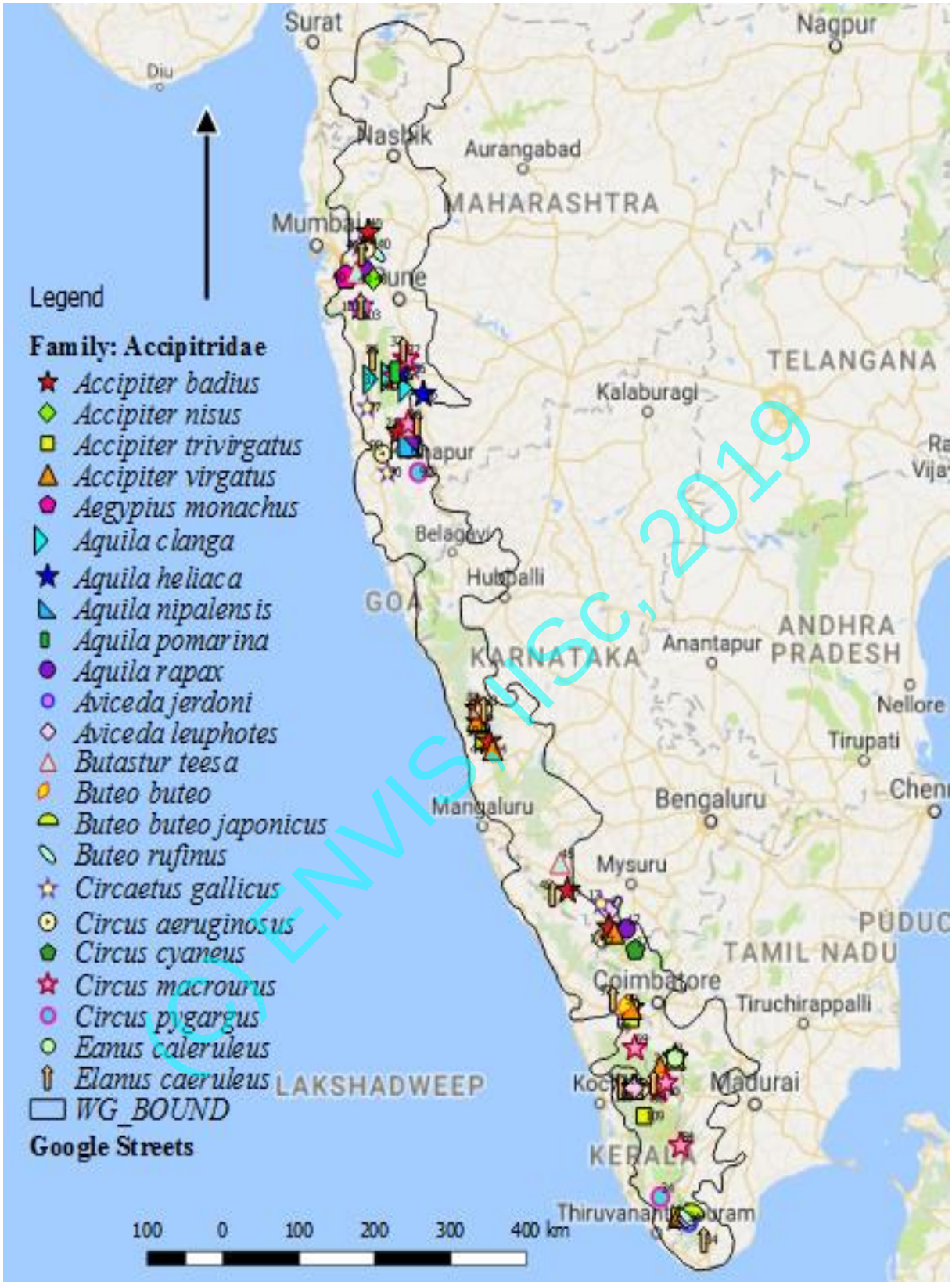


Fig. 6.5.3a. Spatial distribution of the Accipitridae family.

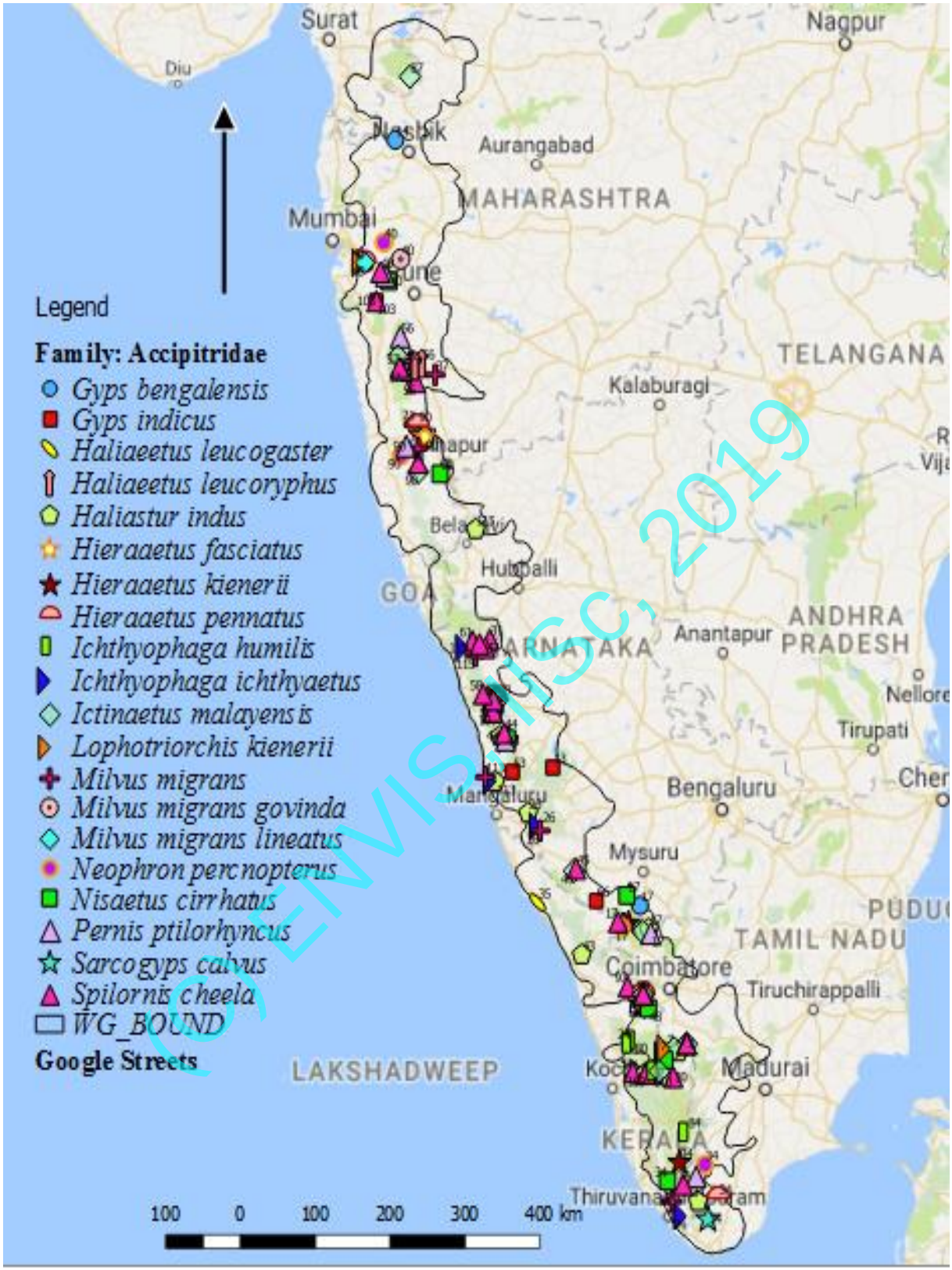


Fig. 6.5.3b. Spatial distribution of the Accipitridae family.

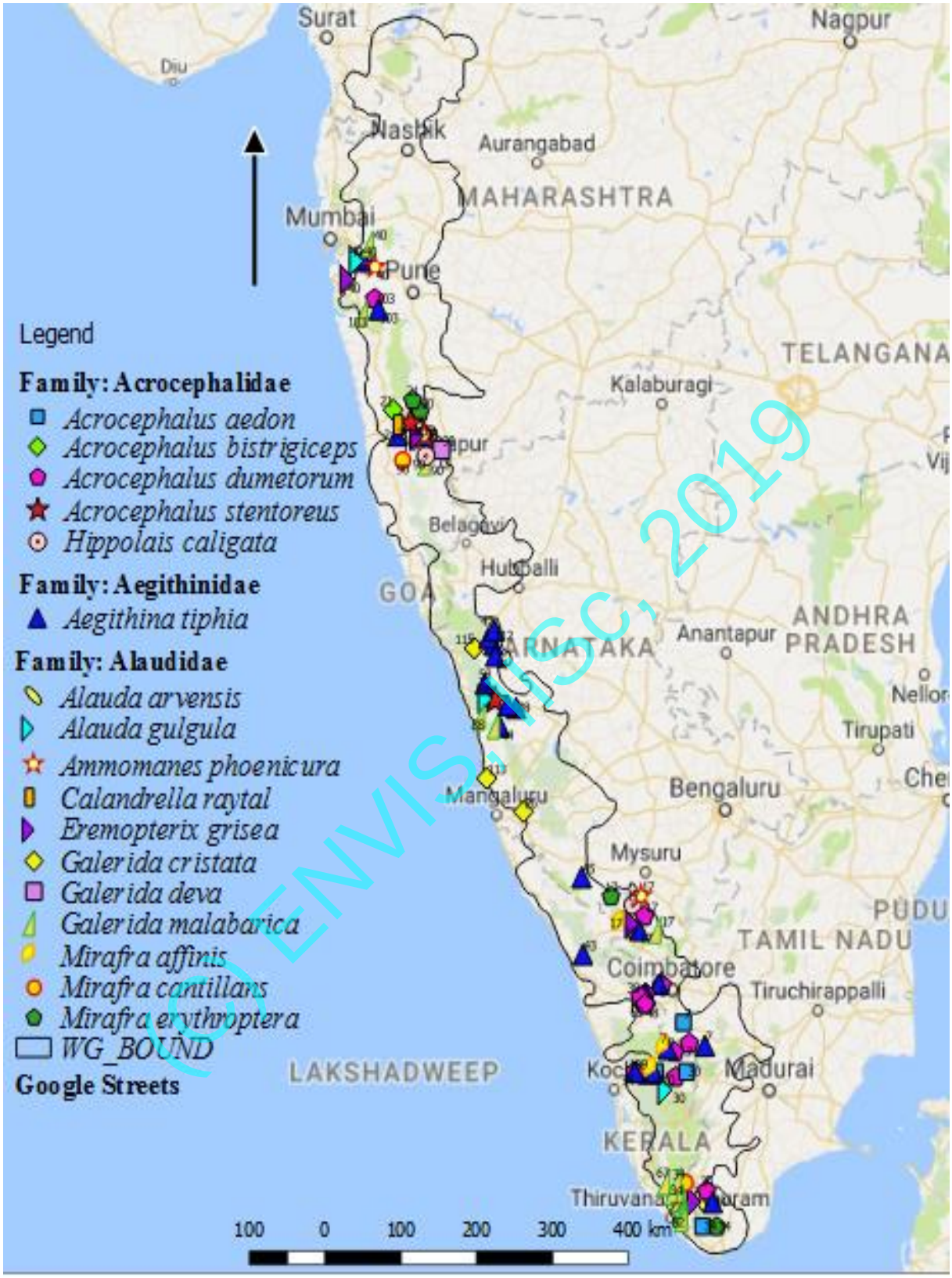


Fig. 6.5.4. Spatial distribution of the Acrocephalidae, Aegithinidae and Alaudidae families.

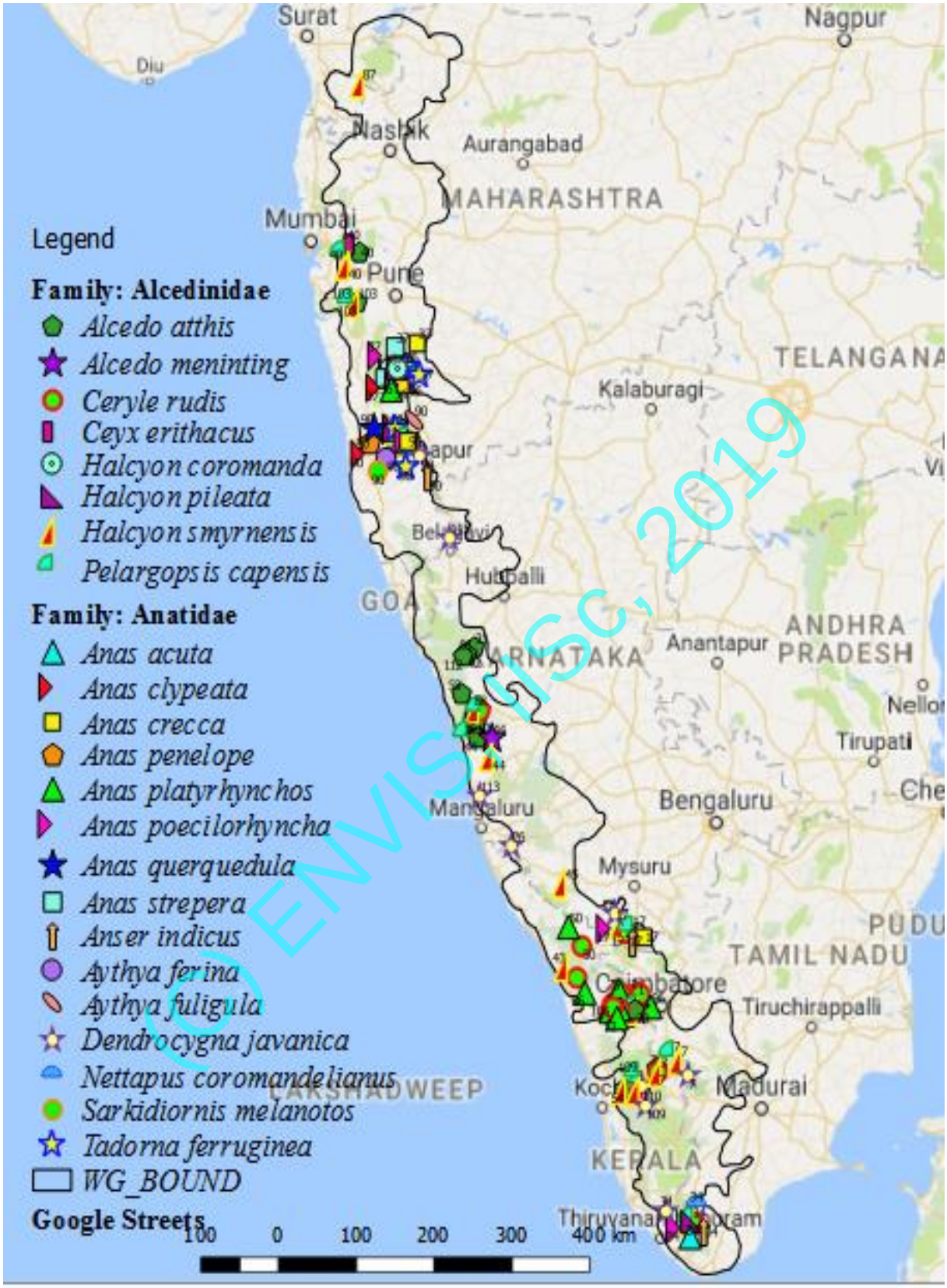


Fig. 6.5.5. Spatial distribution of the Alcedinidae and Anatidae families.

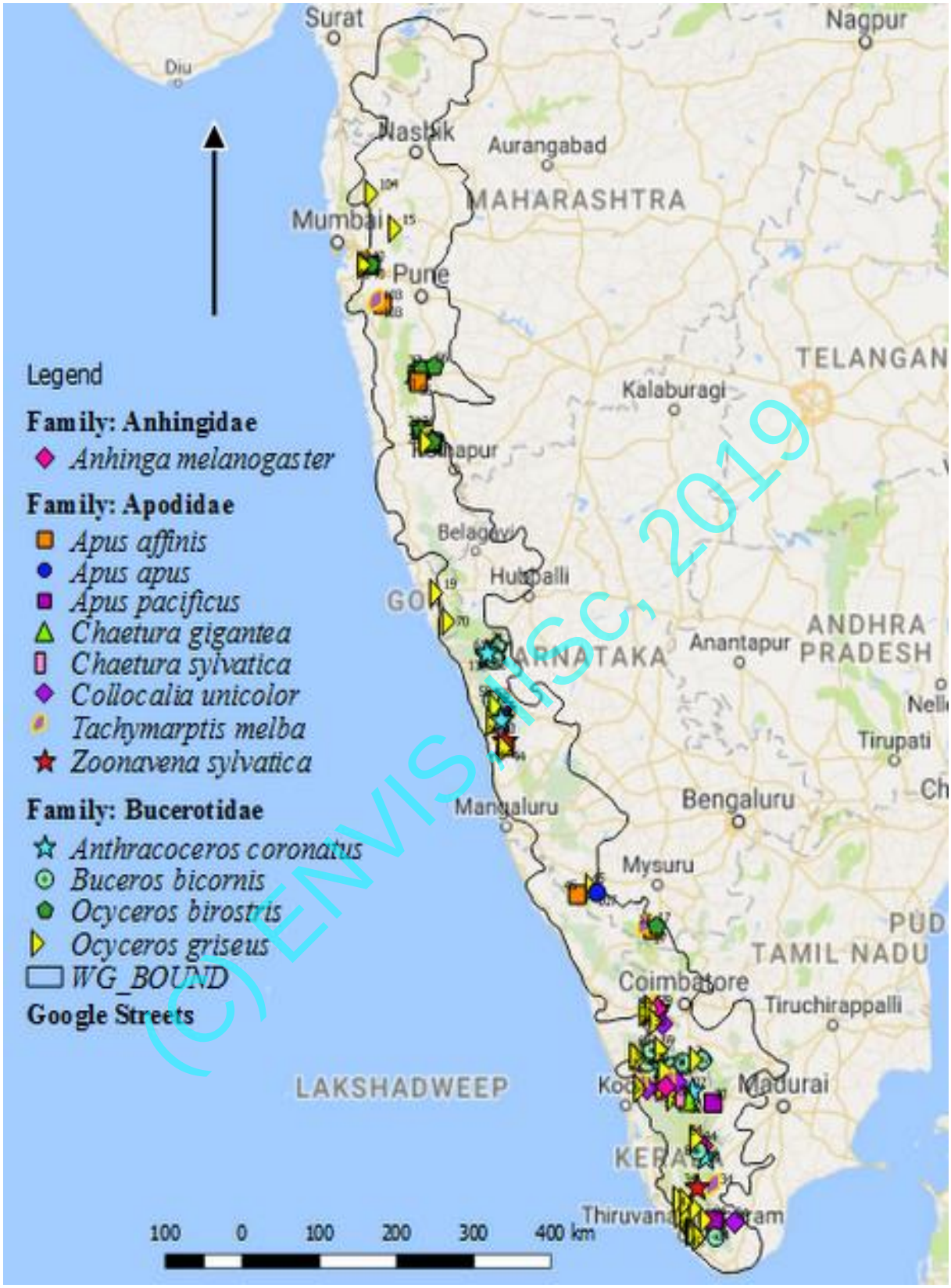


Fig. 6.5.6. Spatial distribution of the Anhingidae, Apodidae and Bucerotidae families.

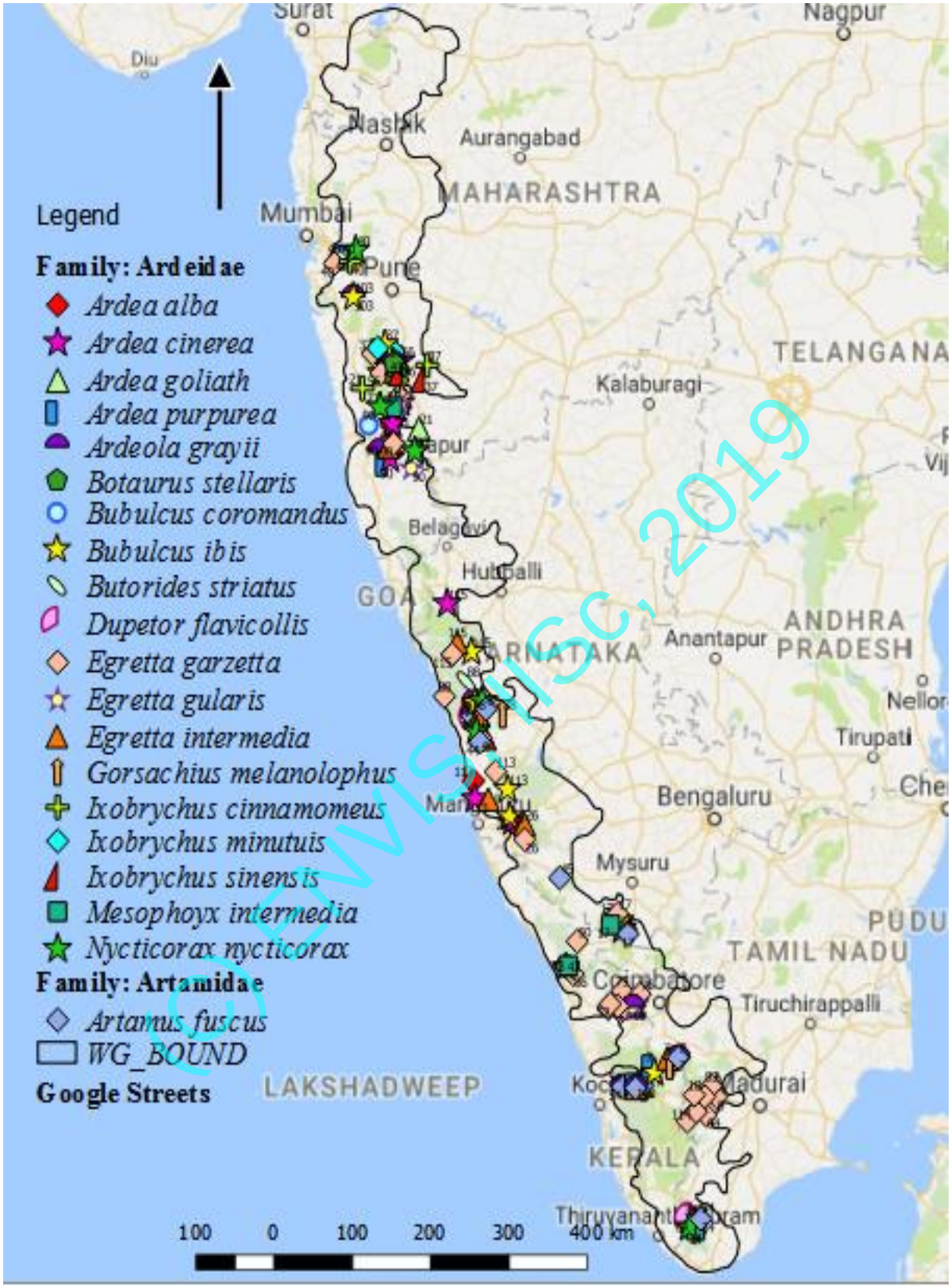


Fig. 6.5.7. Spatial distribution of the Ardeidae and Artdae families.

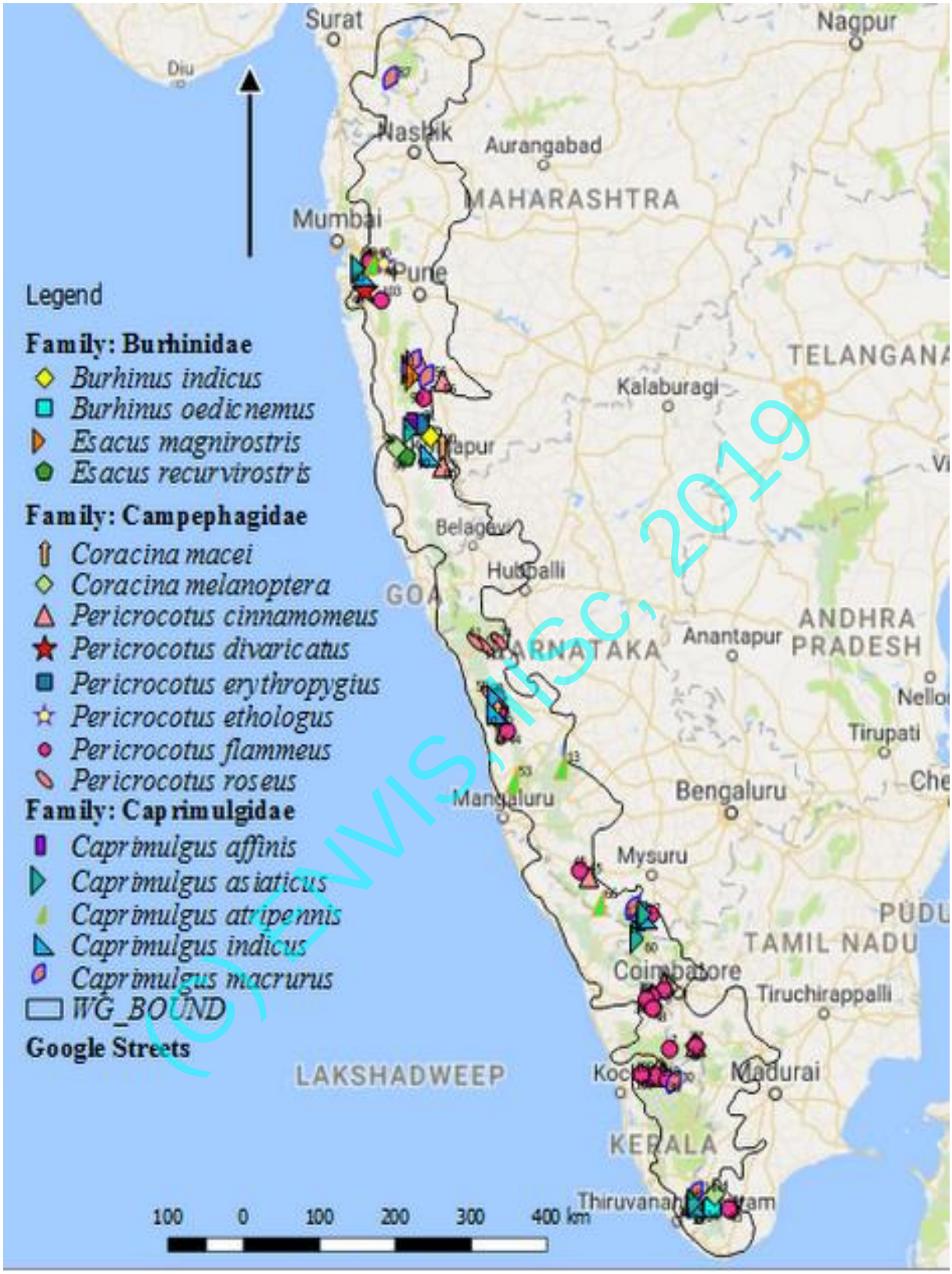


Fig. 6.5.8. Spatial distribution of the Burhinidae, Campephagidae and Caprimulgidae families.

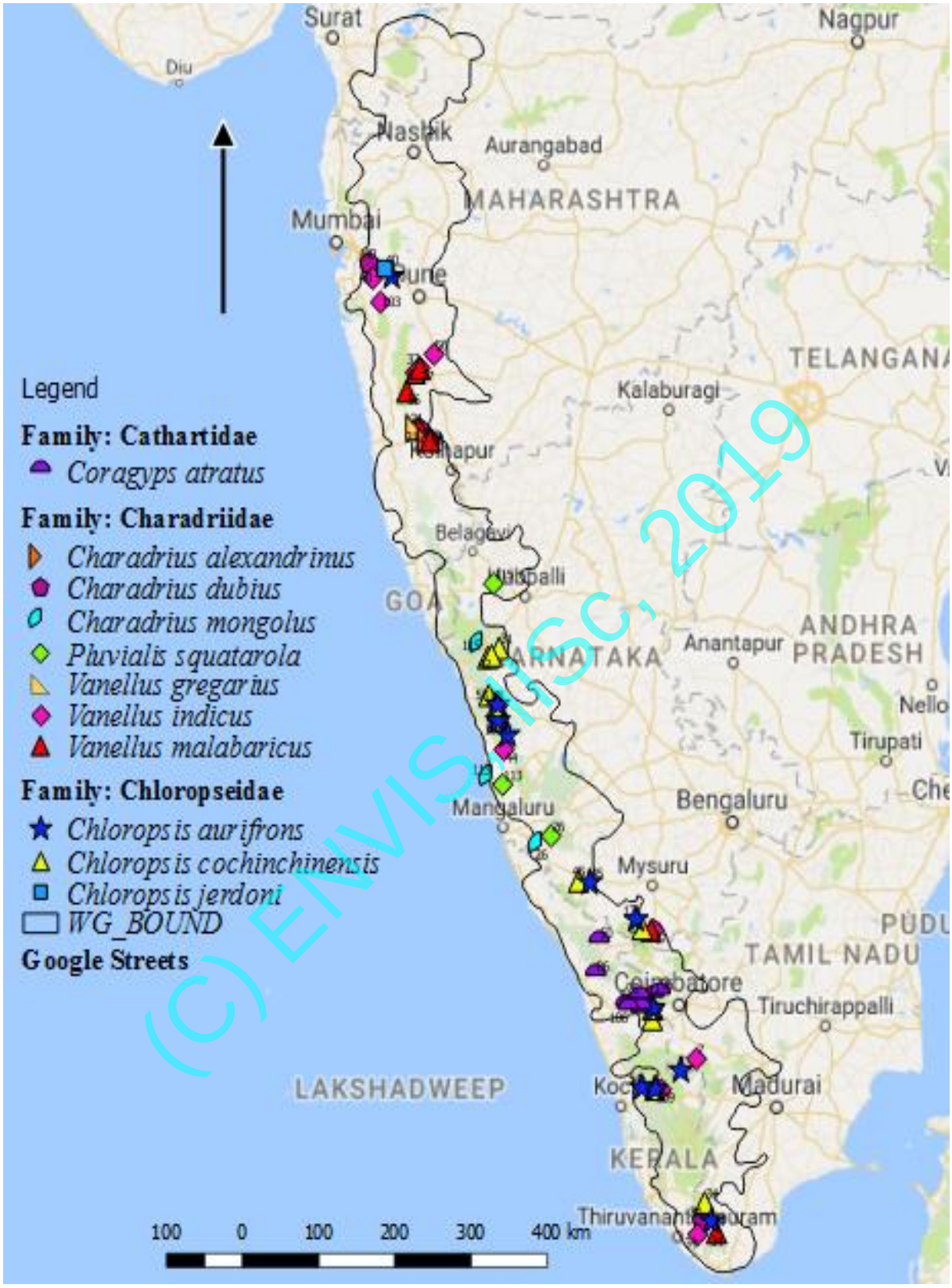


Fig. 6.5.9. Spatial distribution of the Cathartidae, Charadriidae and Chloropseidae families.

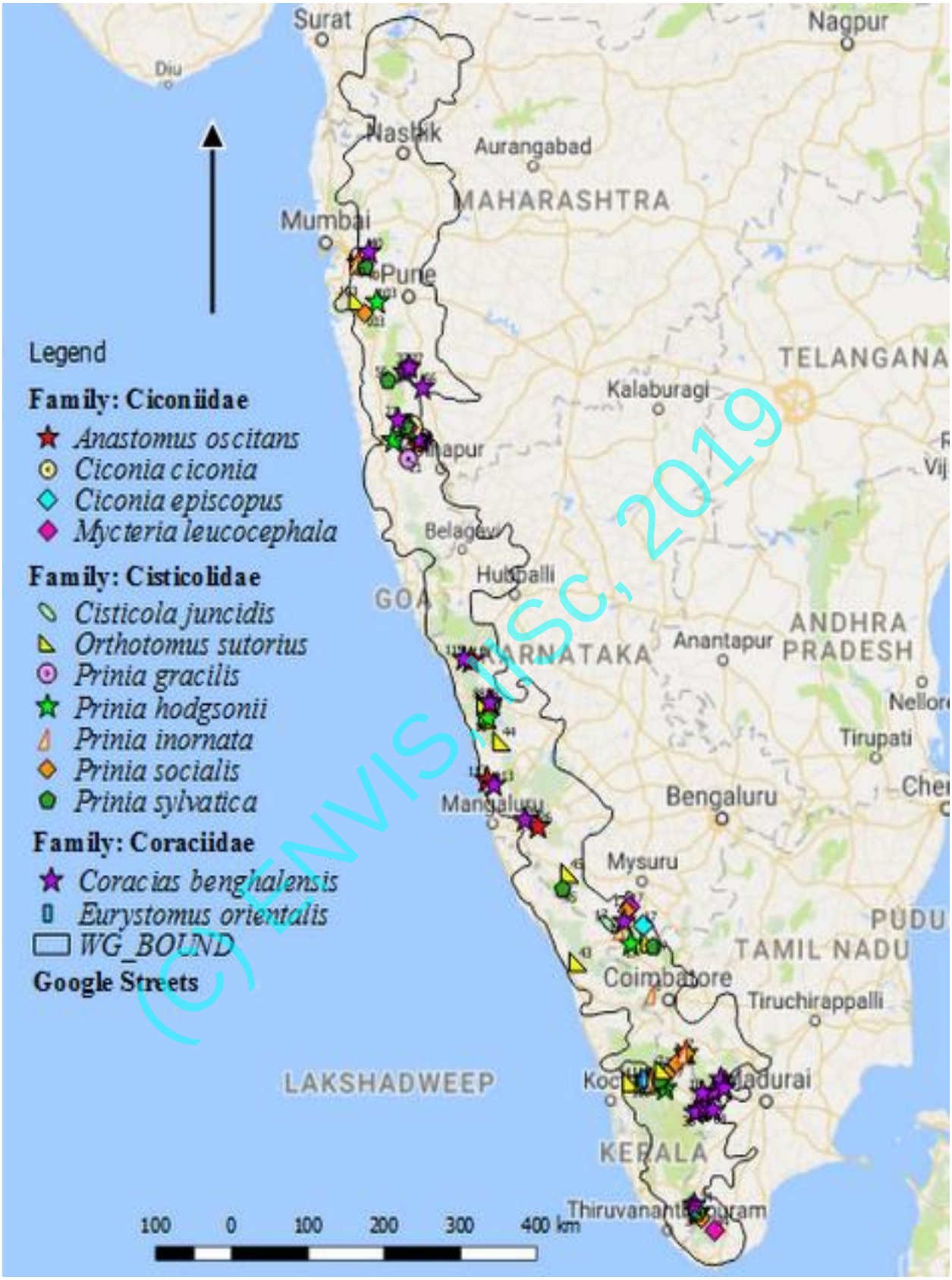


Fig. 6.5.10. Spatial distribution of the Ciconiidae, Cisticolidae and Coraciidae families.

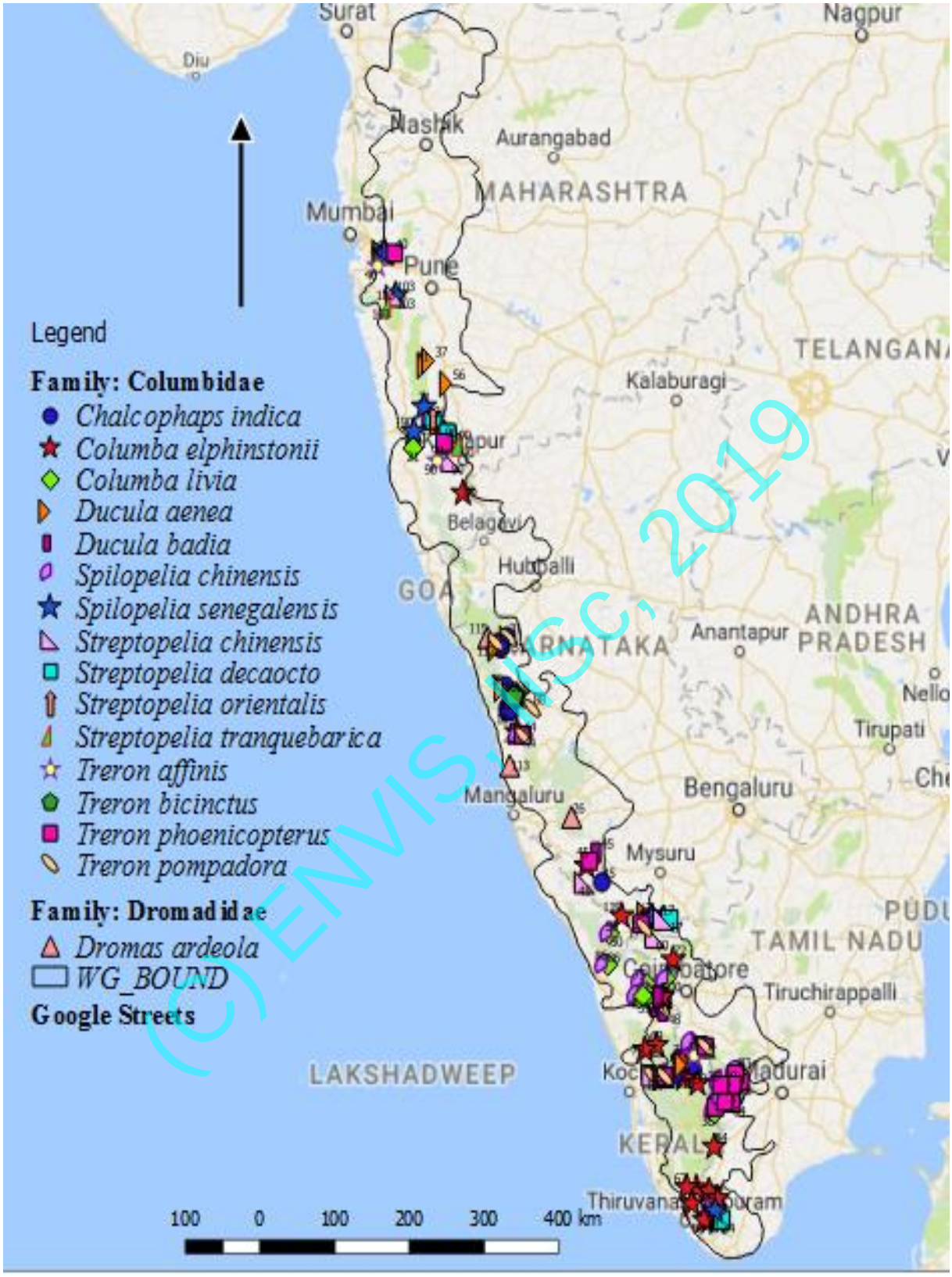


Fig. 6.5.11. Spatial distribution of the Columbidae and Dromadidae families.

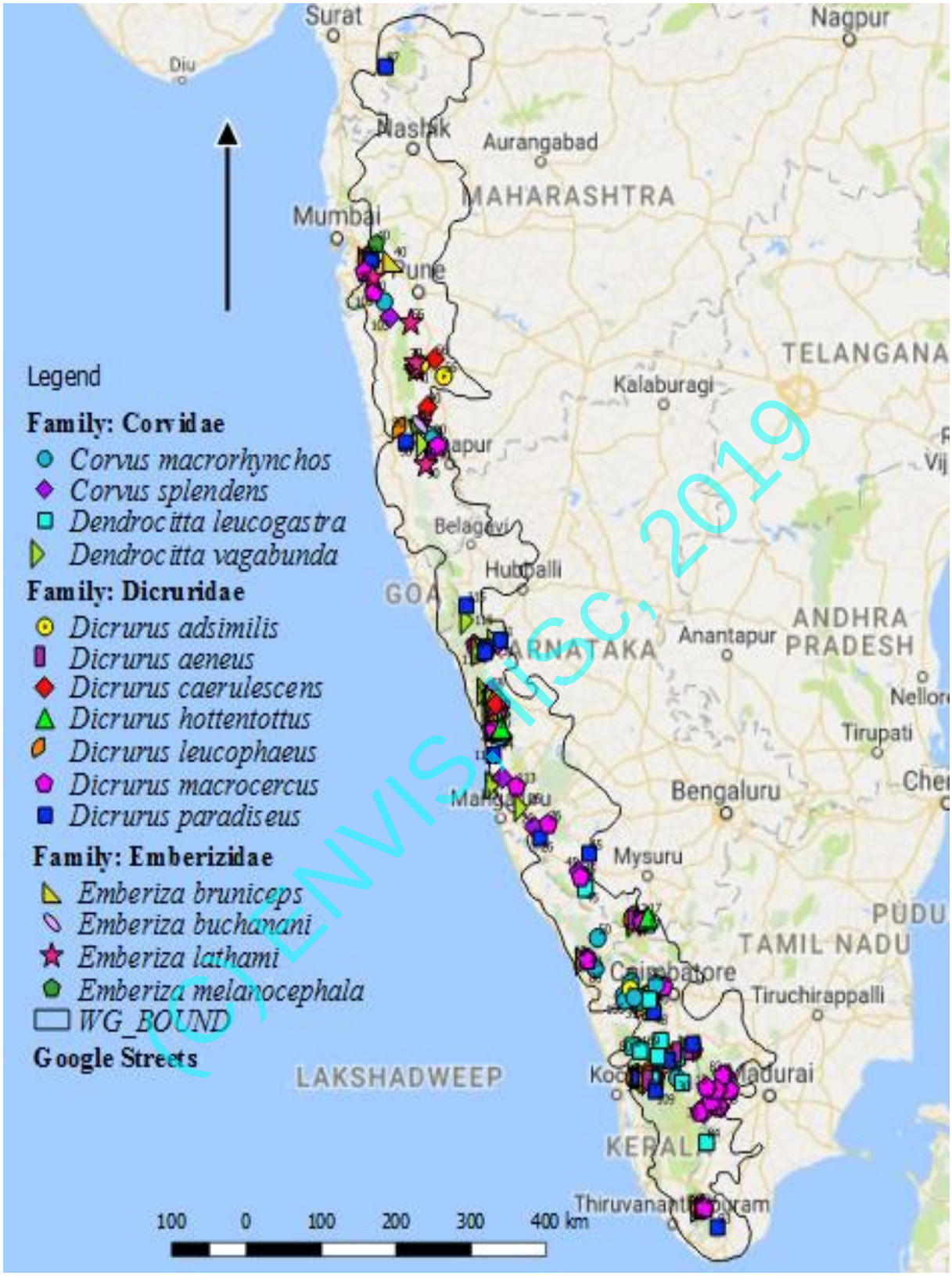


Fig. 6.5.12. Spatial distribution of the Corvidae, Dicruridae and Emberizidae families.

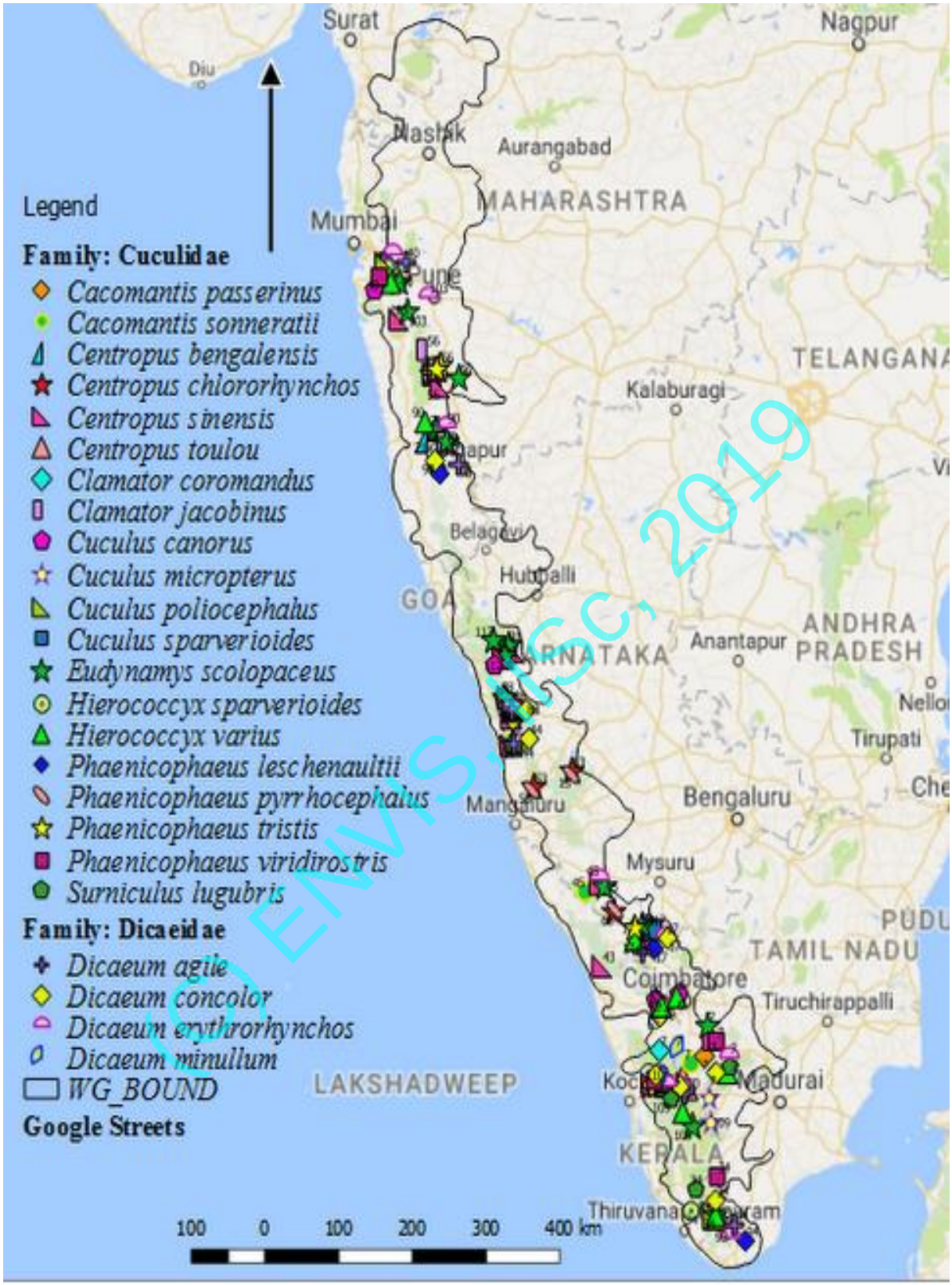


Fig. 6.5.13. Spatial distribution of the Cuculidae and Dicaeidae families.

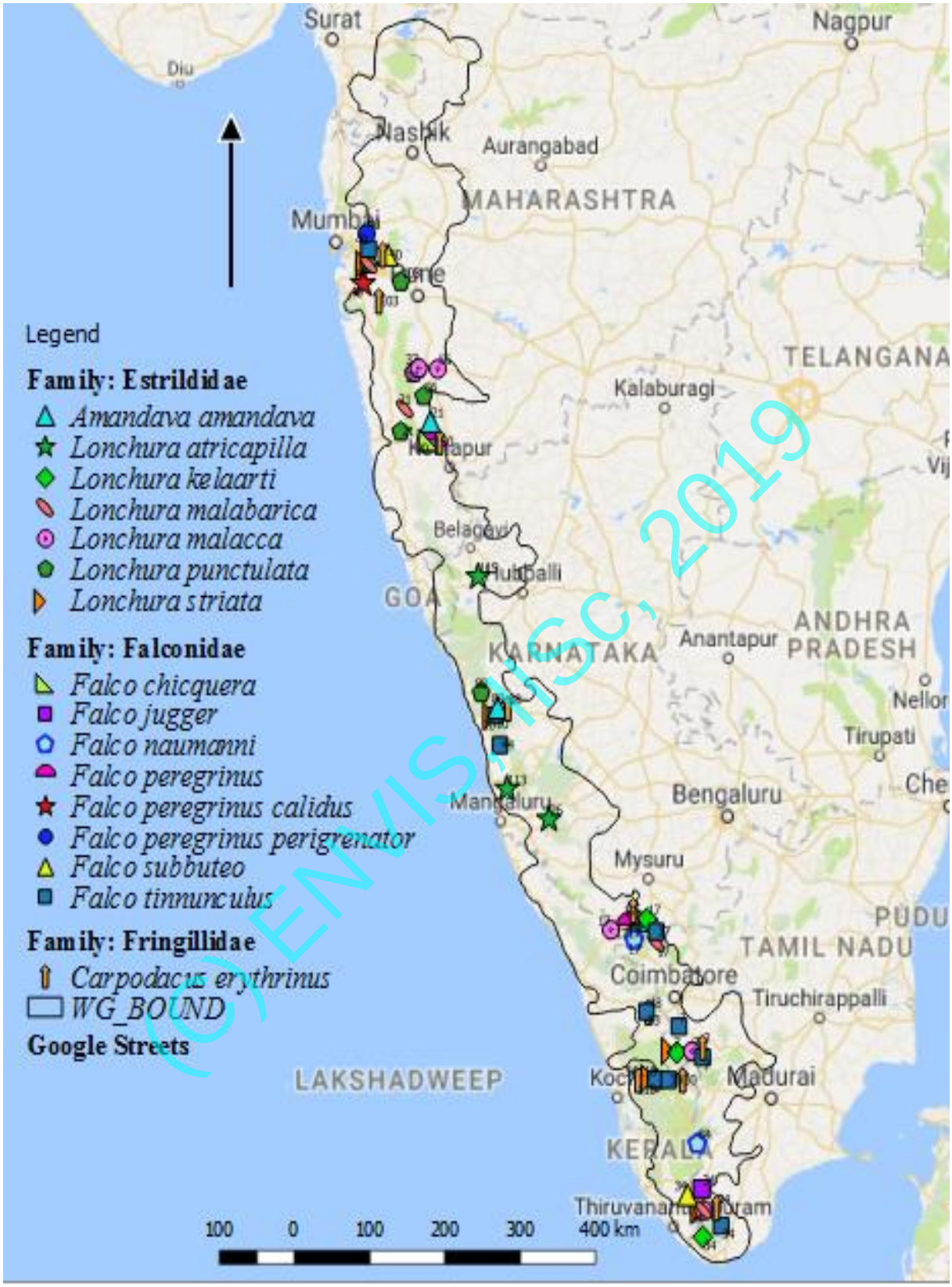


Fig. 6.5.14. Spatial distribution of the Estrildidae, Falconidae and Fringillidae families.

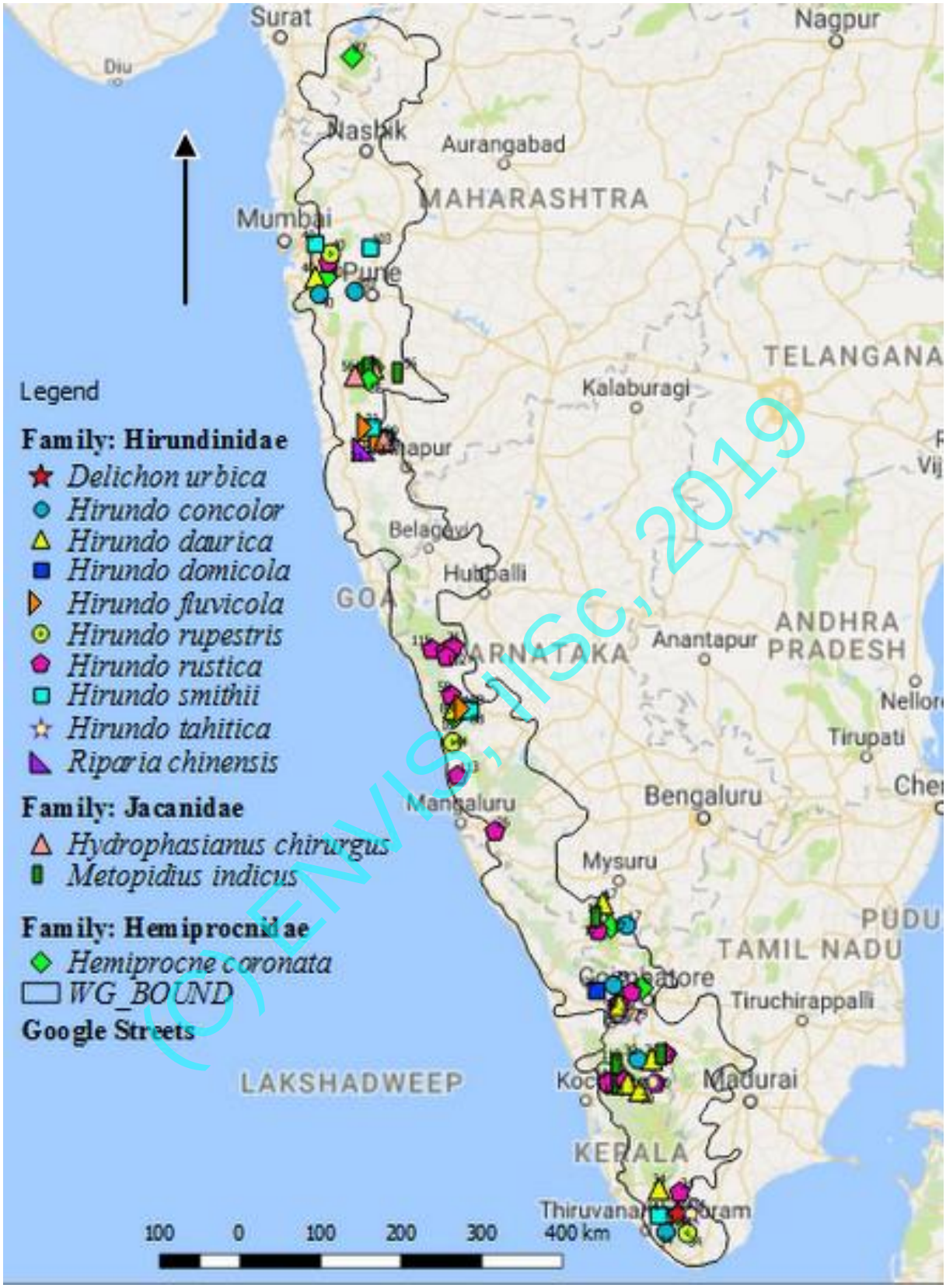


Fig. 6.5.15. Spatial distribution of the Hirundinidae, Jacanidae and Hemiprocnidae families.

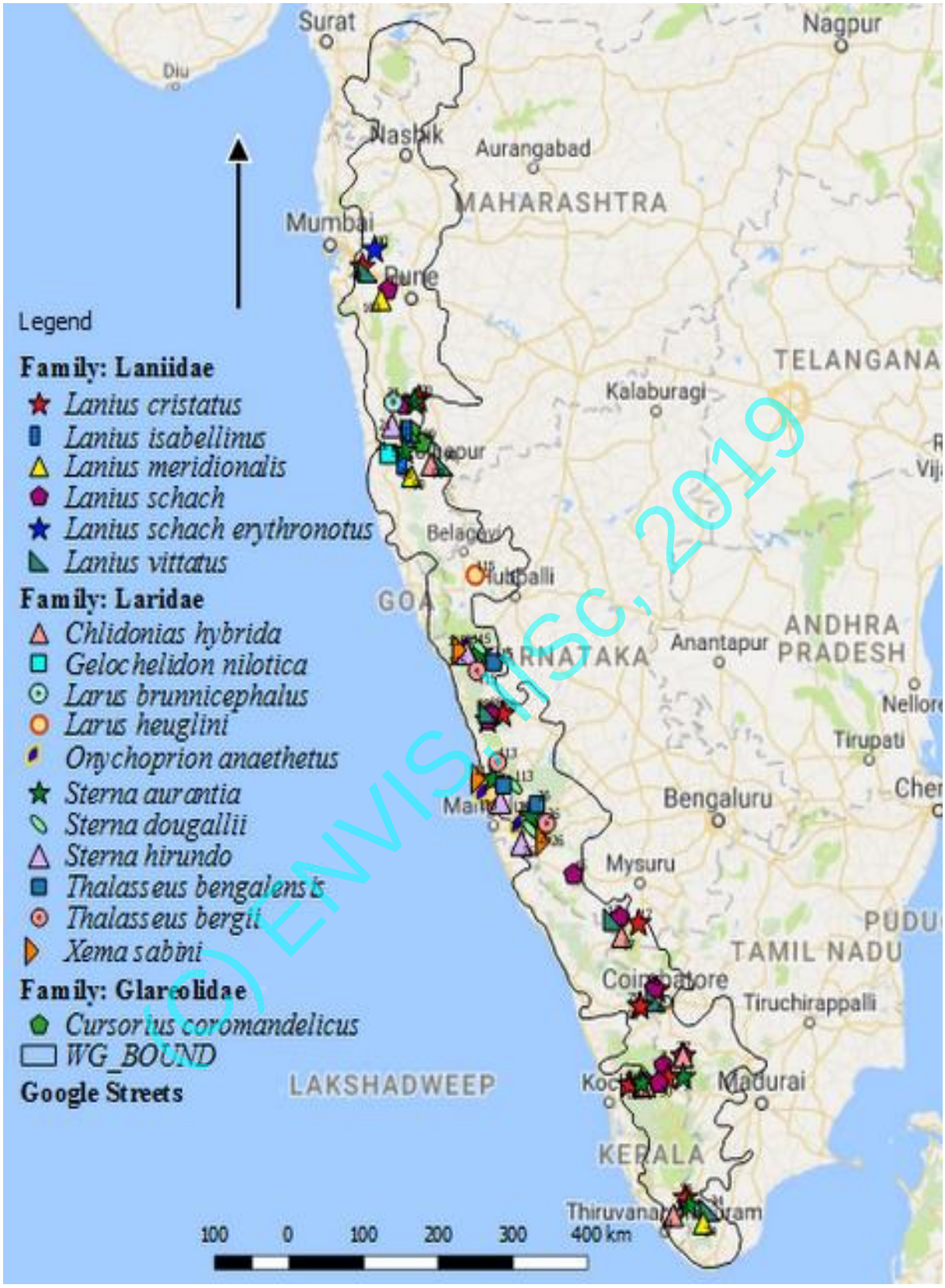


Fig. 6.5.16. Spatial distribution of the Laniidae, Laridae and Glareolidae families.

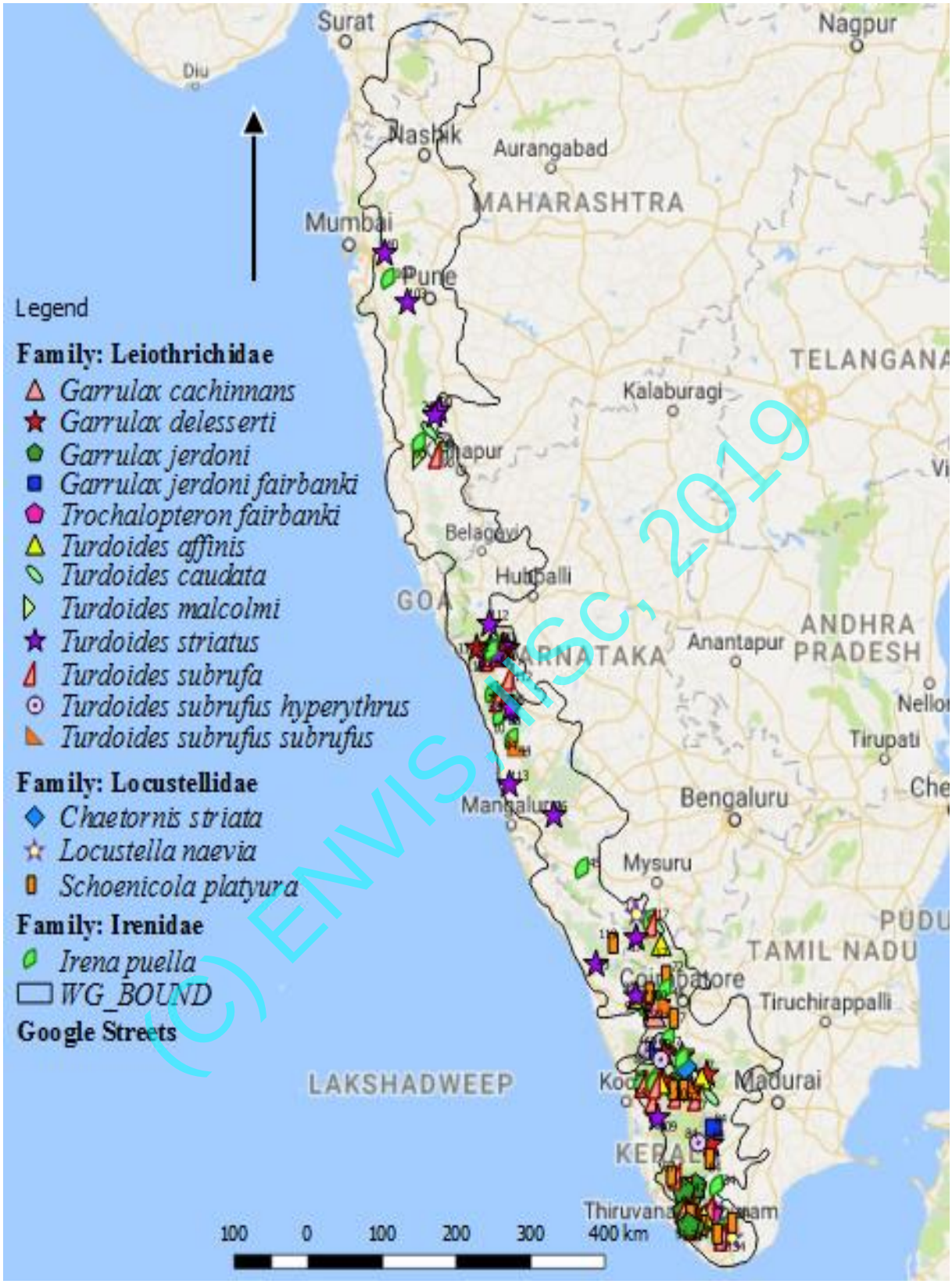


Fig. 6.5.17. Spatial distribution of the Leiothrichidae, Locustellidae and Irenidae families.

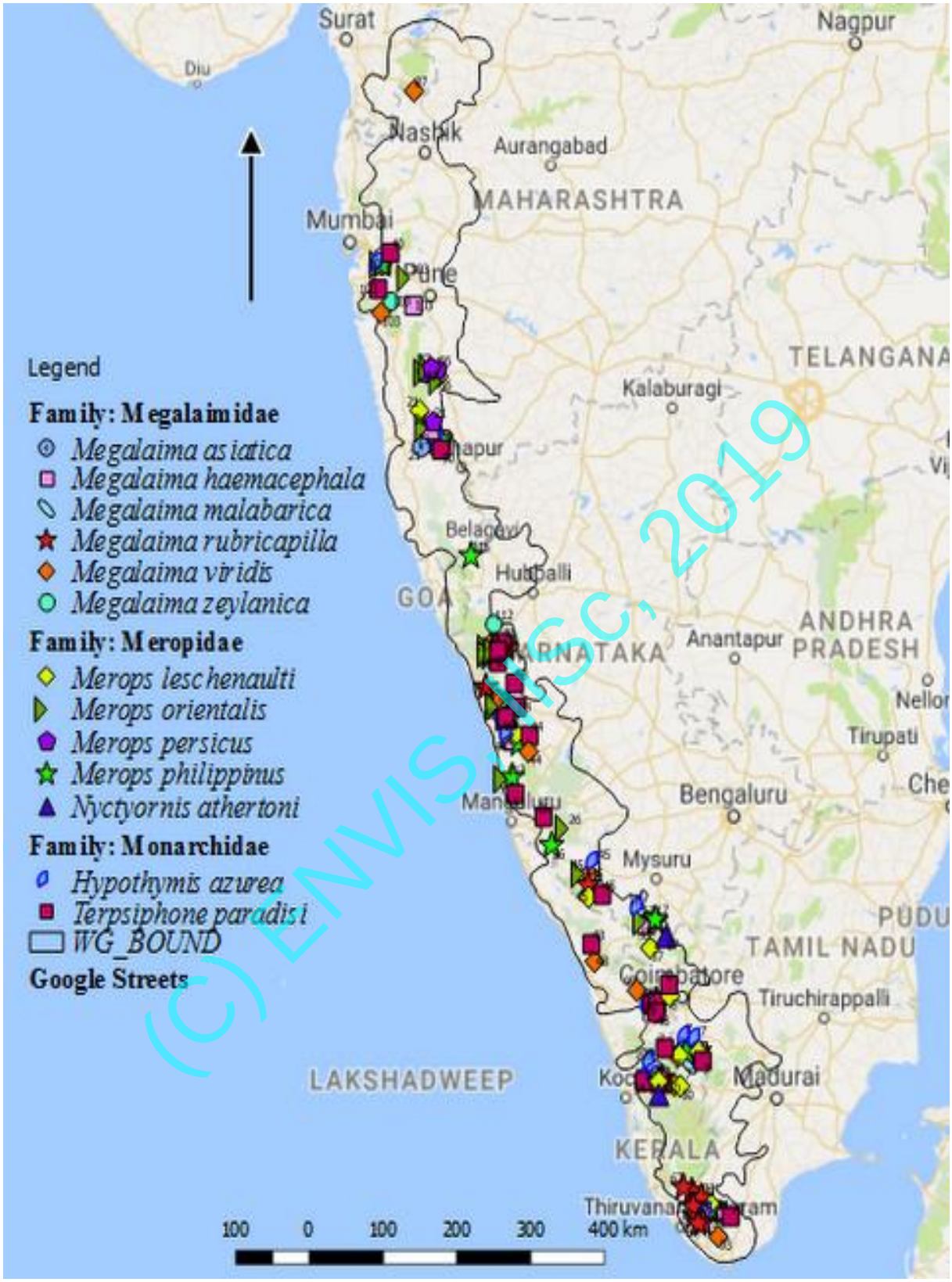


Fig. 6.5.18. Spatial distribution of the Megalaimidae, Meropidae and Monarchidae families.

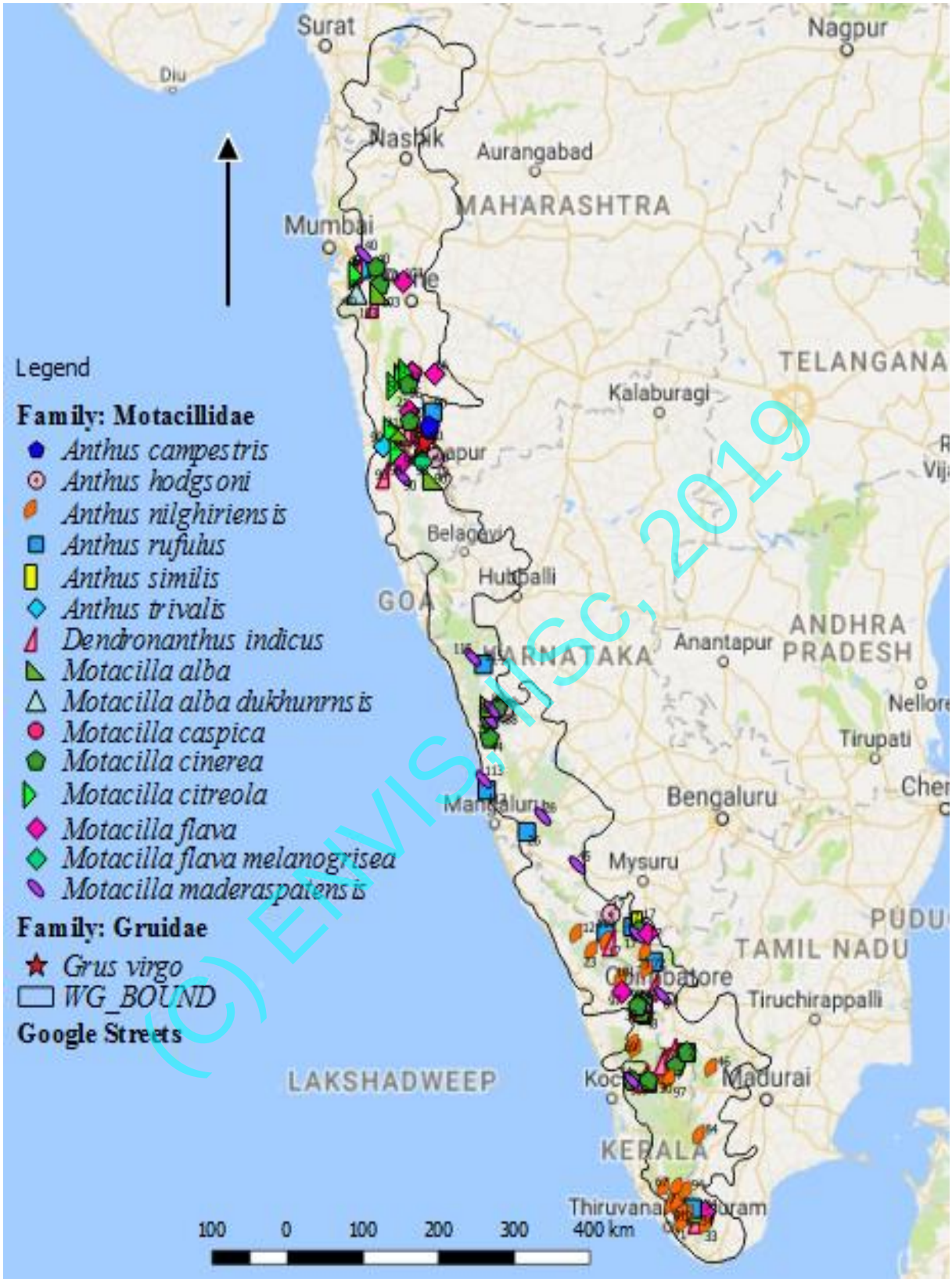


Fig. 6.5.19. Spatial distribution of the Motacillidae and Gruidae families.

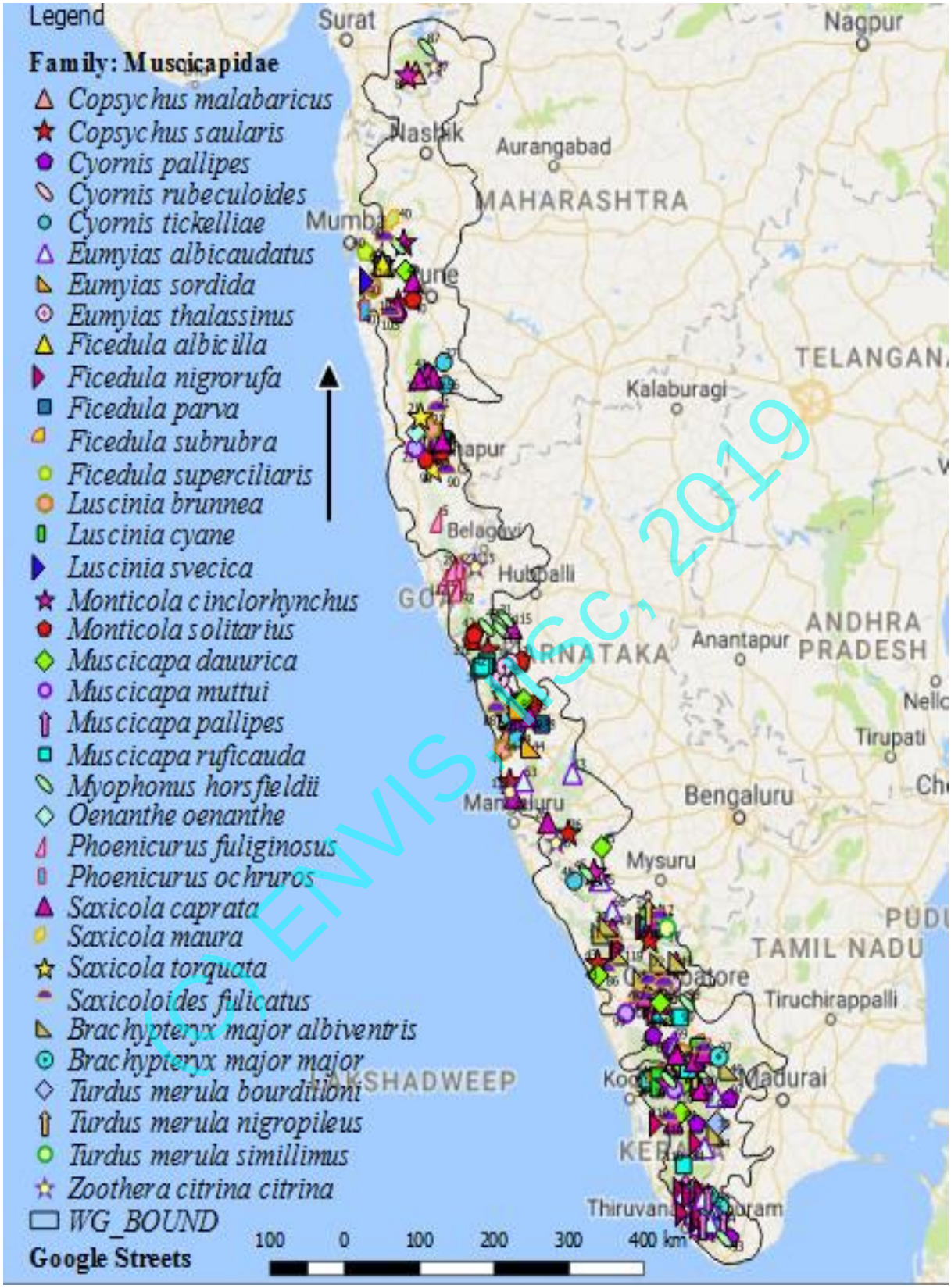


Fig. 6.5.20. Spatial distribution of the Muscicapidae family.

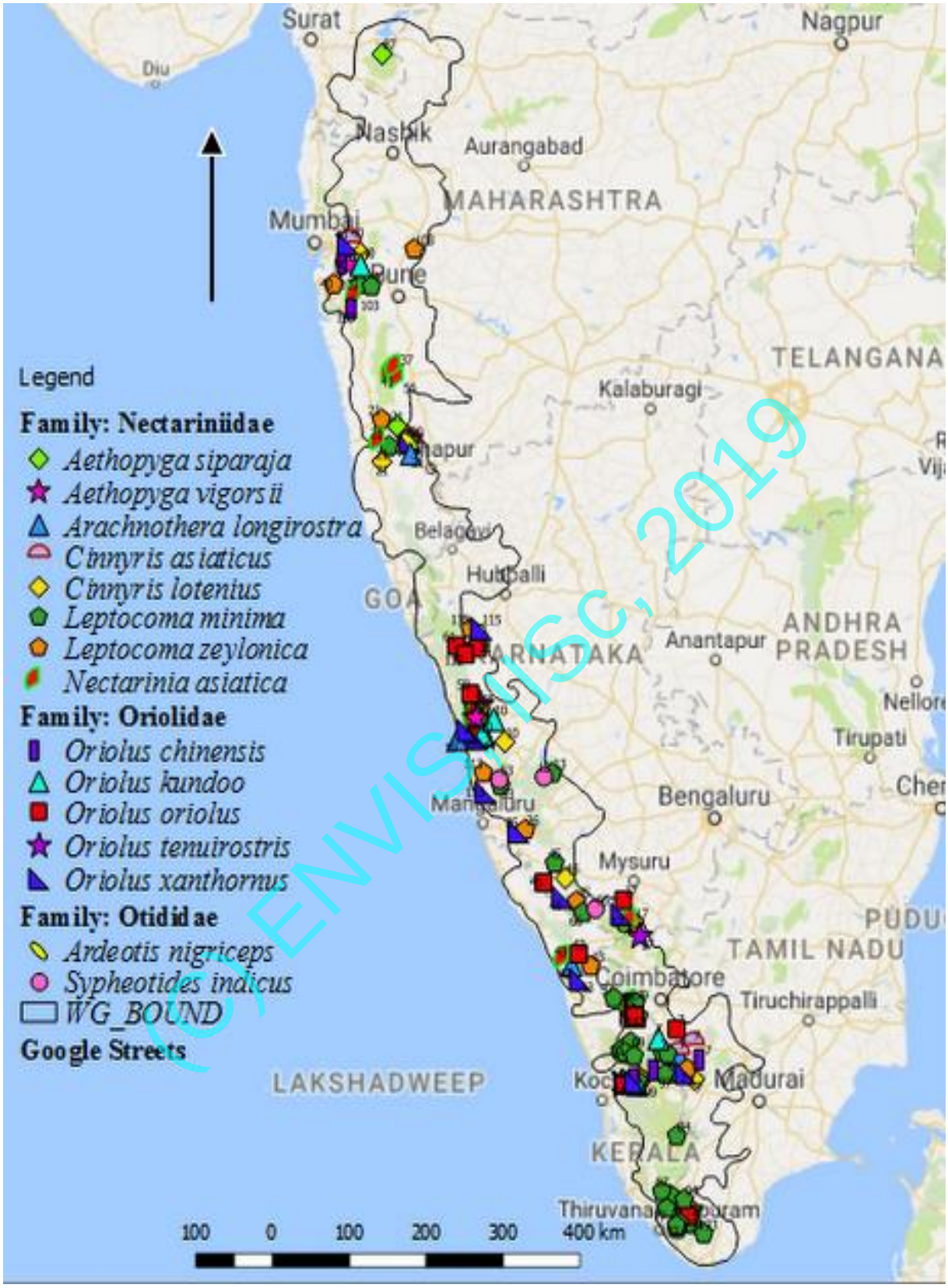


Fig. 6.5.21. Spatial distribution of the Nectariniidae, Oriolidae and Otididae families.

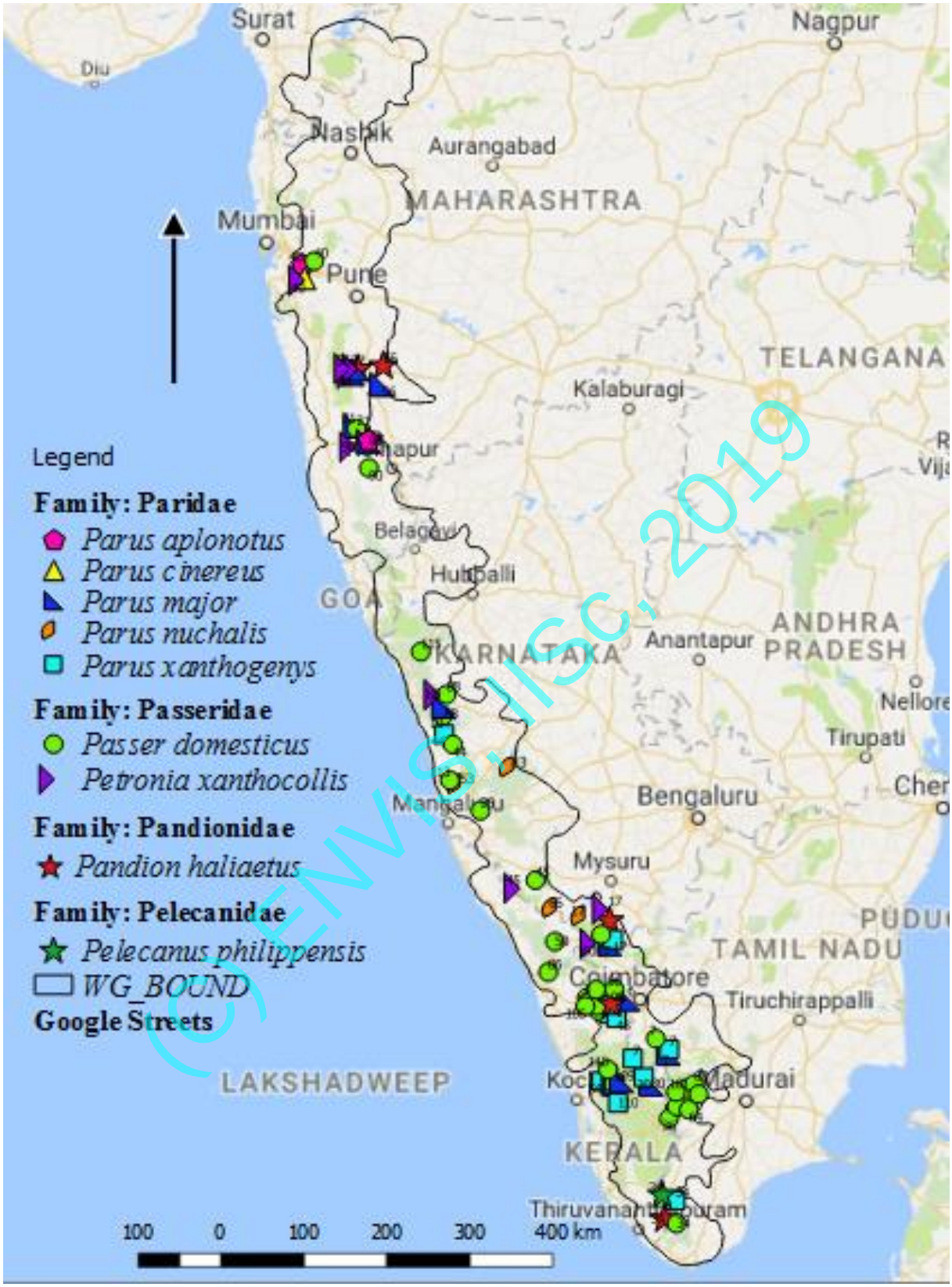


Fig. 6.5.22. Spatial distribution of the Paridae, Passeridae, Pandionidae and Pelecanidae families.

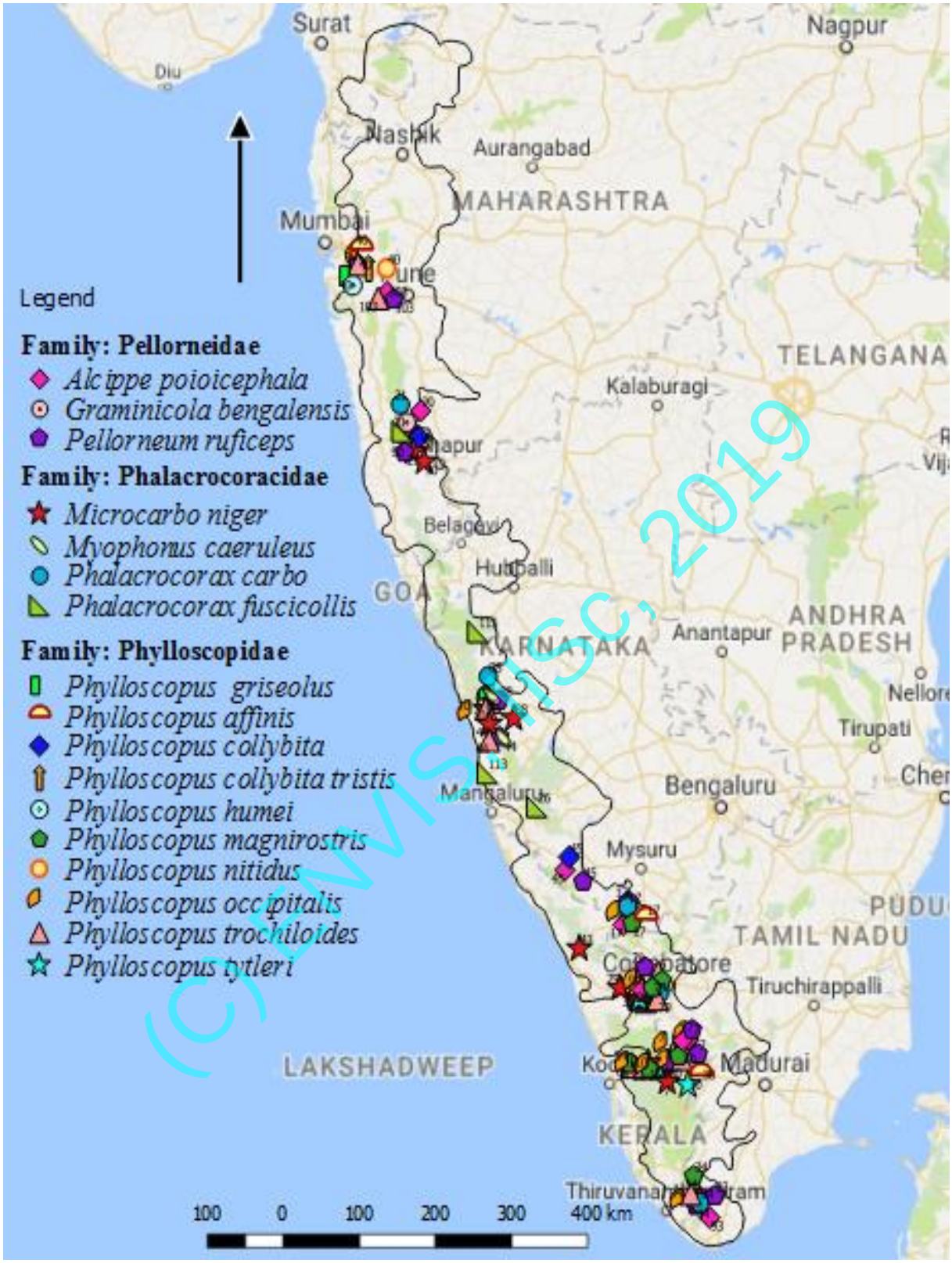


Fig. 6.5.23. Spatial distribution of the Pellorneidae, Phalacrocoracidae and Phylloscopidae families.

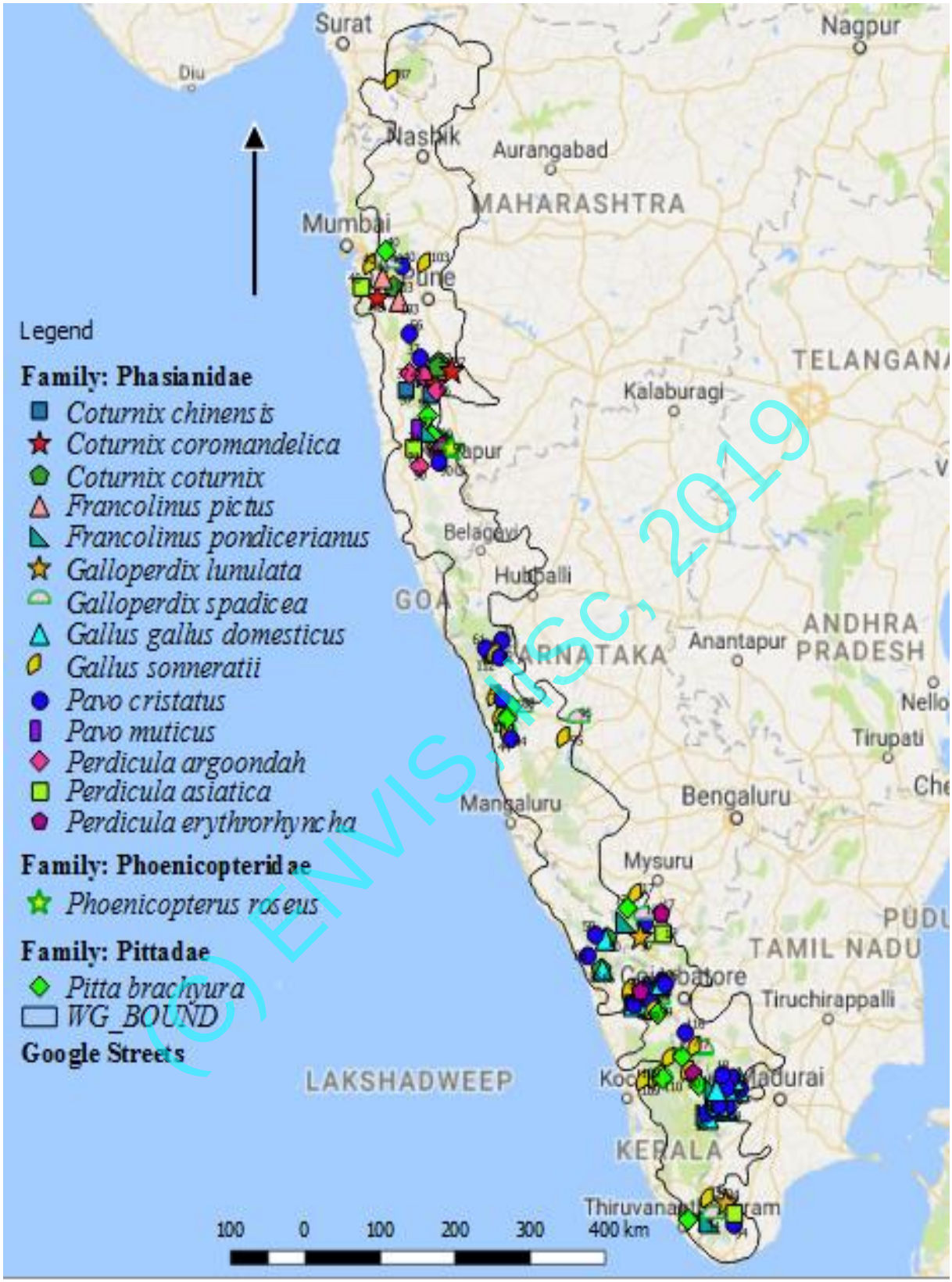


Fig. 6.5.24. Spatial distribution of the Phasianidae, Phoenicopteridae and Pittadae families.

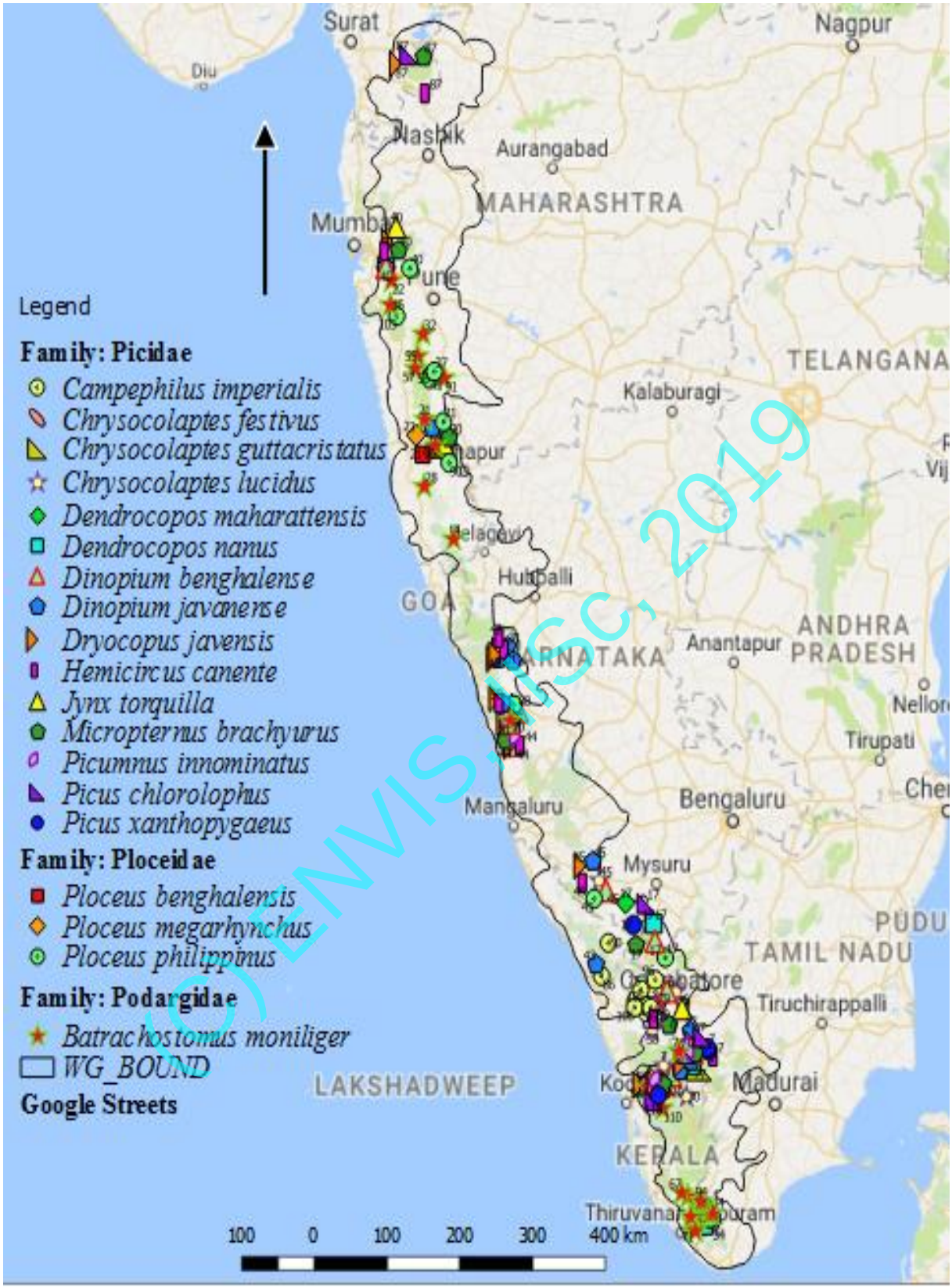


Fig. 6.5.25. Spatial distribution of the Picidae, Ploceidae and Podargidae families.

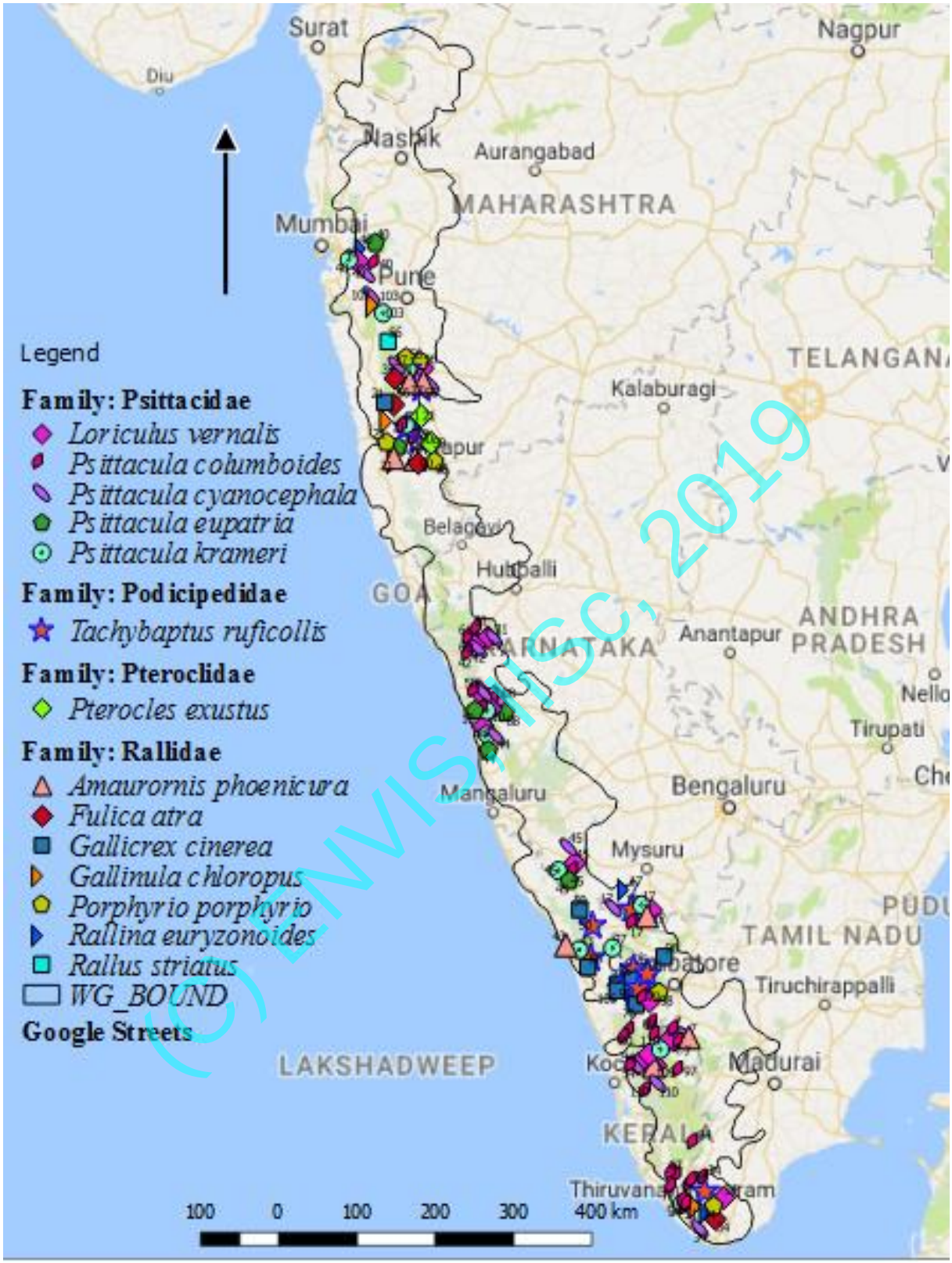


Fig. 6.5.26. Spatial distribution of the Psittacidae, Podicipedidae, Pteroclidae and Rallidae families.

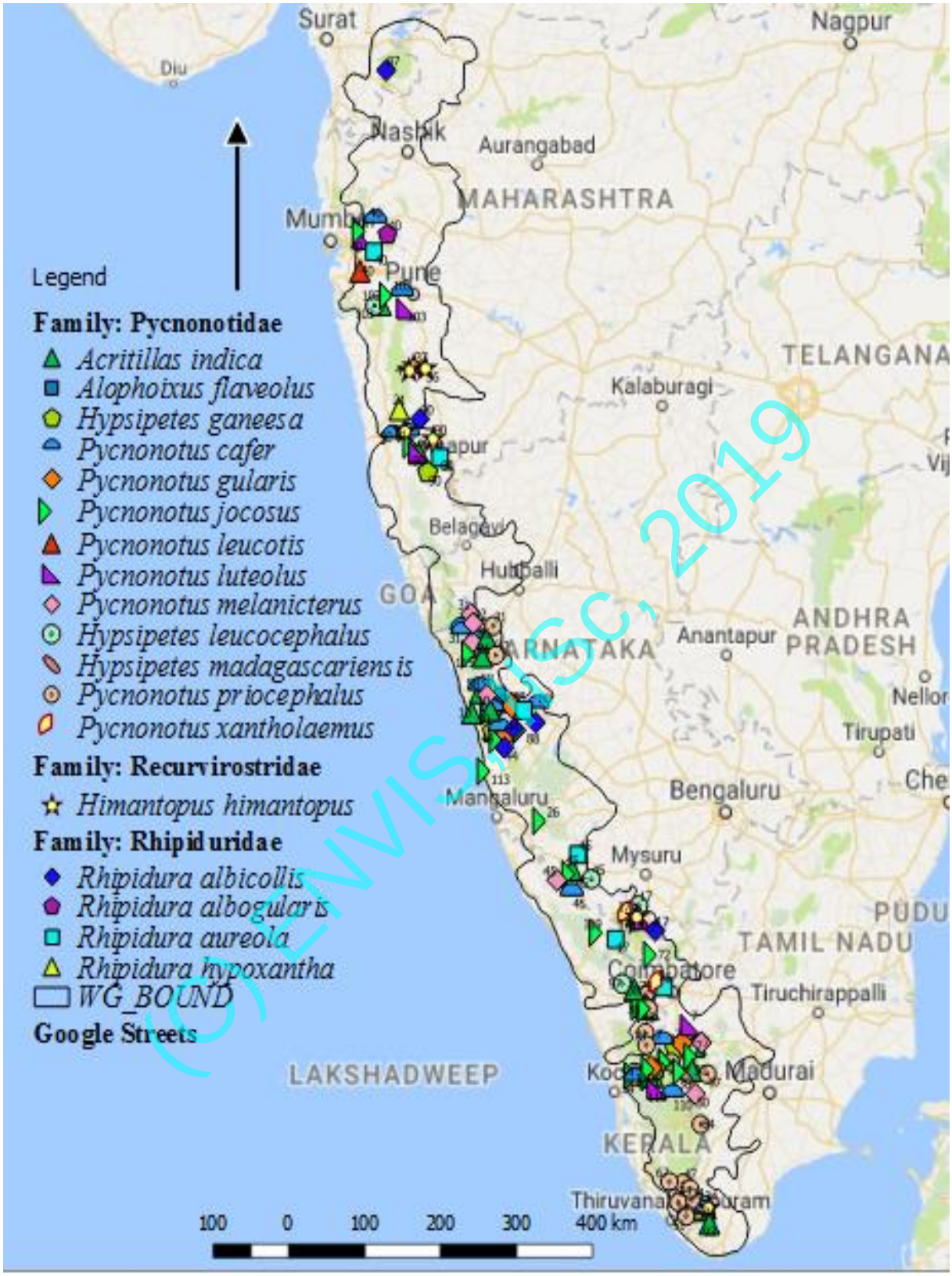


Fig. 6.5.27. Spatial distribution of the Pycnonotidae, Recurvirostridae and Rhipiduridae families.

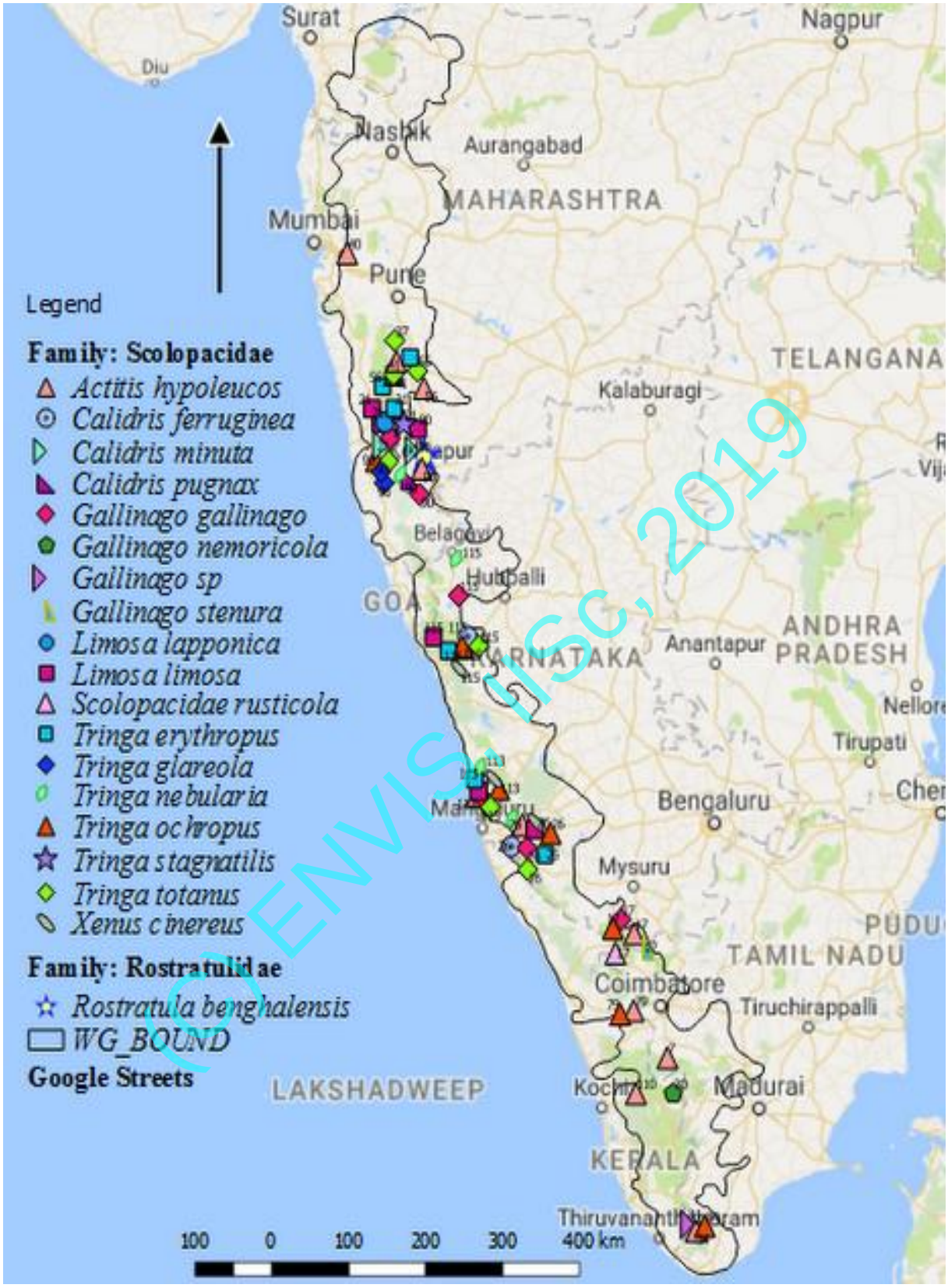


Fig. 6.5.28. Spatial distribution of the Scolopacidae and Rostratulidae families.

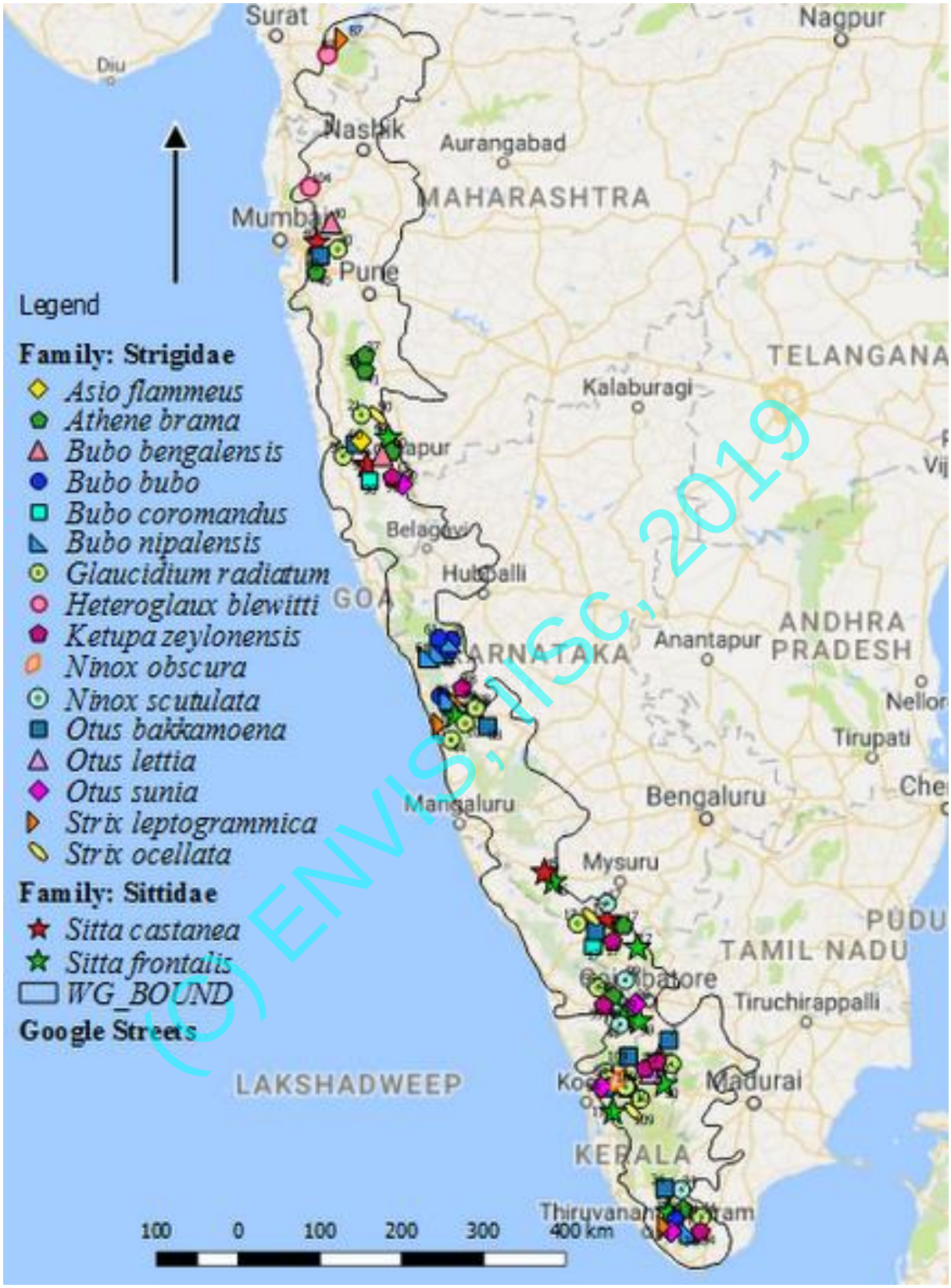


Fig. 6.5.29. Spatial distribution of the Strigidae and Sittidae families.

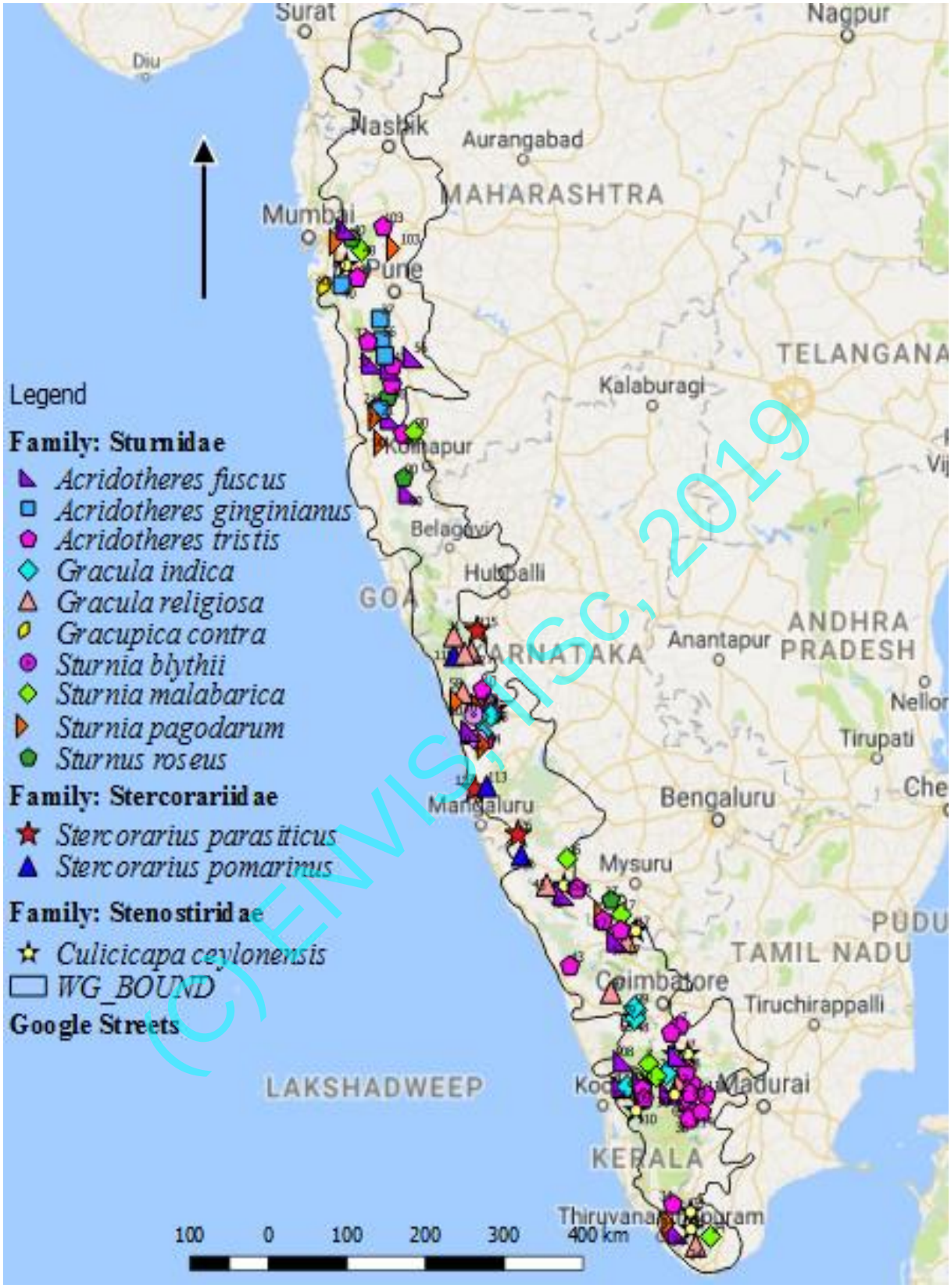


Fig. 6.5.30. Spatial distribution of the Sturnidae, Stercorariidae and Stenostiridae families.

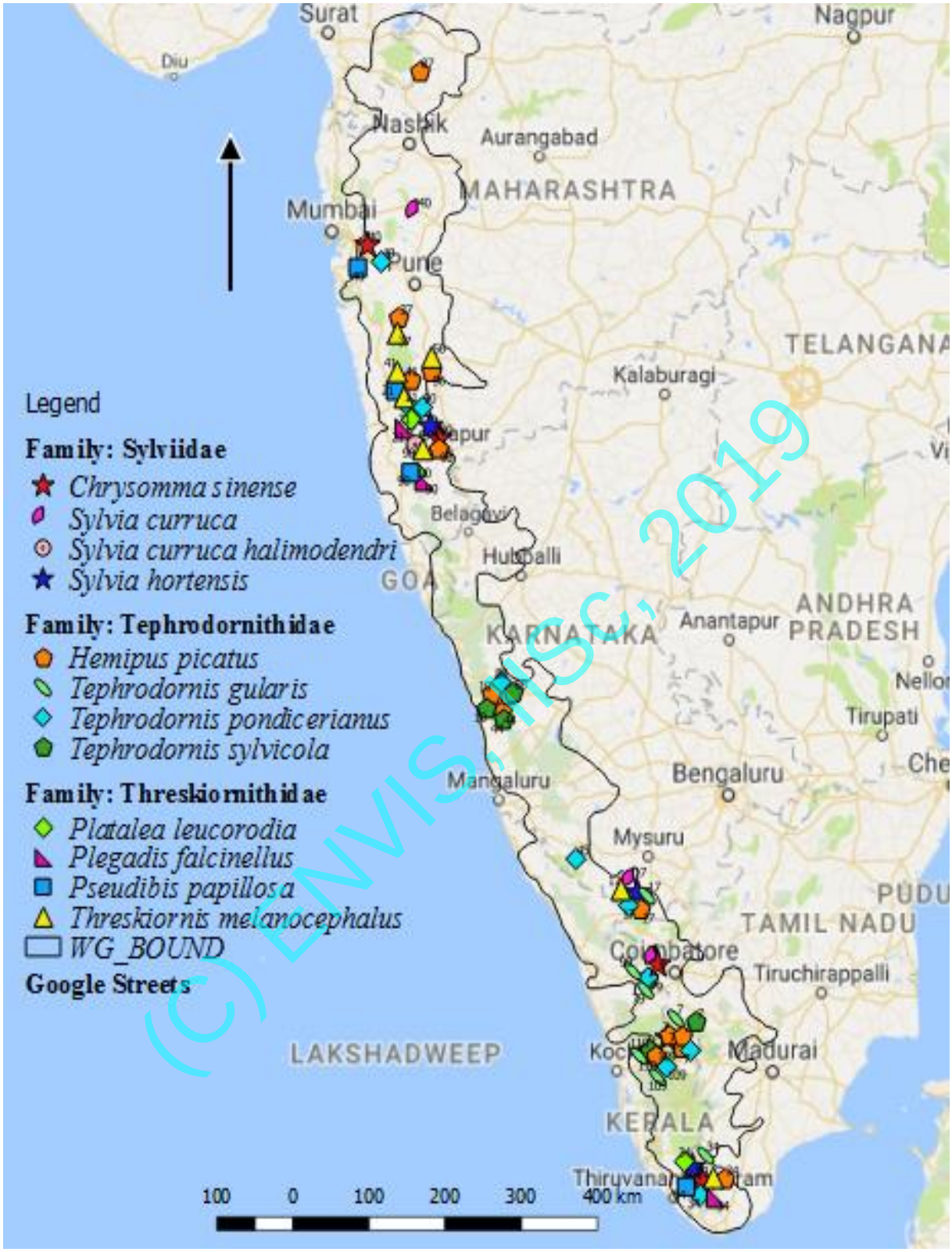


Fig. 6.5.31. Spatial distribution of the Sylviidae, Tephrodornithidae and Threskiornithidae families.

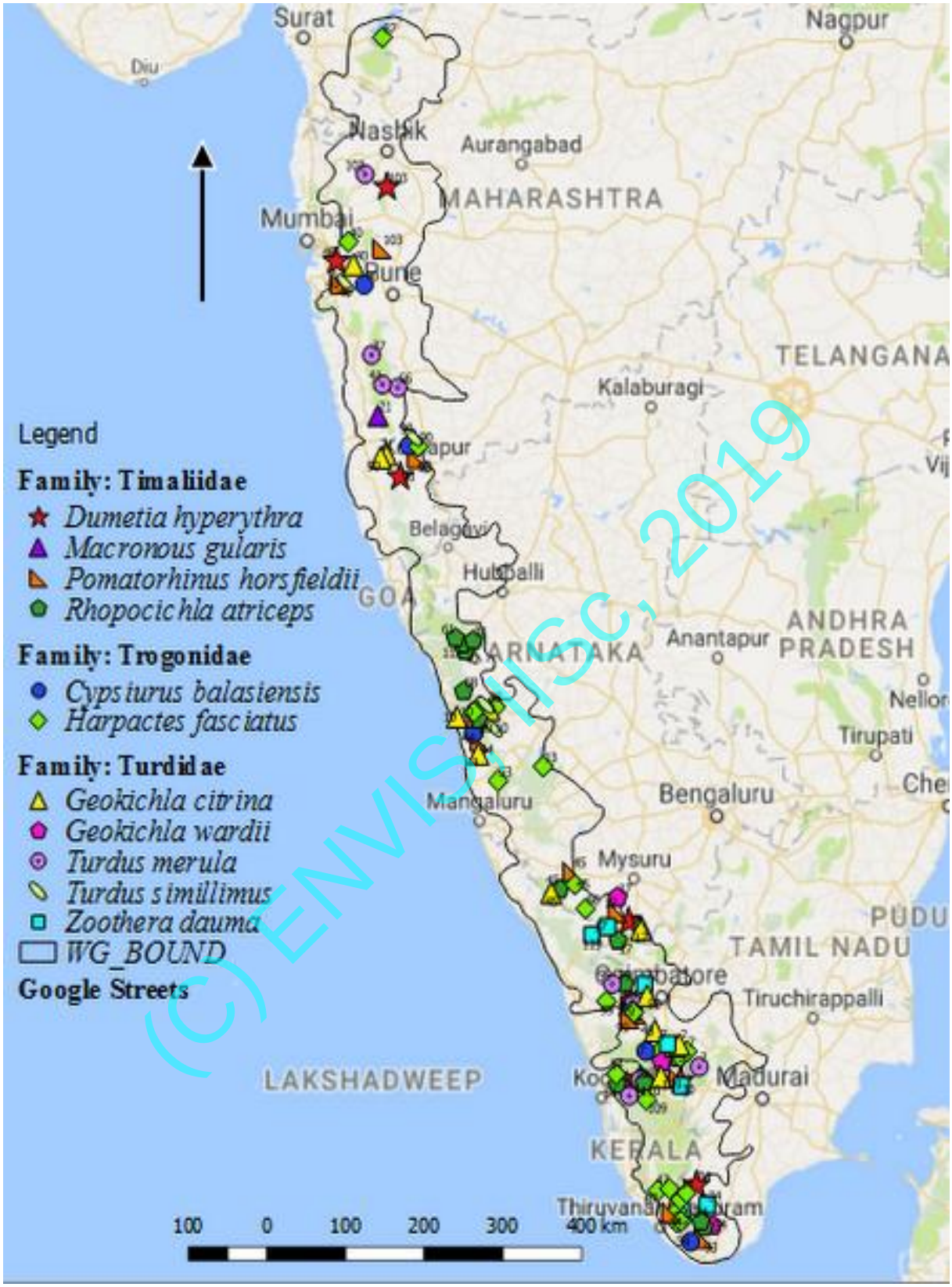


Fig. 6.5.32. Spatial distribution of the Timallidae, Trogonidae and Turdidae families.

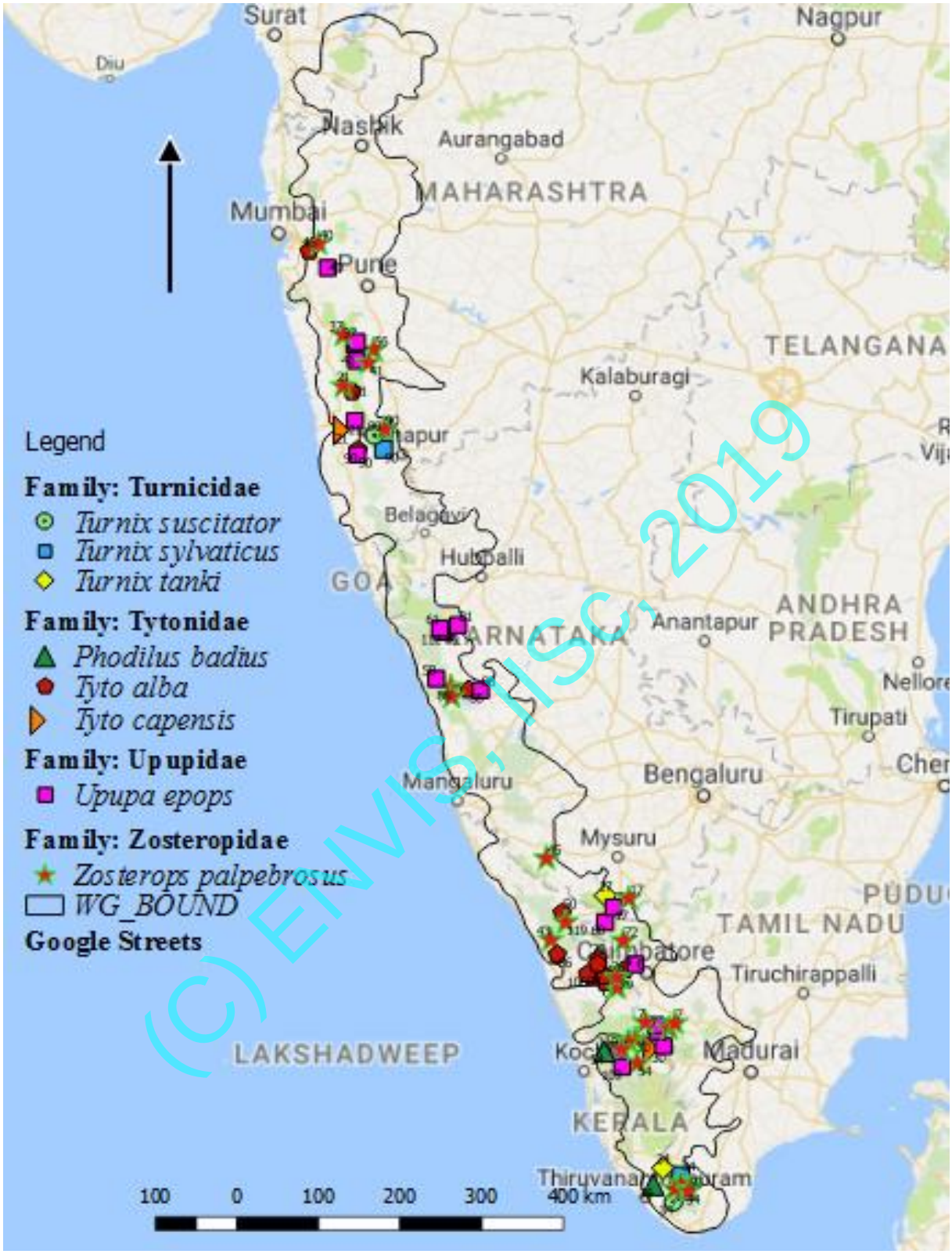


Fig. 6.5.33. Spatial distribution of the Turnicidae, Tytonidae, Upupidae and Zosteropidae families.

Distribution of endemic species

Among the 529 species of birds, 28 species (5%) were Endemic to WG (Fig. 6.5.34 & 6.5.35).

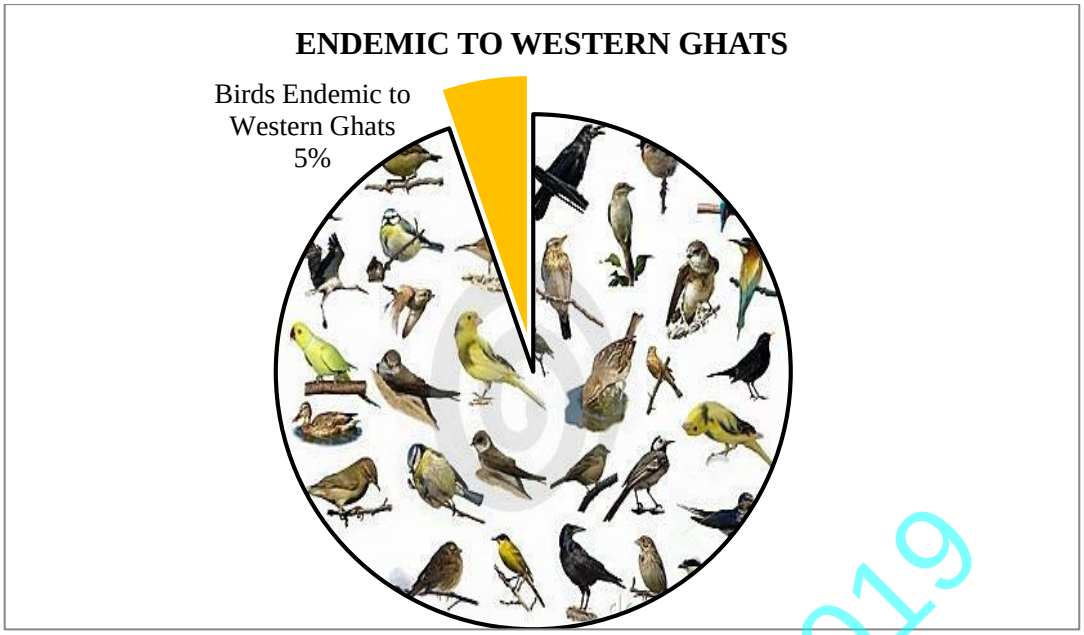


Fig. 6.5.34. Pie chart showing Endemism of Birds in WG.

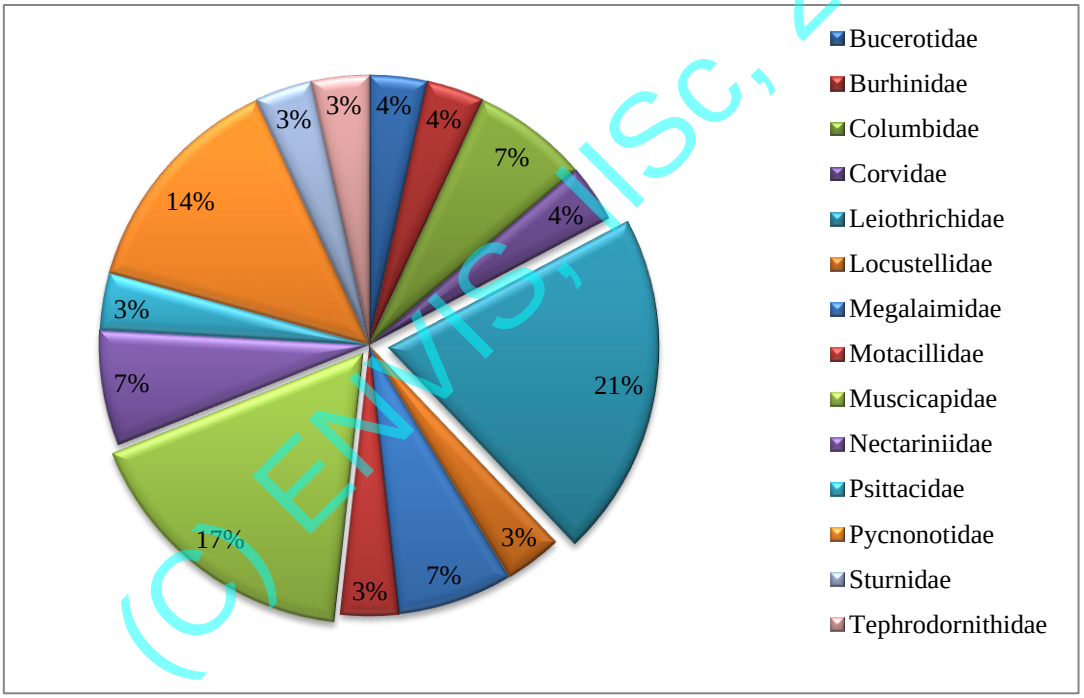


Fig. 6.5.36. Pie chart showing Endemism of Birds families.

The endemic species are from the families Bucerotidae, Burhinidae, Columbidae, Corvidae, Leiothrichidae, Locustellidae, Megalaimidae, Motacillidae, Muscicapidae, Nectariniidae, Psittacidae, Pycnonotidae, Sturnidae, and Tephrodornithidae (Fig. 6.5.36). The majority of endemic species belongs to the family Leiothrichidae (21%) followed by the family Muscicapidae (17%) and Pycnonotidae (14%). The families Columbidae, Megalaimidae, and Nectariniidae show 7% endemism and Bucerotidae and Burhinidae shows 4% endemism. The

families with least number of endemic species are Locustellidae, Motacillidae, Psittacidae, Sturnidae and Tephrodornithidae (3%).

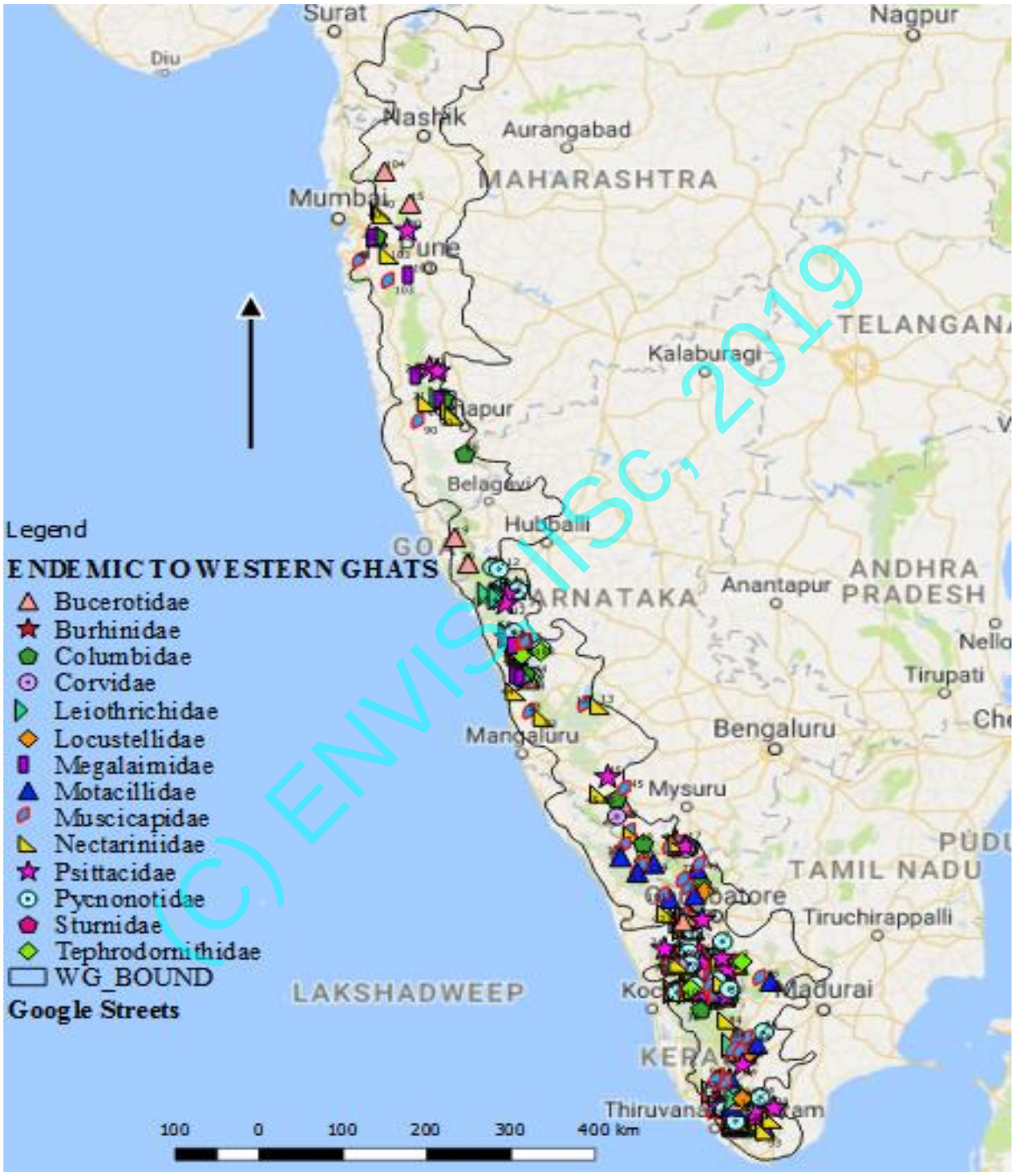


Fig. 6.5.35. Spatial distribution of the Avian families endemic to WG.

Distribution based on conservation status

According to the IUCN conservation status, all the birds species present in the WG were classified into different categories on the basis of their threat status. Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern and Not Evaluated are the different categories (Fig. 6.5.37). Among the 529 Bird species present in the WG region, 7 species were categorized as Critically Endangered (CE), 4 species were categorized as Endangered (EN), 18 species were considered as Vulnerable (VU), 28 species comes under the category Near Threatened (NT) and421 species were grouped under the Least Concern category. Conservation Status of 51 species of birds was not evaluated.The majority of bird species present in the WG region were categorized under least concern category (Fig. 6.5.38).

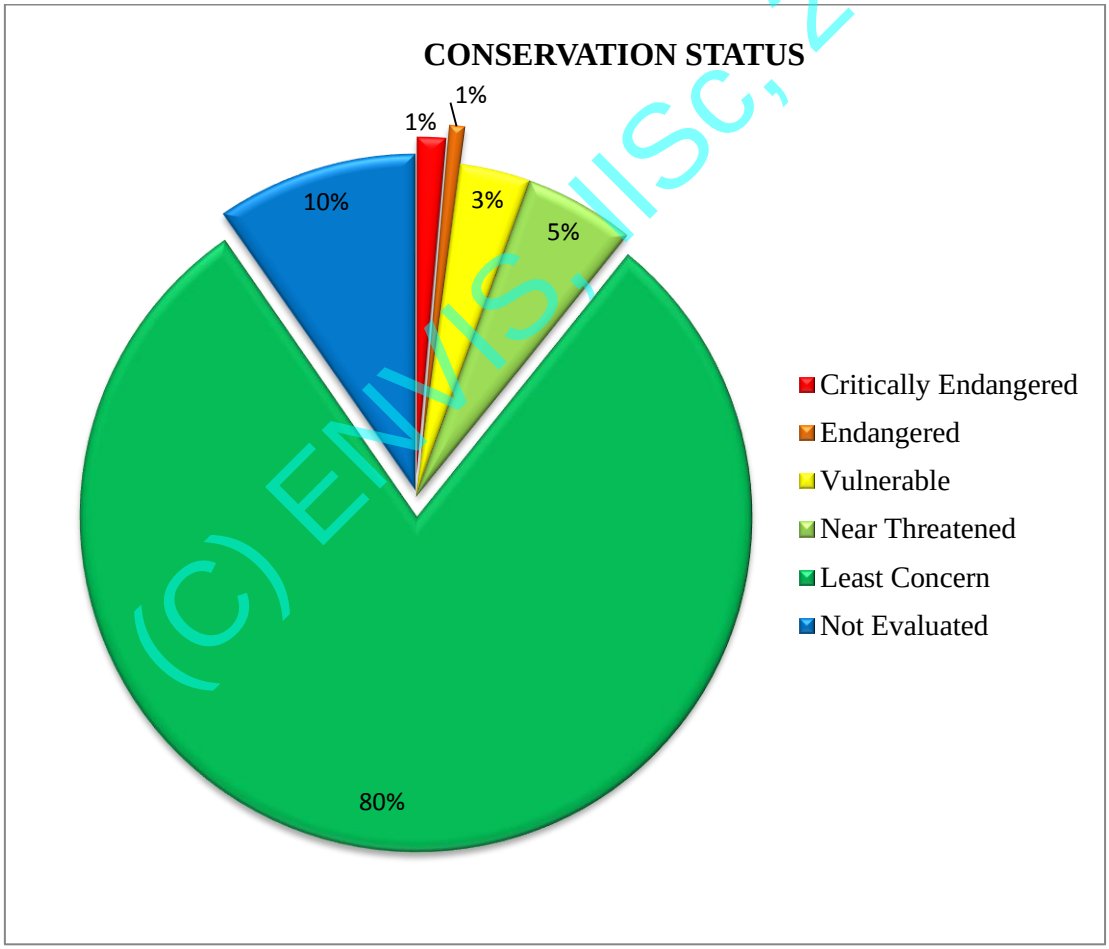


Fig. 6.5.38. Pie chart showing conservation status of Birds in WG.

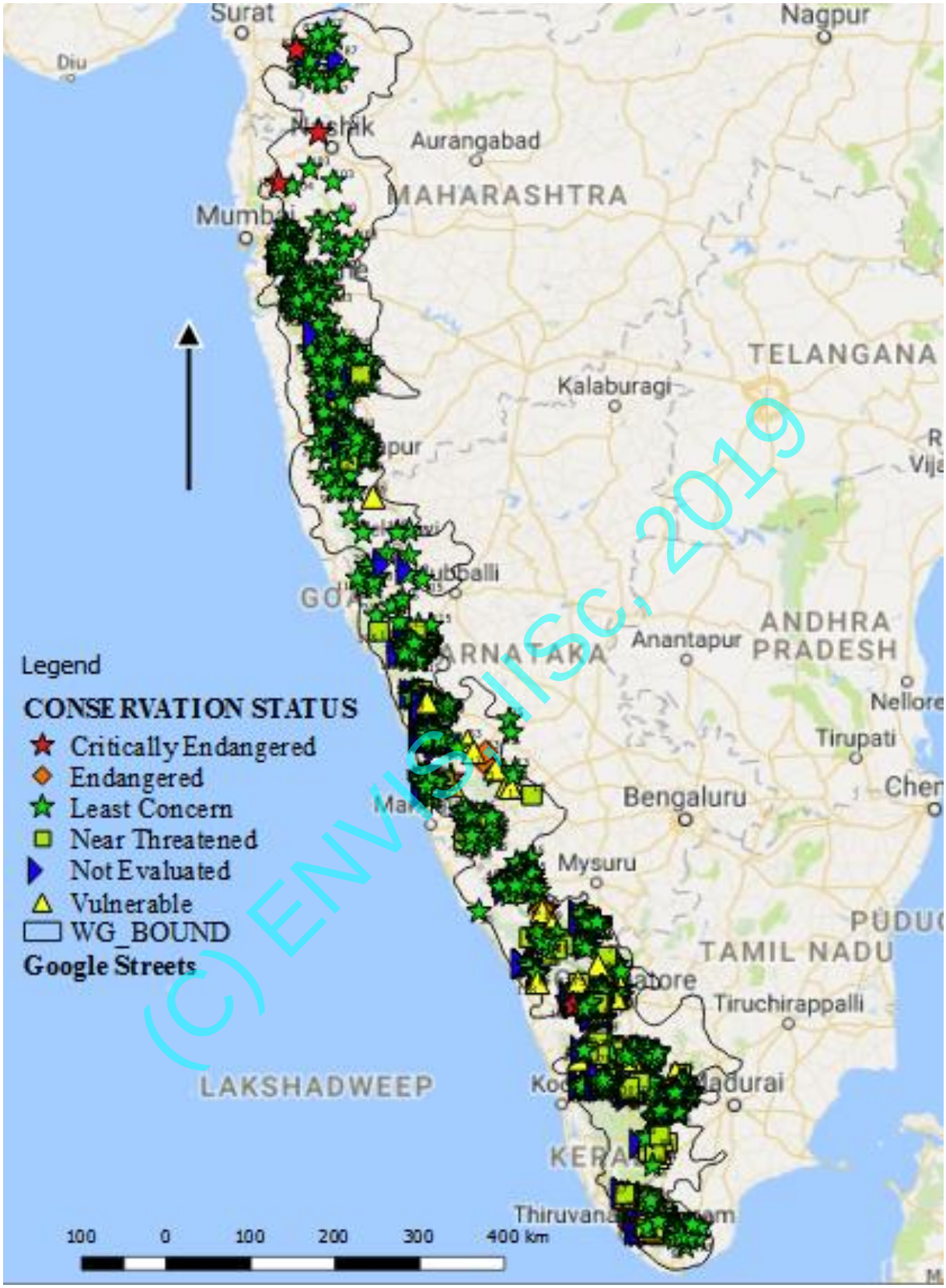


Fig. 6.5.37. Spatial distribution of the Avian species according to IUCN status.

According to IUCN conservation status, *Ardeotis nigriceps*, *Campephilus imperialis*, *Gyps bengalensis*, *Gyps indicus*, *Heteroglaux blewitti*, *Sarcogyps calvus* and *Vanellus gregarius*are considered as Critically Endangered (CE) bird species present in WG. These species have

distributed across the WG regions of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.39).The majority of these species are present in the WG region of Maharashtra.

WG region has 4 endangered (EN) bird species. These endangered species are *Aquila nipalensis, Neophron percnopterus, Pavo muticus* and *Sypheotides indicus* (Fig. 6.5.40). Endangered species were reported from the WG regions of Maharashtra, Karnataka, and Tamilnadu.

According to the IUCN conservation status, 18 bird species (3%) present in the WG region were categorized as Vulnerable (VU). It comprises the 3% of total bird population present in the WG (Fig. 6.5.41). These vulnerable species belong to the families Accipitridae, Ciconiidae, Columbidae, Cuculidae, Falconidae, Locustellidae, Muscicapidae, Paridae, Ploceidae, Pycnonotidae, and Scolopacidae. The species shows distribution across the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu.

In the WG region, 28 bird species were categorized under the category near threatened (NT), comprising the 5% of total bird population (Fig. 6.5.42). The species under near threatened category are belongs to the families, Accipitridae, Anhingidae, Bucerotidae, Burhinidae, Chloropseidae, Ciconiidae, Falconidae, Laridae, Leiothrichidae, Motacillidae, Muscicapidae, Pelecanidae, Phylloscopidae, Psittacidae, Pycnonotidae, Scolopacidae and Threskiomithidae, distributed across the Maharashtra, Karnataka, Kerala, and Tamilnadu regions of WG.

Majority of the bird species present in the WG region were listed under least concern category. WG has 421 least concern bird species, it comprises 80% of the total bird population present in the WG. These species are distributed across the WG region of Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.5.43a & 6.5.43b).

Conservation Status of 51 species of birds was not evaluated, that comprises almost 10% of the total number of species present in the WG (Fig. 6.5.44). The conservation status of the birds of the 22 families was not evaluated. These species show distribution across the WG regions of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu.

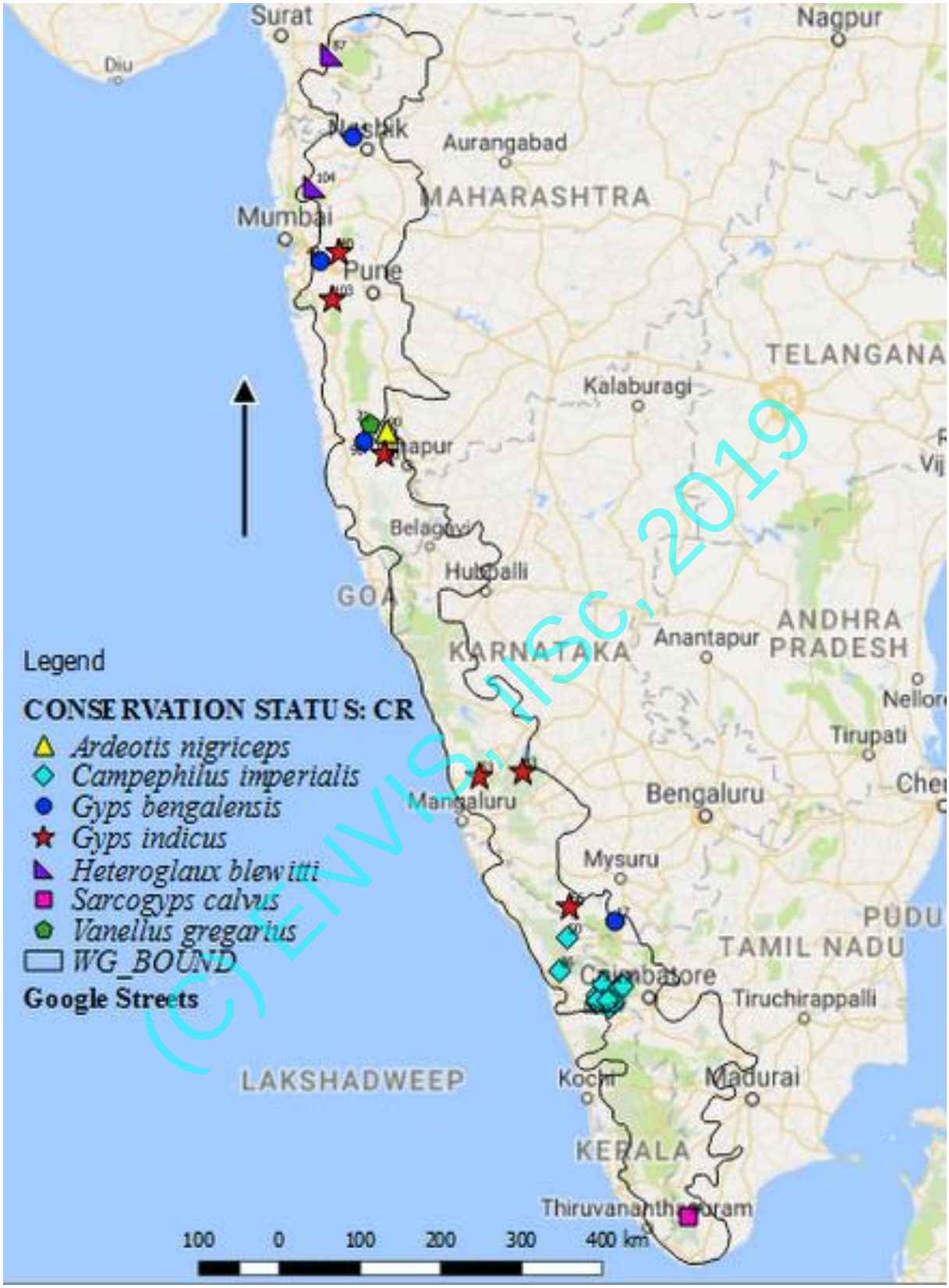


Fig. 6.5.39. Spatial distribution of critically endangered Birds species.

Fig. 6.5.40. Spatial distribution of endangered Birds species.

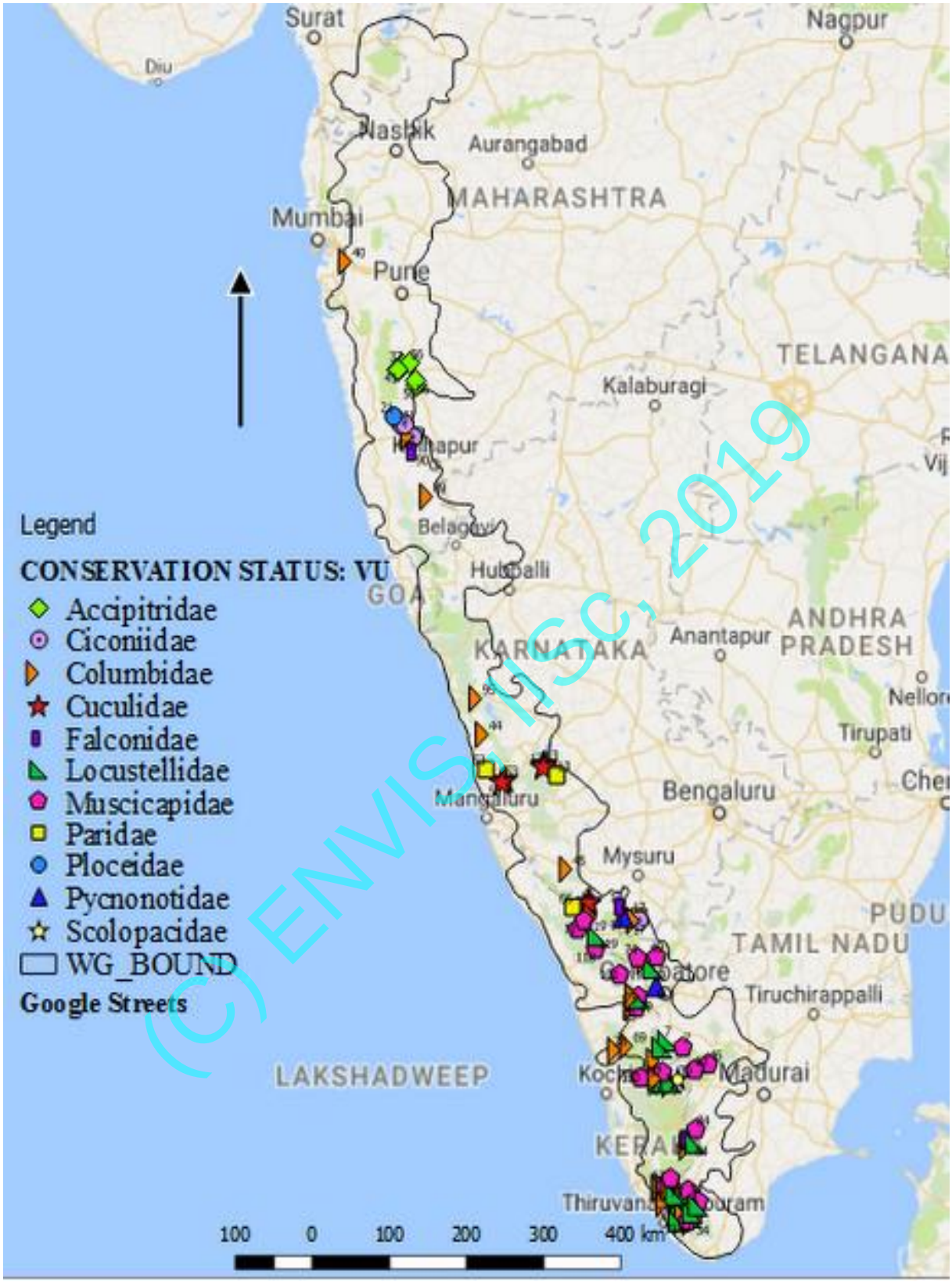


Fig. 6.5.41. Spatial distribution of vulnerable Birds families.

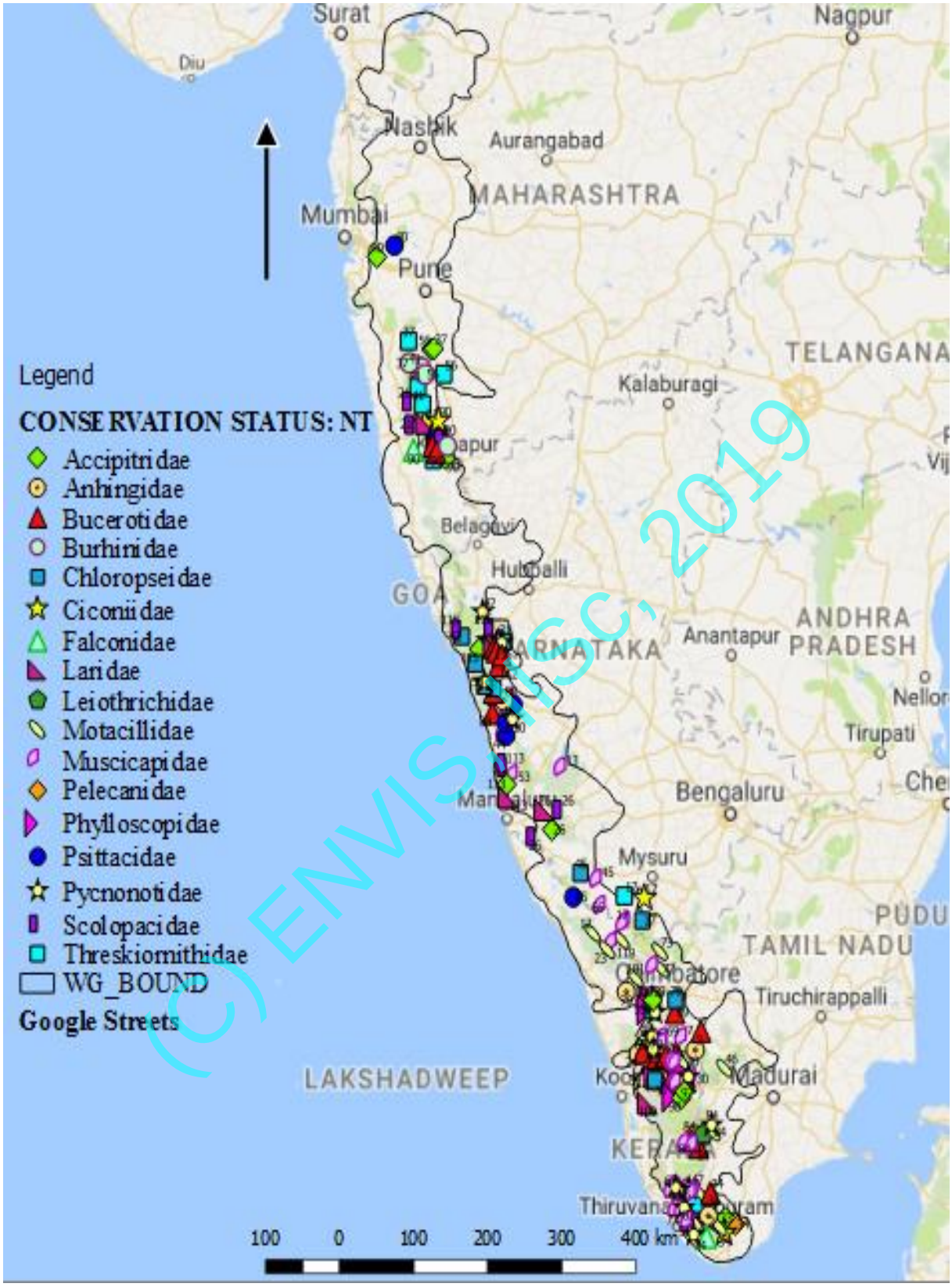


Fig. 6.5.42. Spatial distribution of near threatened Birds families.

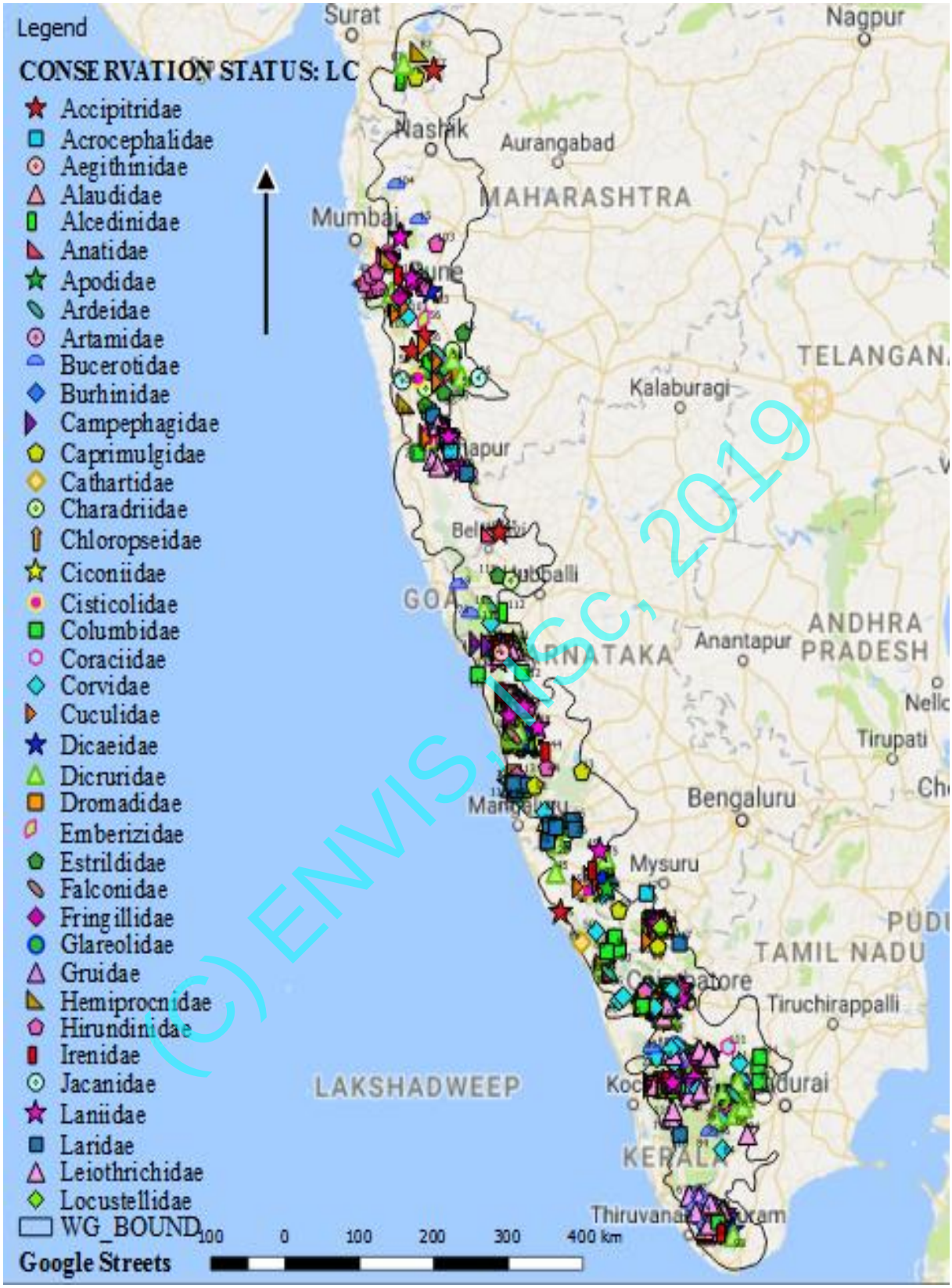


Fig. 6.5.43a. Spatial distribution of least concern Birds families.

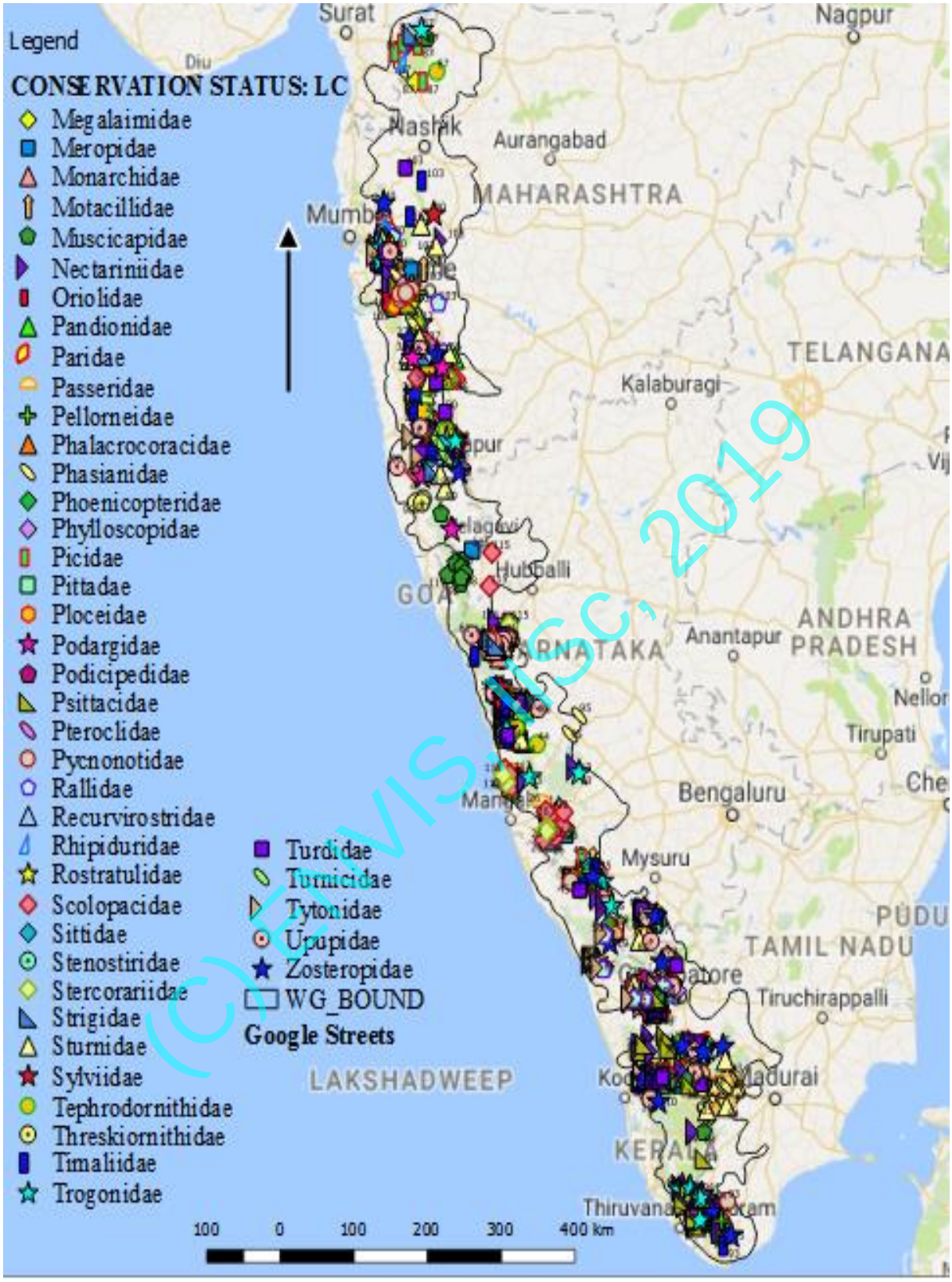


Fig. 6.5.43b. Spatial distribution of least concern Birds families.

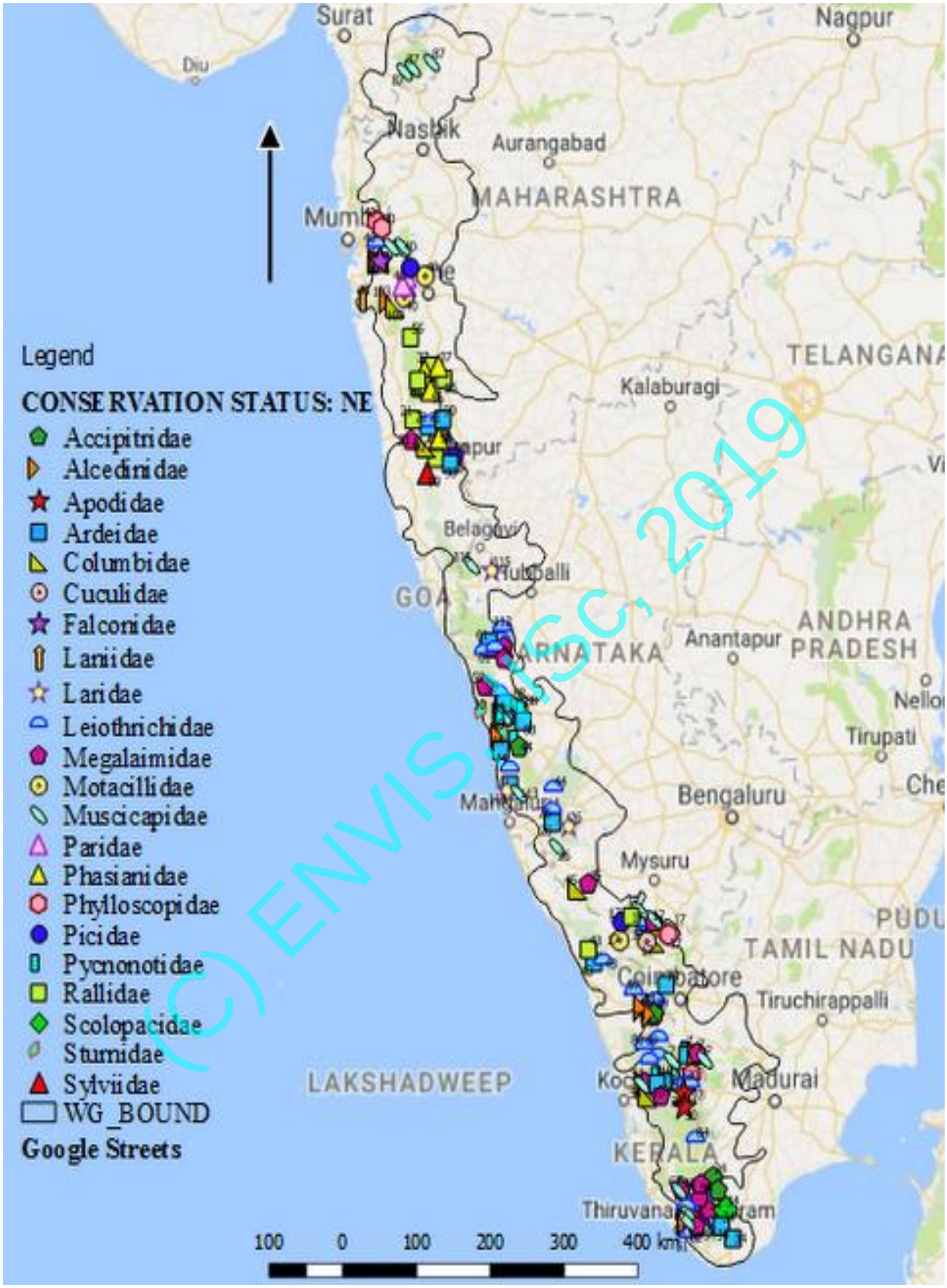


Fig. 6.5.44. Spatial distribution of not evaluated Birds families.

6.6. MAMMALS

Mammals are warm-blooded vertebrates belongs to the Phylum chordata. Other characteristic features include, four-chambered heart, single jaw bone, sweat glands and presence of hair on the body. Females process mammary glands that secrete milk to nourish their young ones. Globally 4629 mammalian species were described (Sreedharan, 2004).

Western Ghats has 161 species of Mammals across 148 locations, as per the reviewed literature. The study sites include Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu state portions of Western Ghats (WG) region (Fig. 6.6.1). The literature highlights studies have identified 156 species up to species level and 5 species has up to genera. WG region has 32 families of mammals. They are Bovidae, Canidae, Cercopithecidae, Cervidae, Elephantidae, Emballonuridae, Equidae, Erinaceidae, Felidae, Herpestidae, Hipposideridae, Hyaenidae, Hystricidae, Leporidae, Lorisidae, Megadermatidae, Molossidae, Muridae, Mustelidae, Pholidota, Platacanthomyidae, Pteropodidae, Rhinolophidae, Rhinopomatidae, Sciuridae, Soricidae, Suidae, Tragulidae, Tupaiidae, Ursidae, Vespertilionidae, and Viverridae. Vespertilionidae is the largest family consists of 25 species present in the WG. Elephantidae, Erinaceidae, Hyaenidae, Hystricidae, Leporidae, Pholidota, Platacanthomyidae, Suidae, Ursidae, and Tupaiidae are the smallest families consist of only one species, *Elephas maximus, Hemiechinus nudiventris, Hyaena hyaena, Hystrix indica, Lepus nigricollis, Manis crassicaudata, Platacanthomys lasiurus, Sus scrofa, Melursus ursinus* and *Anathana ellioti* respectively (Fig. 6.6.2). Cercopithecidae, Felidae, Hipposideridae, Hystricidae, Muridae, Rhinolophidae, Suidae, Ursidae, and Vespertilionidae are widely distributed mammalian family, reported across the regions of WG. Families like Bovidae, Canidae, Leporidae, Pteropodidae, Sciuridae, Tragulidae, and Viverridae show higher distribution in the WG regions of Maharashtra, Karnataka, Kerala, and Taminadu. Elephantidae, Emballonuridae, Megadermatidae, Mustelidae and Soricidae are the families show higher distribution in Karnataka, Kerala and Tamilnadu regions of WG. Equidae, Molossidae, and Platacanthomyidae has distributed across southern WG region. Erinaceidae, Rhinopomatidae and Tupaiidae reported from the WG region of Tamilnadu.

Distribution based on the family

The **Bovidae** are the mammalian family includes bison, African buffalo, water buffalo, antelopes, sheep, goats, muskoxen and cattle. WG has 11 species of Bovidae family *Antilope cervicapra, Bos gaurus, Bos taurus, Bos taurus primigenius, Bubalus bubalis, Capra hircus, Capra hircus aegagrus, Capra indicus, Nilgiritragus hylocrius, Ovis sp* and *Tetracerus quadricornis* distributed across the regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.3). Nilgiri tahr, *Nilgiritragus hylocrius* is the endemic species has distributed across the Southern WG. *Capra indicus* shows higher distribution in the WG areas of Kerala (Vijayakumar et al., 2015). According to the IUCN Red list, *Nilgiritragus hylocrius* is categorized as endangered species. Other Bovidae species, As per the review, *Bos gaurus* (Indian bison) is most widely distributed mammalian species present in the WG. *Antilope cervicapra, Bubalus bubalis* and *Tetracerus quadricornis* are categorized as near threatened, endangered and vulnerable respectively. *Nilgiritragus hylocrius, Antilope cervicapra,* and *Bos gaurus* are legally protected by including in the Schedule I of Indian Wildlife Protection Act. *Tetracerus quadricornis*, commonly known as Four-horned Antelope is legally protected by including in Schedule I of Indian Wildlife Protection Act, Appendix III of CITES.

Erinaceidae is the mammalian family which includes hedgehogs. It is one of the smallest families present in the WG. Only one species of this family, *Hemiechinus nudiventris* is reported from the WG part of Tamilnadu (Srinivas et al., 2013; Johnsingh, 2001) (Fig. 6.6.3). It is commonly known as Madras hedgehog or Bare-bellied hedgehog. According to IUCN Red list, it is considered as least concern species.

Canidae family includes carnivore mammals like domestic dogs, wolves, foxes, jackals, dingoes etc. *Canis aureus, Canis familiaris, Canis lupus, Cuon alpines* and *Vulpes bengalensis* are the canidae species present in the WG. As per the review, it shows higher distribution in the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.4). *Canis familiaris* is reported by Padmanabhan and Sujana (2008) from Palakkad district of Kerala.*Canis aureus* and *Cuon alpines* show wide distribution across the WG region. *Cuon alpines* is also considered as endangered species by IUCN and it is legally protected by including in Schedule II of Indian Wildlife Protection Act and Appendix II of CITES. *Canis lupus* is the Indian Grey Wolf species which is protected by Appendix II of CITES shows higher distribution in Maharashtra, Karnataka and Tamilnadu portions of WG. While *Vulpes bengalensis* shows higher distribution in the WG areas of Karnataka and Tamilnadu only and it is legally protected

by including in the schedule II of Indian Wildlife Protection Act, 1972. Common Jackal or Asiatic jackal (*Canis aureus*) is legally protected by Indian Wildlife Protection Act, Schedule III and Appendix III of CITES.

Emballonuridae are the family of sac-winged or sheath-tailed bats. *Taphozous longimanus, T. melanopogon, T. saccolaimus, T. nudiventris* and *T. theobaldi* are 5 Emballonuridae members present in the WG. These species have distributed across the central and southern WG (Fig. 6.6.4). Korad et al (2007) reported *Taphozous longimanus, T. nudiventris, T. saccolaimus* and *T. theobaldi* from the Karnataka region of WG.

Cercopithecidae is the family of monkeys. *Macaca fascicularis, Macaca radiata, Macaca silenus, Macaca sp, Semnopithecus dussumieri, Semnopithecus entellus, Semnopithecus entellus hypoleucos, Semnopithecus priam* and *Trachypithecus johnii* are the Cercopithecidae members distributed across the WG region of Maharashtra, Goa, Karnataka, Kerala and Tamilnadu (Fig. 6.6.5) As per the reviewed literatures, *Macaca fascicularis* is highly distributed in the WG region of Kerala (Vijayakumar et al., 2015). According to the IUCN red list conservation status, *Macaca silenus, Trachypithecus johnii* and *Semnopithecus priam* are categorized as endangered, vulnerable and near threatened species respectively. These species show higher distribution in the central and southern WG. Bonnert macaque, *Macaca radiata* has widely distributed across the Goa, Maharashtra, Kerala and Tamilnadu regions of WG. *Semnopithecus dussumieri* is the Cercopithecidae species present in WG region of Goa (Kumara and Singh, 2011). *Semnopithecus entellus hypoleucos* is reported from the WG regions of Karnataka and Kerala and it is commonly known as Common langur. *Macaca silenus* is the endemic Cercopithecidae species present in the WG region. *Trachypithecus johnii* is legally protected by Indian Wildlife Protection Act 1972 as amended up to 1991 by including in Schedule II Part I and Appendix II of CITES. Similarly, *Semnopithecus priam* in Appendix I of CITES and Schedules II, Part I of Indian Wildlife Protection Act, 1972 amended up to 2002. *Semnopithecus entellus* in schedule II of Indian Wildlife Protection Act 1972 as amended up to 1991 and Appendix I of CITES, *Semnopithecus dussumieri* in Appendix I of CITES and Schedule II, Part II of Indian Wildlife Protection Act, 1973. *Macaca silenus* in Appendix I of CITES and Schedule I, Part I of Indian Wildlife Protection Act, 1972 amended up to 2002. *Macaca radiata* is protected under Schedule II, Part I of Indian Wildlife Protection Act, 1972.

Hyaenidae is one of the smallest mammalian families present in the WG. *Hyaena hyaena* is the only member of this family present in WG region. It is commonly known as striped hyaena

and has distributed in the WG region of Maharashtra, Karnataka, and Tamilnadu (Fig. 6.6.5). According to IUCN conservation status, *Hyaena hyaena* is categorized as near threatened species and it is legally protected by including in Schedule III of Indian Wildlife Protection Act and Appendix III of CITES.

Cervidae family is commonly known as 'deer family'. WG has 3 species of Cervidae family, *Axis axis* commonly known as Indian Spotted Deer, *Muntiacus muntjak* (Barking Deer) and *Rusa unicolor* (Sambar Deer). These species are highly distributed in the WG areas of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.6). According to IUCN conservation status, *Rusa unicolor* is categorized as vulnerable species. All the three Cervidae species present in the WG are legally protected by including in Schedule III of Indian Wildlife Protection Act.

Elephantidae are the family of large, herbivorous mammals, elephants and mammoths. It one of the small families present in WG consists of only one species, Elephas maximus. As per the review, it has distributed across the WG region of Karnataka, Kerala, and Tamilnadu (Fig. 6.6.6). As per IUCN, it is an endangered species and legally protected by Indian Wildlife Protection Act by categorizing under Schedule I.

Equidae family comprises horses, donkeys, and zebras. *Equus africanus*, *Equus africanus asinus*, *Equus ferus caballus* and an unidentified *Equus species* were reported from the southern WG regions (Fig. 6.6.7). *Equus africanus* and *Equus ferus caballus* are widely distributed in the WG region of Tamilnadu (Chellappandian et al., 2014) and *Equus africanus asinus* is reported from the Kerala region (Vijayakumar et al., 2015). IUCN categorize *Equus africanus* as a critically endangered species.

Felidae is the cat family which includes cheetah, puma, jaguar, leopard, lion, lynx, tiger, and domestic cat. WG has 7 Felidae members; they are *Felis catus*, *Felis chaus*, *Panthera pardus*, *Panthera tigris*, *Prionailurus bengalensis*, *Prionailurus rubiginosus* and *Prionailurus viverrinus*. This is one of the highly distributed families across the WG region of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.7). *Panthera tigris* is the widely distributed felidae species, as per the review, it is the only Felidae species reported from the WG region of Gujarat (Trivedi and Soni, 2006). According to IUCN red list, *Panthera pardus*, *Panthera tigris*, and *Prionailurus rubiginosus* are grouped as vulnerable, endangered species and near threatened species respectively. As per the legal protection *Panthera pardus*, *Prionailurus bengalensis* and *Prionailurus rubiginosus* are included in the Schedule I of Indian

Wildlife Protection Act. Srinivas et al (2013) reported *Prionailurus viverrinus*, commonly known as Fishing Cat from the WG regions of Tamilnadu and it is also legally protected by adding in Appendix II of CITES.

Herpestidae family is the mammalian family of small carnivores popularly known for mongoose. *Herpestes brachyurus, Herpestes edwardsii, Herpestes fuscus, Herpestes javanicus, Herpestessmithii*and *Herpestes vitticollis* are the Herpestidae species present in the WG region. It has distributed across the areas of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.8). As per the reviewed literature, *Herpestes brachyurus* (Kumara, 2007) and *Herpestes javanicus* (Ali et al., 2006) are reported from the WG region Karnataka. *Herpestes brachyurus* is a near threatened species. Indian Brown Mongoose, *Herpestes fuscus*, Ruddy Mongoose, *Herpestessmithii* and Stripe-necked Mongoose, *Herpestes vitticollis* are the legally protected Herpestidae species present in WG. *Herpestes fuscus* and *Herpestes vitticollis* are included in Schedule II of Indian Wildlife Protection Act and *Herpestes smithii* is included in Appendix III of CITES and schedule IV of Indian Wildlife Protection Act.

Hystricidae is one of the smallest and widely distributed mammalian families present in the WG. This family includes large terrestrial rodents, Porcupines. *Hystrix indica* is the only species present across the WG regions of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.8). *Hystrix indica* is commonly known as Indian porcupine or Indian crested porcupine. As per the IUCN status, it is considered as least concern species and it is legally protected by including under Schedule IV of Indian Wildlife Protection Act. It shows a habitat preference of Rocky Hillsides, Tropical and Temperate Shrublands, Grasslands, Forests, Arable Lands, Plantations, and Gardens.

Hipposideridae is the family of leaf-nosed bat. WG has 6 Hipposideridae species, *Hipposideros ater, Hipposideros fulvus, Hipposideros galeritus, Hipposideros lankadiva, Hipposideros Pomona* and *Hipposideros speoris* distributed across the WG region of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.9) As per the review, *Hipposideros ater* has reported from the WG region of Tamilnadu (Johnsingh, 2001; Basil et al., 2015; Korad et al., 2007). *Hipposideros lankadiva* is reported from the Maharashtra region of WG (Korad et al., 2007).

Leporidae is the mammalian family includes rabbits and hares. It is one of the smallest family present in the WG which consists of only one species, *Lepus nigricollis*. It is distributed across the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.9). It is commonly

known as Indian Hare or Black-naped Hare. According to IUCN, *Lepus nigricollis* is categorized as least concern and legally protected by including in Schedule IV of Indian Wildlife Protection Act.

Mustelidae is the family of carnivorous mammals including otter, marten etc. *Amblonyx cinereus, Lutra lutra, Lutrogale perspicillata, Martes gwatkinsii* and *Mellivora capensis* are the Mustelidae species distributed across the WG region of Karnataka, Kerala, and Tamilnadu (Fig. 6.6.10). Gubbi et. al., (2014) reported Mellivora capensis, commonly known as Honey Badger from the WG region of Karnataka. *Martes gwatkinsii* (Nilgiri marten) is the only Mustelidae species which is endemic to WG. According to IUCN red list, *Amblonyx cinereus, Lutrogale perspicillata* and *Martes gwatkinsii* are categorized as vulnerable species and *Lutra lutra* is considered as near threatened species. *Amblonyx cinereus* is legally protected by including in Schedule II of Indian Wildlife Protection Act 1972 as ammended upto 1999 and Appendix II of CITES. *Lutrogale perspicillata, Mellivora capensis,* and *Martes gwatkinsii* are legally protected by including in Appendix II of CITES, Appendix III of CITES and schedule II Part II of Indian Wildlife Protection Act and Appendix III of CITES respectively.

Molossidae is the family of free-tailed bats belongs to the order Chiroptera. WG has 4 species, *Otomops wroughtoni, Tadarida aegyptiaca* and *Tadarida plicata* and has distributed across the regions of southern WG (Fig. 6.6.10). As per the review, *Otomops wroughtoni* is reported from the Kerala region of WG and legally protected by included in Schedule I of Indian Wildlife Protection Act amended in 2006. *Tadarida plicata* is reported from the WG region of Tamilnadu (Korad, 2007).

Muridae is the mammalian family of rodents. It is one of the largest and widely distributed mammalian families present in the WG. *Bandicota bengalensis, B. indica, B. sp, Golunda ellioti, Millardiakondana, M. meltada, Mus booduga, Mus cervicolor paillica, M. famulus, M. musculus, M. platythrix, M. sp, Rattus ranjiniae, R. rattus, Rattus rattus wroughtoni, R. rufescens, R. satarae, Tatera indica, Vandeleuria nilagirica* and *V. oleracea* are the Muridae species distributed in the WG regions of Maharashtra, Goa, Karnataka, Kerala and Tamilnadu (Fig. 6.6.11). As per the review, *Rattus ranjiniae* is reported from the WG regions of Kerala (Nameer et al., 2015), *Tateraindica* is reported from the WG region of Tamilnadu (Johnsingh, 2001) and *Mus cervicolor paillica* is reported from Kerala regions (Radhakrishnan, 2003) and *Millardiakondana* from Maharashtra region of WG (Talmale et al., 2013). *Rattus rattus wroughtoni*, *Rattus satarae* and *Vandeleuria nilagirica* are the species endemic to WG and it

is highly distributed in the Karnataka region of WG (Molur and Singh, 2009). Majority of Muridae species are legally protected. These species are added in the schedule V of Indian Wildlife Protection Act which includes, *Bandicota bengalensis, B. indica, Golunda ellioti, Millardiakondana, M. meltada, Mus booduga, Mus cervicolorpaillica, M. famulus, Rattus ranjiniae, Rattus rattus wroughtoni, R. satarae, Tatera indica, Vandeleuria nilagirica* and *Vandeleuria oleracea.*

Megadermatidae family includes false vampire bats. Megaderma is the only one genera present in the WG region. *Megaderma lyra* and *Megaderma spasma* are the two Megadermatidae species present in the regions of central and southern WG (Fig. 6.6.11). Both species were considered as least concern by IUCN Red data list.

Pteropodidae is the mammalian family belongs to the order Chiroptera consists of fruit bats. WG has 6 Pteropodidae species, which comprises *Cynopterus brachyotis, Cynopterus sphinx, Eonycteris spelaea, Latidens salimalii, Pteropus giganteus* and *Rousettus leschenaultia*. These species are distributed in the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.12). As per the reviewed literatures, *Eonycteris spelaea* is reported from the WG region of Kerala (Korad et al., 2007). *Cynopterus brachyotis* shows higher distribution in Karnataka and Tamilnadu regions of WG. According to the IUCN conservation status, *Latidens salimalii* is categorized as endangered species. *Cynopterus brachyotis, Cynopterus sphinx, Rousettus leschenaultia* and *Cremnomys blanfordi* included in Schedule V of Indian Wildlife Protection Act and *Latidens salimalii* is included in the Schedule I of Indian Wildlife Protection Act.

Platacanthomyidae is one of the smallest rodent families present in the WG. *Platacanthomys lasiurus* is the only one species of Platacanthomyidae family distributed across the regions of Southern WG (Fig. 6.6.12). It is commonly known as Malabar spiny dormouse and it is endemic to WG. According to IUCN conservation status, it is categorized as vulnerable species and protected according to Indian Wildlife Protection Act, Schedule V.

Rhinolophidae is the family of Horseshoe bats. It is one of the widely distributed mammalian families present in the WG. Members of Rhinolophidae family present in the WG region are *Cremnomys blanfordi, Rhinolophus affinis, Rhinolophus beddomei, Rhinolophus Lepidus, Rhinolophus luctus, Rhinolophus pusillus* and *Rhinolophus rouxii*. These species are distributed across Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.13). Korad et al (2007) reported *Rhinolophus affinis, Rhinolophus pusillus, Rhinolophus beddomei,*

Rhinolophus rouxii and *Rhinolophus luctus* are the from the Western Ghats region. *Cremnomys blanfordi* are legally protected by including under Schedule V of Indian Wildlife Protection Act, 1972.

Rhinopomatidae is the family of insectivorous mouse-tailed bats. Rhinopoma is the only genera of Rhinopomatidae family present in the WG. *Rhinopoma hardwickii* and *Rhinopoma microphyllum* are the two species present across the WG region of Tamilnadu (Fig. 6.6.13). These species are classified under least concern category.

Manidae is the only mammalian family belongs to the order Pholidota and this family has only one genus, Manis. *Manis crassicaudata* is the only Manidae species present in the WG region of Maharashtra, Karnataka, and Tamilnadu (Fig. 6.6.13). This species is commonly known as Indian Pangolin. Indian Wildlife Protection Act, Schedule It is categorized as endangered species and included in Schedule I of Indian Wildlife Protection Act.

Soricidae is the mammalian family which commonly includes shrews. *Feroculus feroculus, Suncus dayi, Suncus etruscus, Suncus montanus, Suncus murinus* and *Suncus niger* are the Soricidae species present in WG region and it has distributed across the WG region of Karnataka, Kerala, and Tamilnadu (Fig. 6.6.14). As per the review, *Feroculus feroculus* is reported from the Western Ghats region of Kerala (Radhakrishnan, 2002). *Suncus dayi* is the only Soricidae species which is endemic to WG and it is categorized as endangered species. *Suncus murinus*, commonly known as House Shrew is the highly distributed species in the WG.

Lorisidae is the family of strepsirrhine primates which includes arboreal mammals like lorises, pottos, and angwantibos. WG has 3 Lorisidae species; it includes *Loris lydekkerianus lydekkerianus, Loris lydekkerianus malabaricus* and *Loris tardigradus*. These are distributed across the regions of Maharashtra, Goa, Karnataka, and Tamilnadu (Fig. 6.6.14). *Loris tardigradus* is an endangered species reported from the WG region of Tamilnadu (Johnsingh, 2001; Seshadri and Ganesh. 2011). *Loris lydekkerianus lydekkerianus* and *Loris lydekkerianus malabaricus* are legally protected and included in Schedule I of Indian Wildlife Protection Act.

Suidae is the family of pigs, hogs, or boars. *Sus scrofa* is the only one Suidae species present in the WG. It is distributed in the WG region of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.14). This species is included in the Schedule I and III of Indian Wildlife Protection Act.

Sciuridae is the family contains squirrels. *Ammospermophilus interpres, Funambulus palmarum, Funambulus sublineatus, Funambulus tristriatus, Funamhulus layardi, Petaurista petaurista, Petaurista philippensis, Petinomys fuscocapillus, Ratufa indica* and *Ratufa macroura* are the Sciuridae family present in the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.15). *Funambulus tristriatus* is the only Sciuridae species which is endemic to WG. As per the IUCN conservation status, *Funambulus sublineatus* and *Ratufa macroura* are categorized as vulnerable and near threatened species respectively. According to the reviewed literatures, *Funamhulus layardi* and *Ammospermophilus interpres* are reported from Kerala region of WG (Radhakrishnan, 2002; Vijayakumar et al., 2015). *Petaurista petaurista* is reported from the Karnataka region (Ali et al., 2006). *Petaurista petaurista, Petaurista philippensis,* and *Ratufaindica* are the legally protected species under Schedule II of Indian Wildlife Protection Act and *Petinomys fuscocapillus* is under Schedule I. *Ratufa macroura* is included in Schedule II and CITES.

Tragulidae is the family which includes the species of deer-mouse. *Moschiola indica* and *Moschiola meminna* are the two species present in the WG region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.15). *Moschiola indica* (Indian deer mouse) is legally protected by including in Schedule I of Indian Wildlife Protection Act.

Vespertilionidae is the largest bat family which includes evening bats or common bats. It is the largest bat family present in the WG. There are 25 species; *Barbastella leucomelas darjelingensis, Harpiocephalus harpia, Harpiocephalus harpia madrassius, Hesperoptenus tickelli, Hypsugo savii, Kerivoula hardwickii, Kerivoula lenis, Kerivoula picta, Mimiopterus fuliginosus, Miniopterus schreibersii, Miniopterus pusillus, Murina cyclottis, Myotis horsfieldii, Myotis montivagus, Pipistrellus affinis, Pipistrellus ceylonicus, Pipistrelluscoromandra, Pipistrellus javanicus, Pipistrellus kuhlii, Pipistrellus mimus, Pipistrellus pipistrellus, Scotophilus kuhlii* and *Scotophilus heathii.* These species are distributed across the WG region of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.16). *Barbastella leucomelas darjelingensis, Hesperoptenus tickelli, Mimiopterus fuliginosus, Miniopterus pusillus, Myotis horsfieldii, Myotis montivagus, Pipistrellus ceylonicus* and *Scotophilus kuhlii* are reported from the Tamilnadu regions of WG (Wordley et al., 2014). Radhakrishnan, 2002 reported *Harpiocephalus harpia madrassius* from the WG region of Kerala. *Hypsugo savii, Kerivoula hardwickii* and *Kerivoula lenis* are reported from the Maharashtra, Karnataka, and Kerala respectively (Korad, 2007).

Viverridae is the family consists of small-medium sized animals such as otter, civet etc. WG has *Lutrogale perspicillata*, *Paradoxurus hermaphrodites*, *Paradoxurus jerdoni*, *Viverra civettina*, Viverricula indica are the Viverridae species. These species has distributed across the region of Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.17). *Lutrogale perspicillata* is the Smooth Coated Otter is considered as vulnerable and Malabar Civet, *Viverricula indica* is categorized as critically endangered species. *Viverra civettina* is the endemic species present in the WG, it is commonly known as Malabar civet, Malabar large-spotted civet. *Paradoxurus jerdoni*, *Lutrogale perspicillata*, *Viverricula indica* are legally protected species.

Tupaiidae is the mammalian family of tree shrews. WG has only one Tupaiidae species, *Anathana ellioti*. It is commonly known as South Indian Tree shrew or Madras tree shrew. Srinivas et al (2013) reported *Anathana ellioti* from the Tamilnadu regions of WG (Fig. 6.6.17).

Ursidae is one of the smallest mammalian family present in the WG. *Melursus ursinus*, commonly known as Sloth bear is the Ursidae species distributed in the regions of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.17). According to the IUCN Red data list, it is categorized under the Category vulnerable and it is legally protected by including in the Schedule I of Indian Wildlife Protection Act of 1972 and Appendix I of CITES.

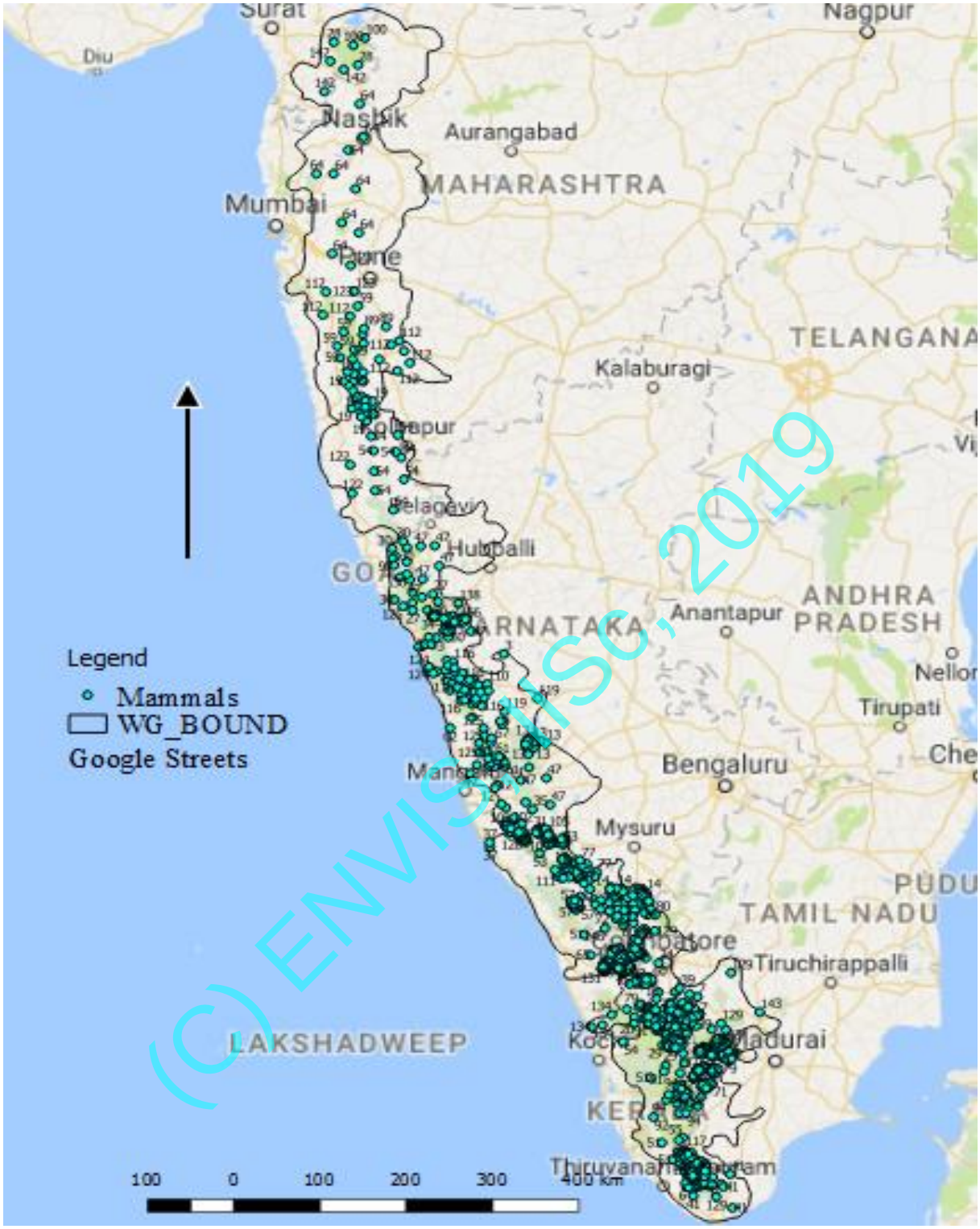


Fig. 6.6.1. Spatial distribution of Mammals in the WG.

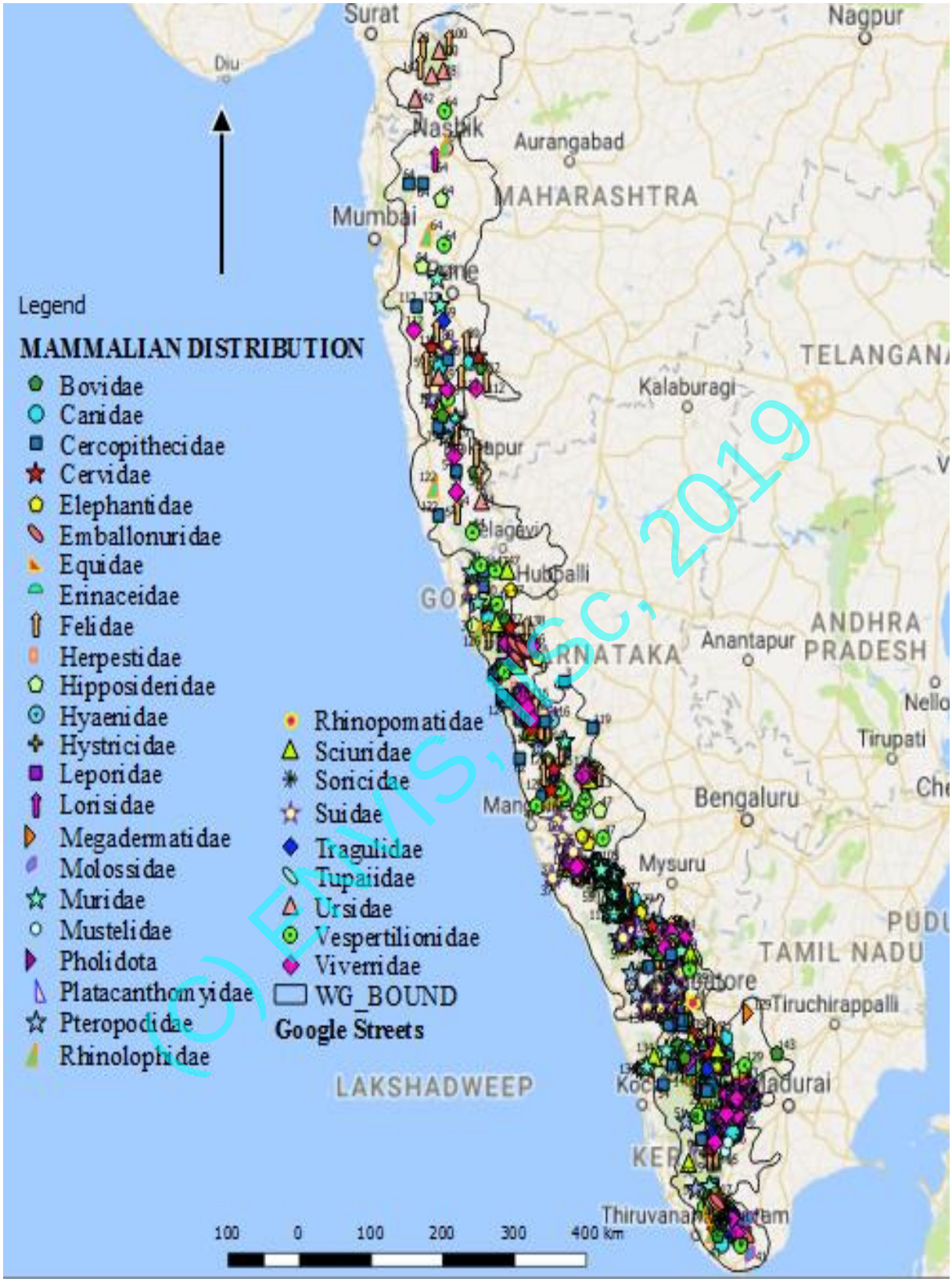


Fig. 6.6.2. Spatial distribution of Mammalian families in WG.

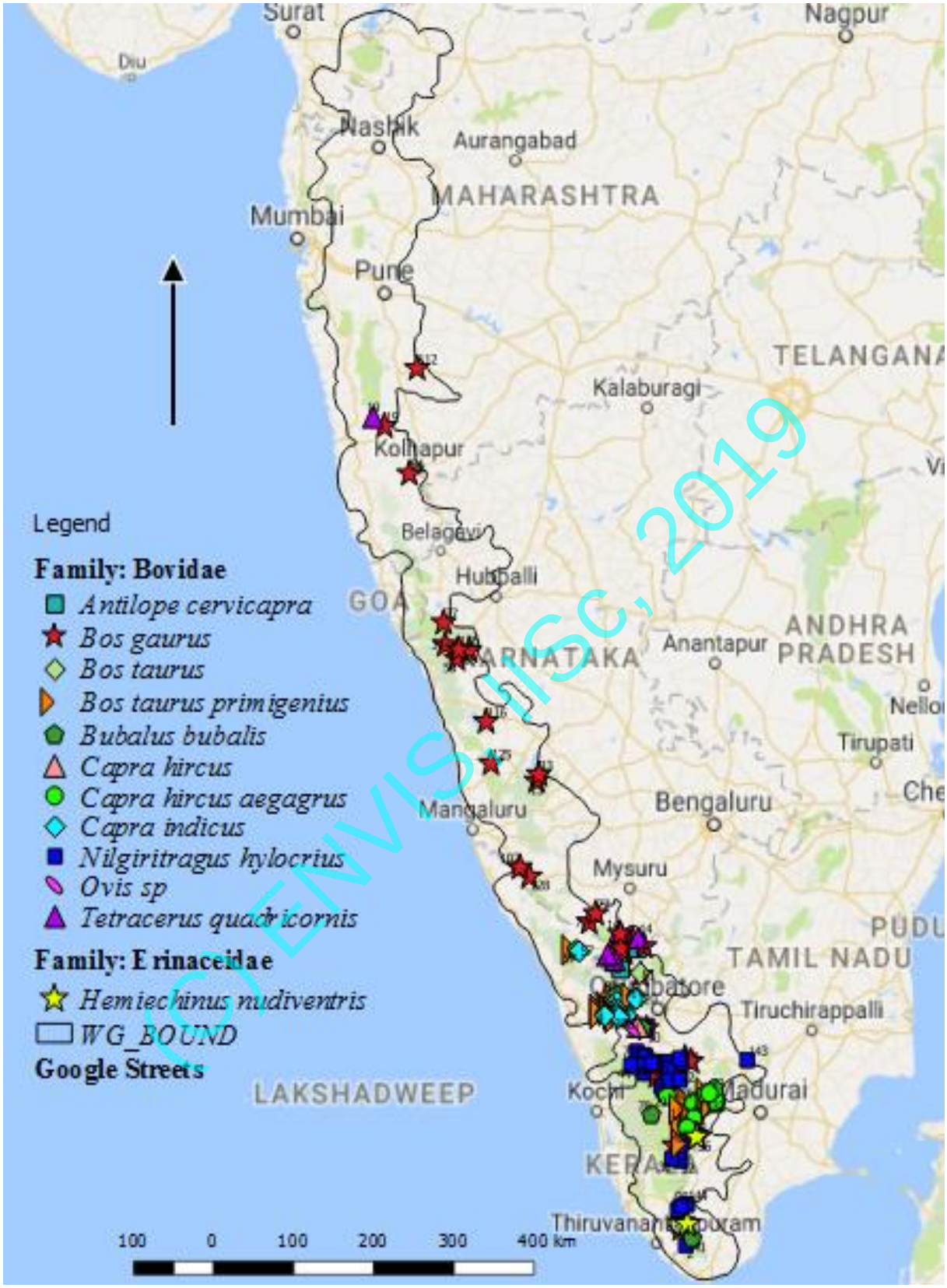


Fig. 6.6.3. Spatial distribution of the Bovidae and Erinceidae families.

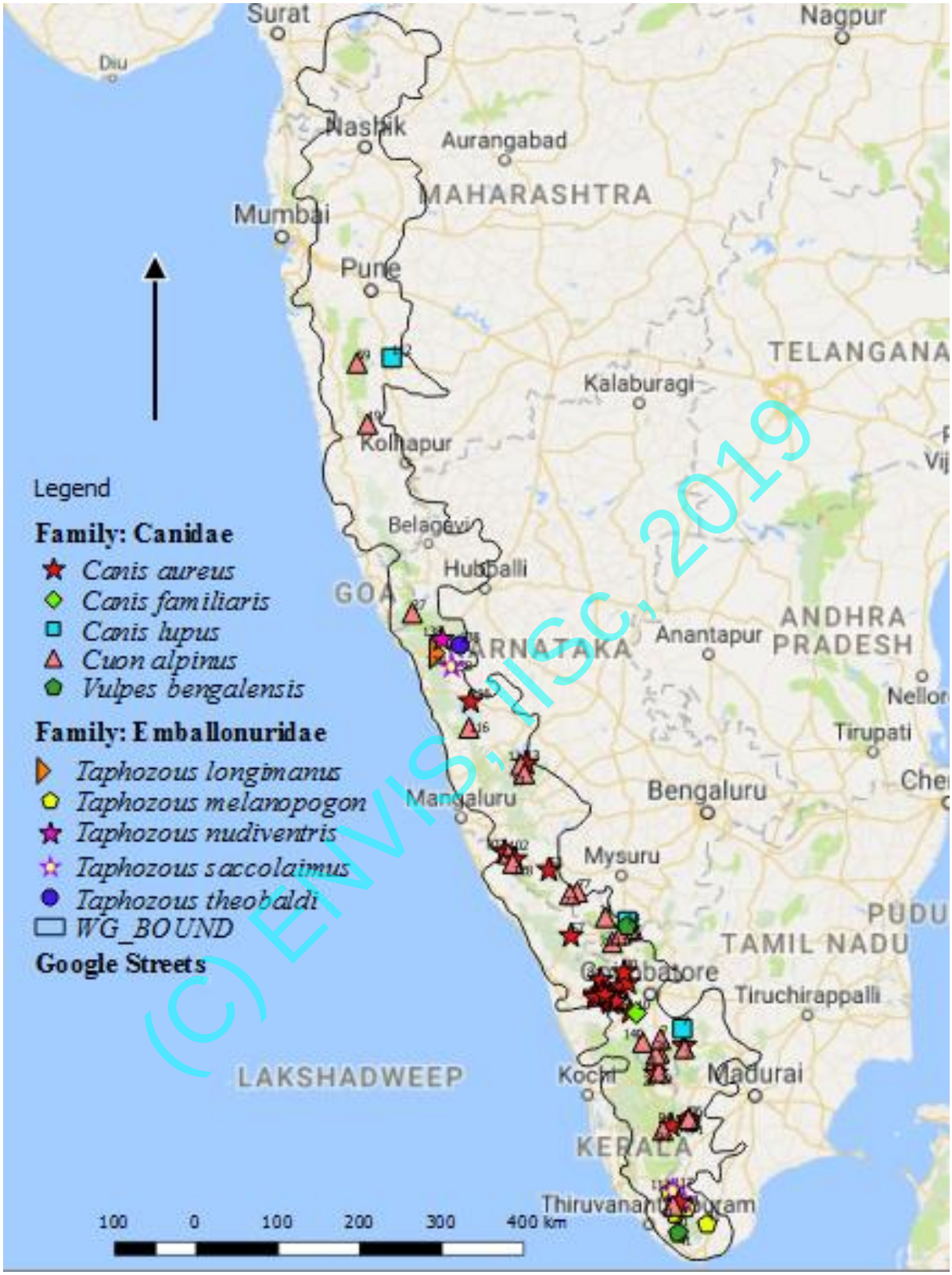


Fig. 6.6.4. Spatial distribution of the Canidae and Emballonuridae families.

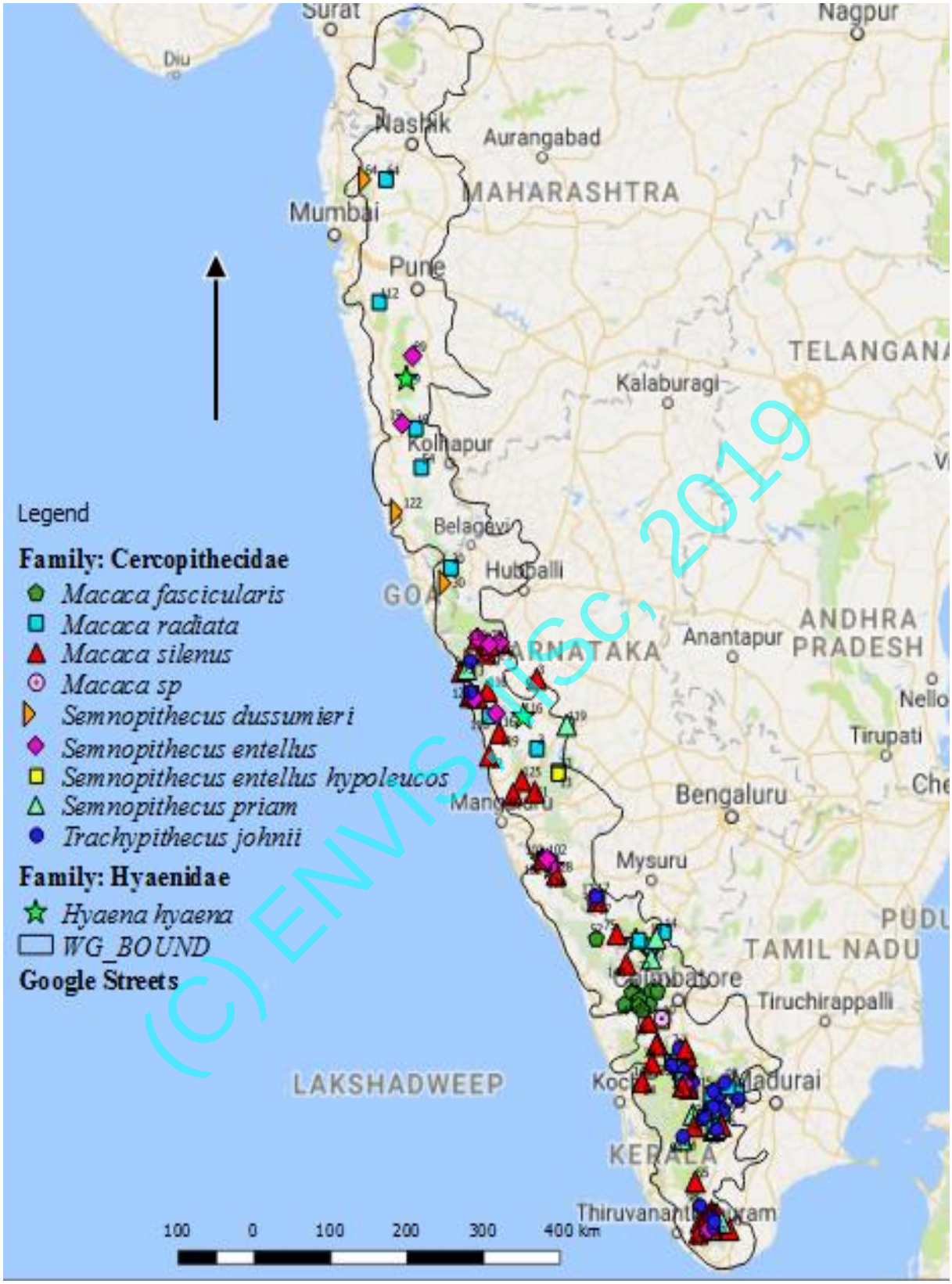


Fig. 6.6.5. Spatial distribution of the Cercopithecidae and Hyaenidae families.

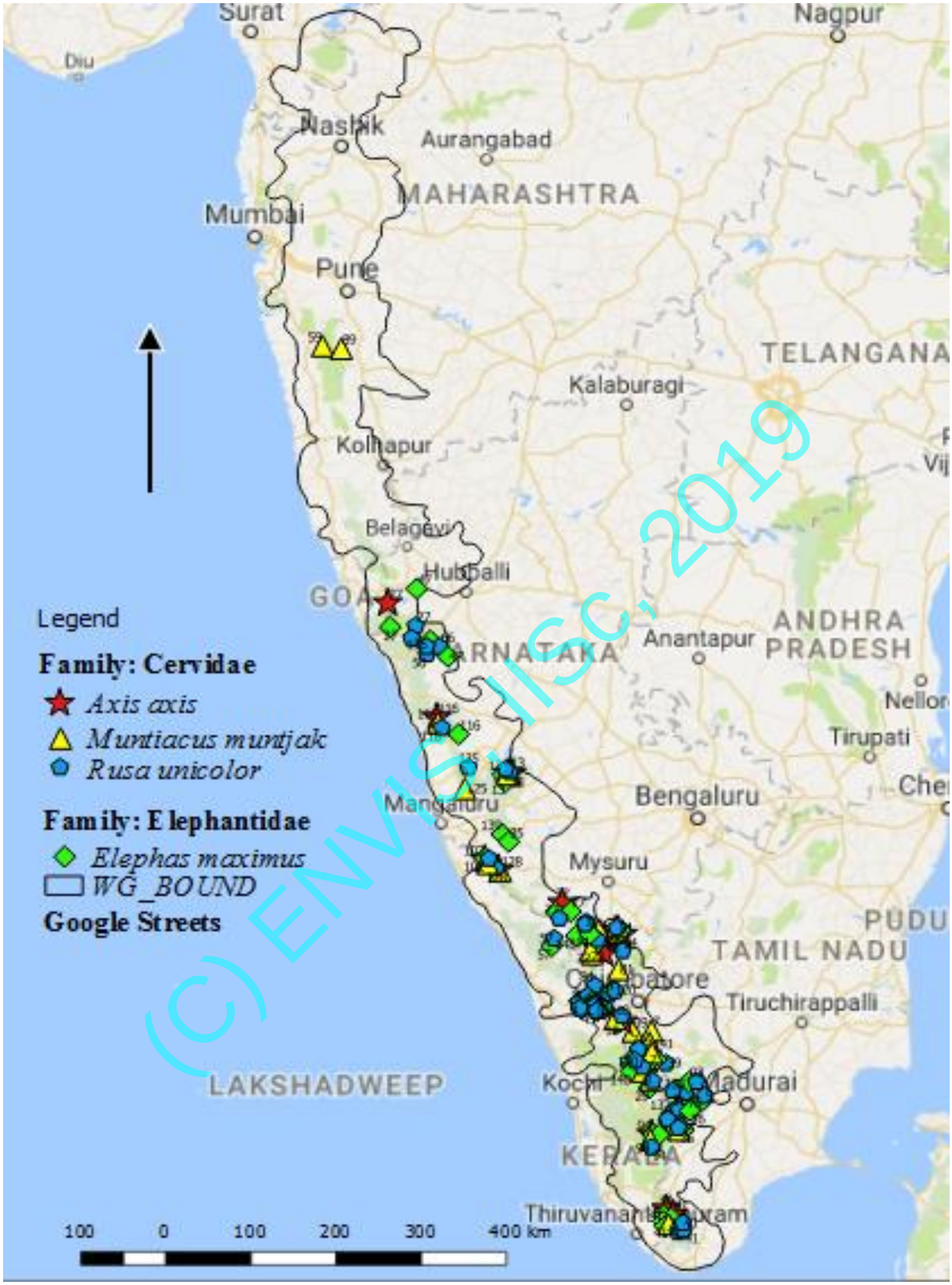


Fig. 6.6.6. Spatial distribution of the Cervidae and Elephantidae families.

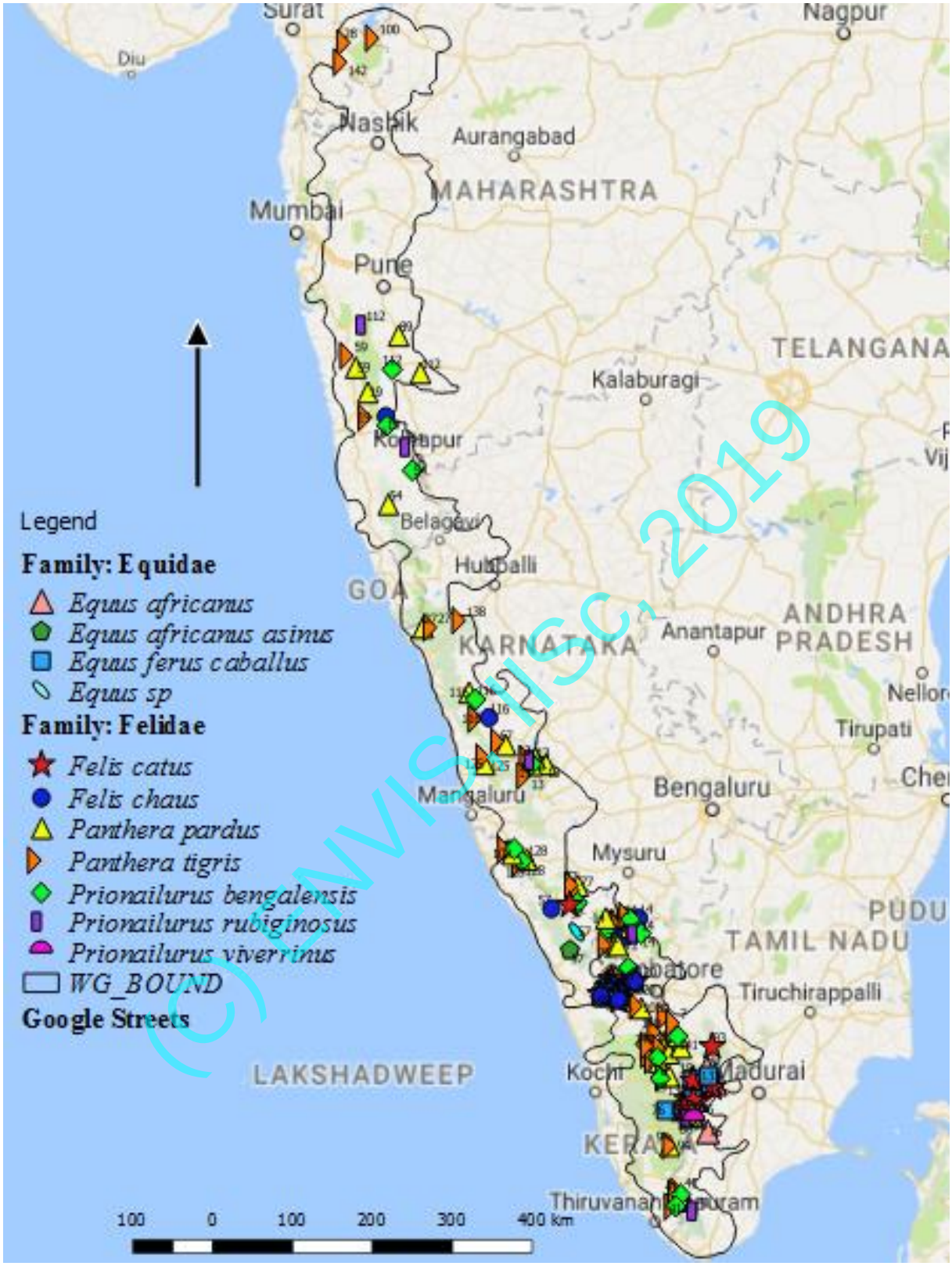


Fig. 6.6.7. Spatial distribution of the Equidae and Felidae families.

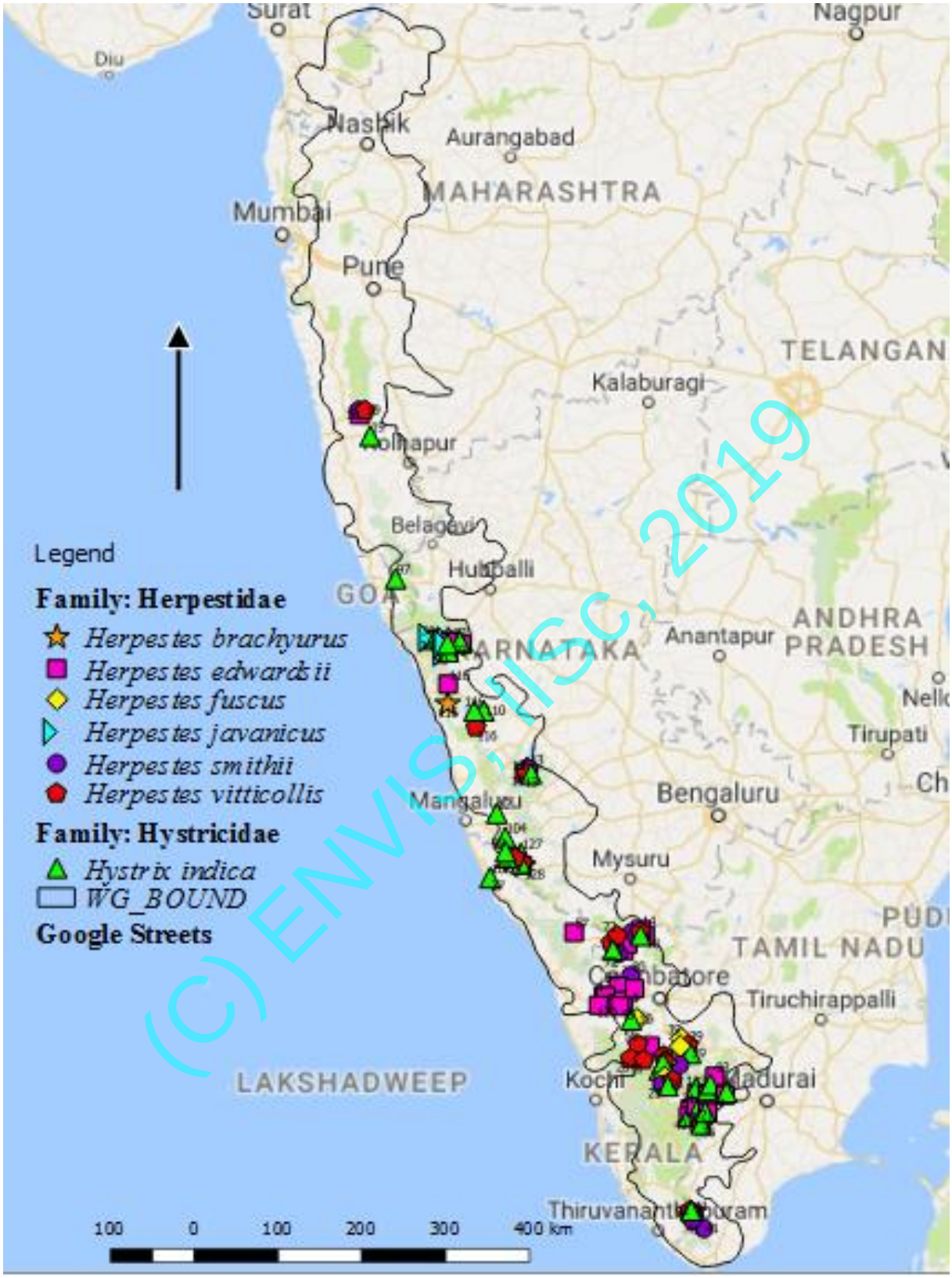


Fig. 6.6.8. Spatial distribution of the Herpestida and Hystricidae families.

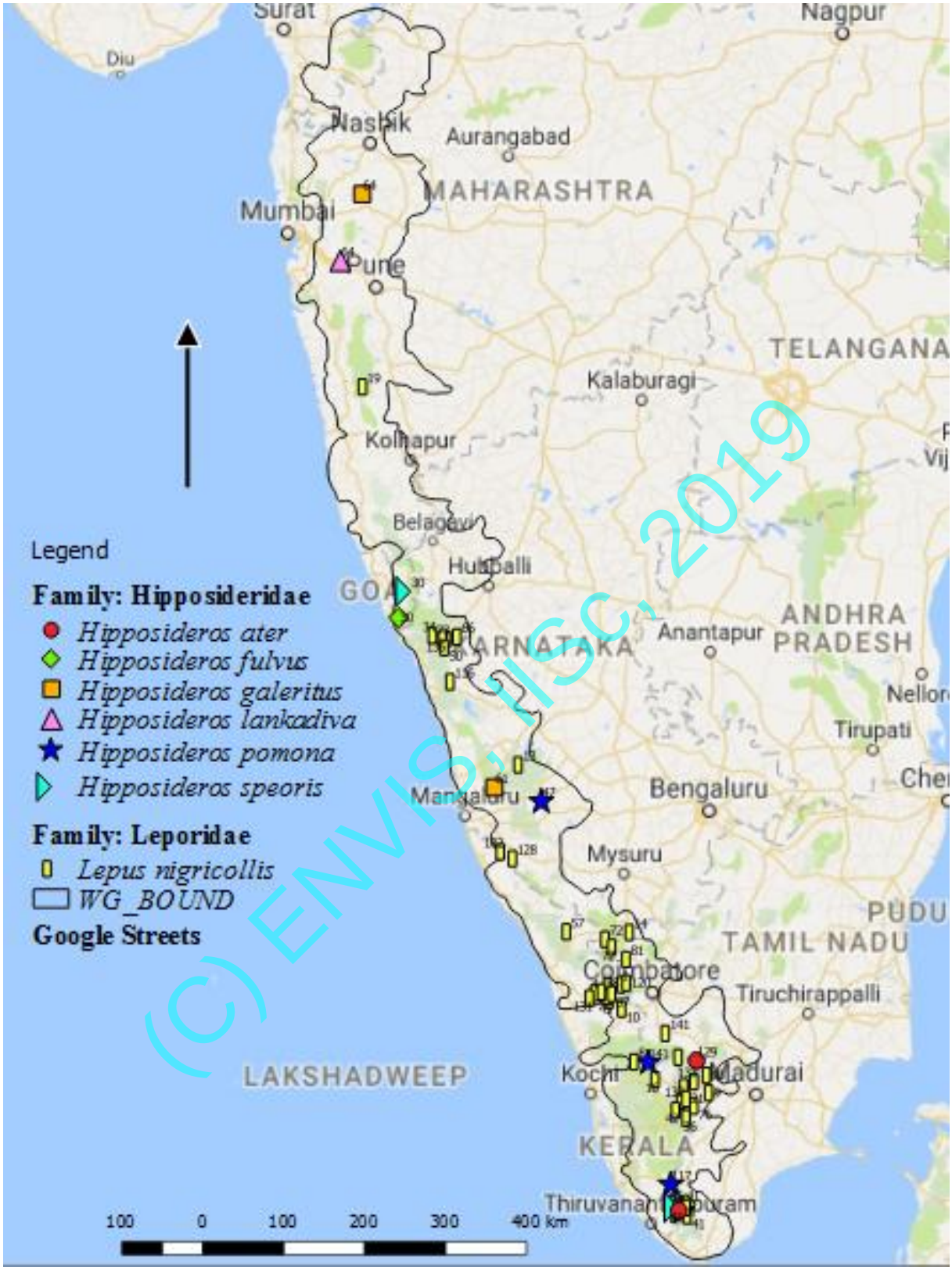


Fig. 6.6.9. Spatial distribution of the Hipposideridae and Leporidae families.

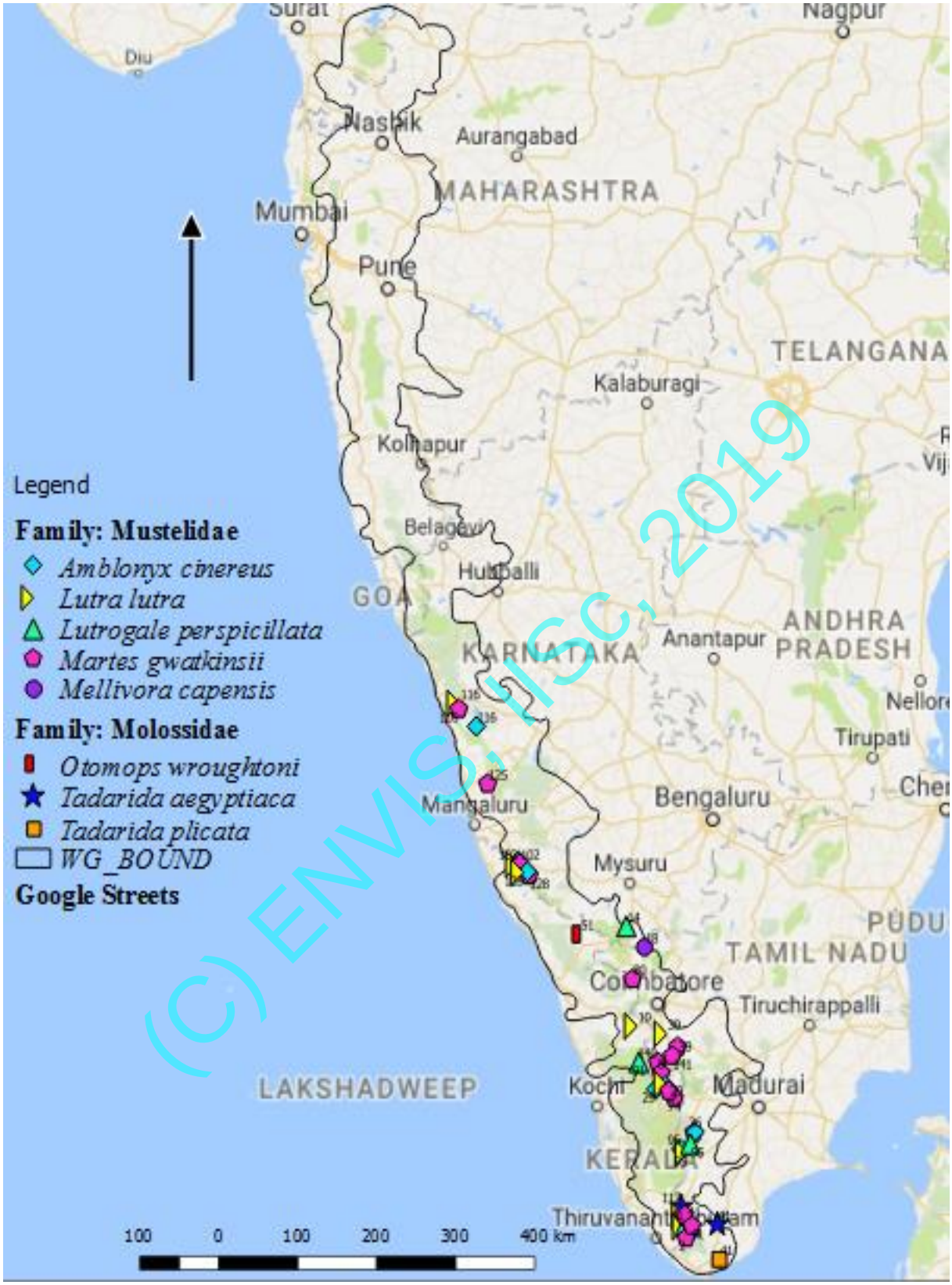


Fig. 6.6.10. Spatial distribution of the Mustelidae and Molossidae families.

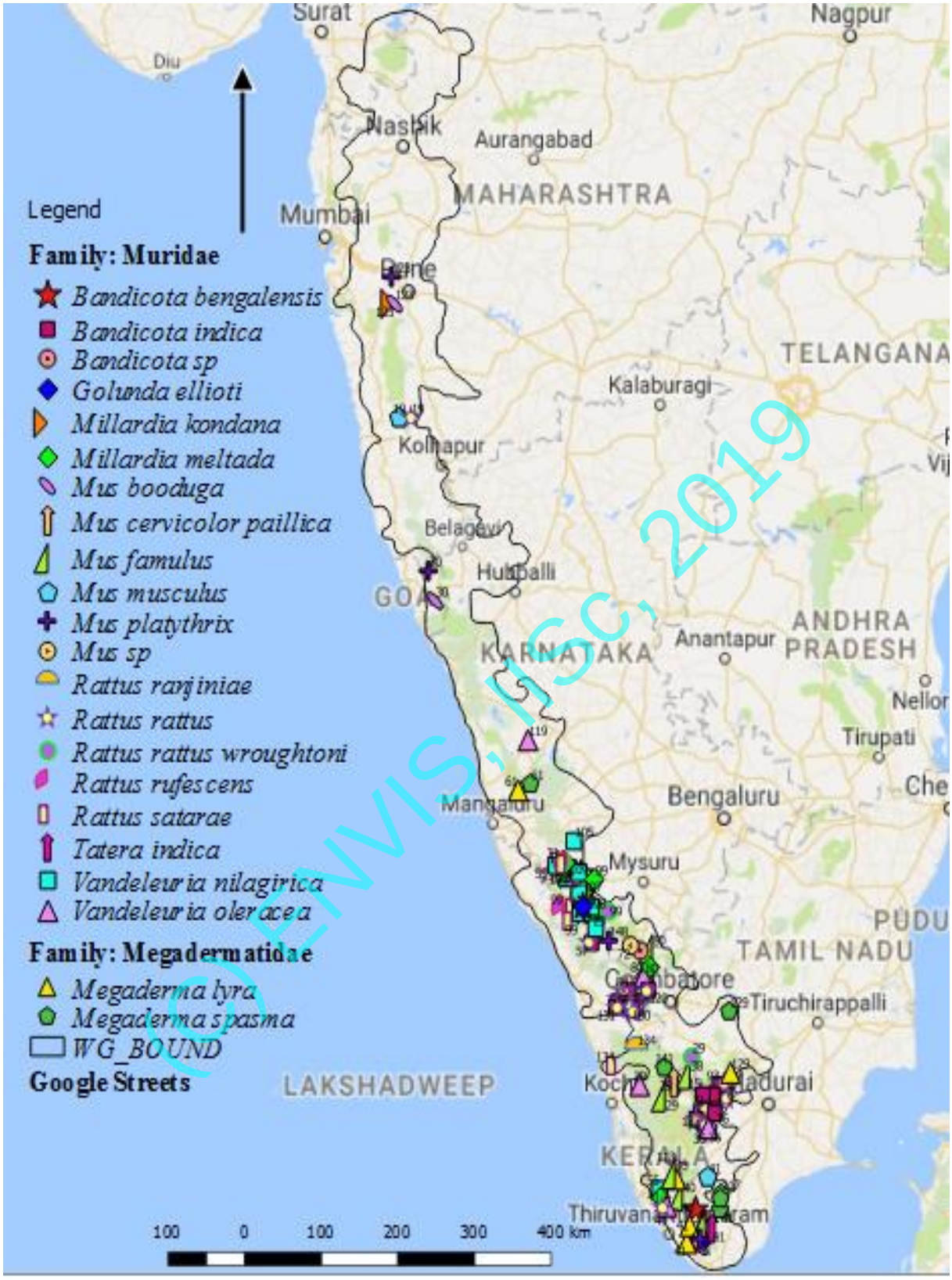


Fig. 6.6.11. Spatial distribution of the Muridae and Megadermatidae families.

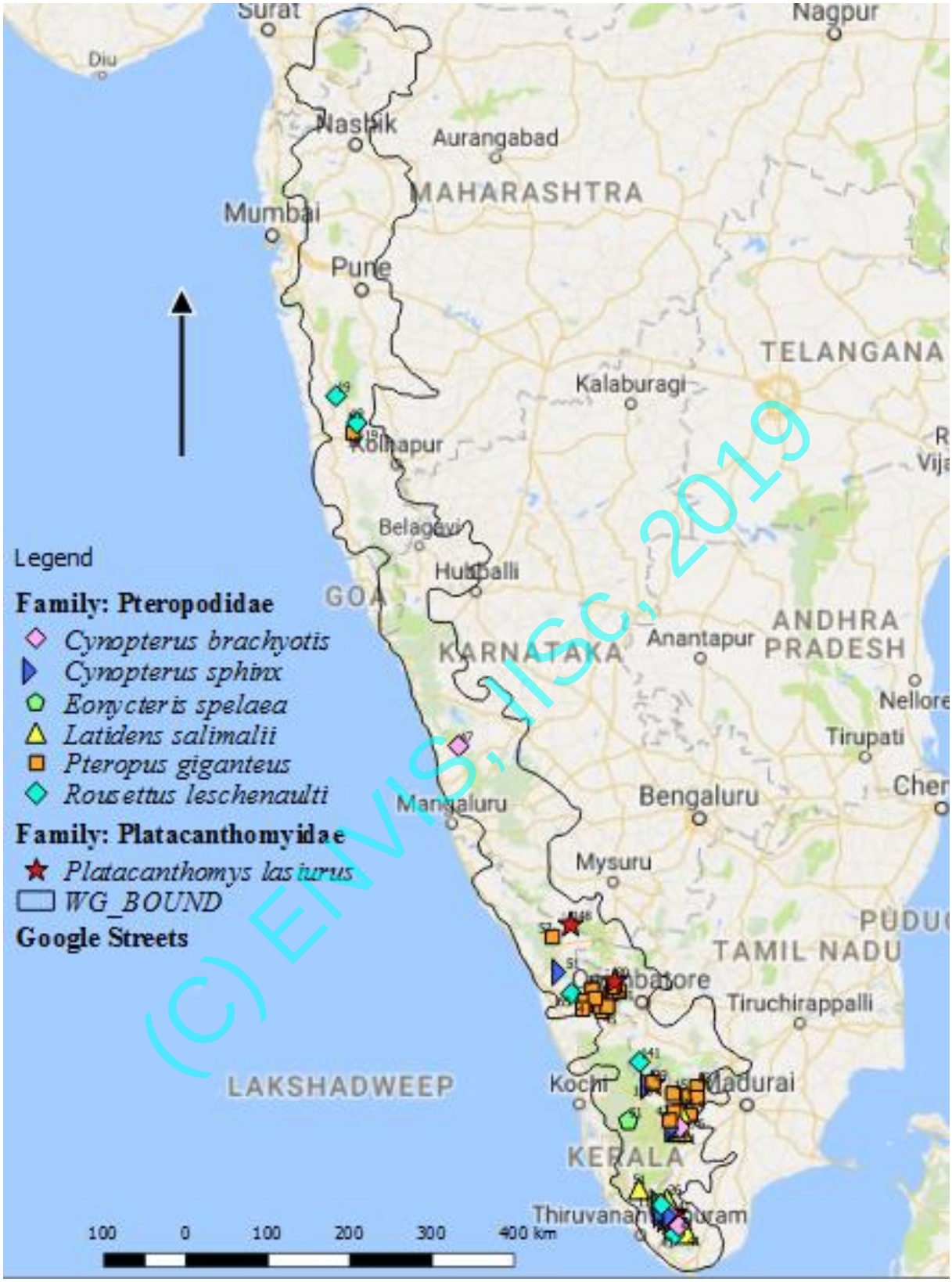


Fig. 6.6.12. Spatial distribution of the Pteropodidae and Platacanthomyidae families.

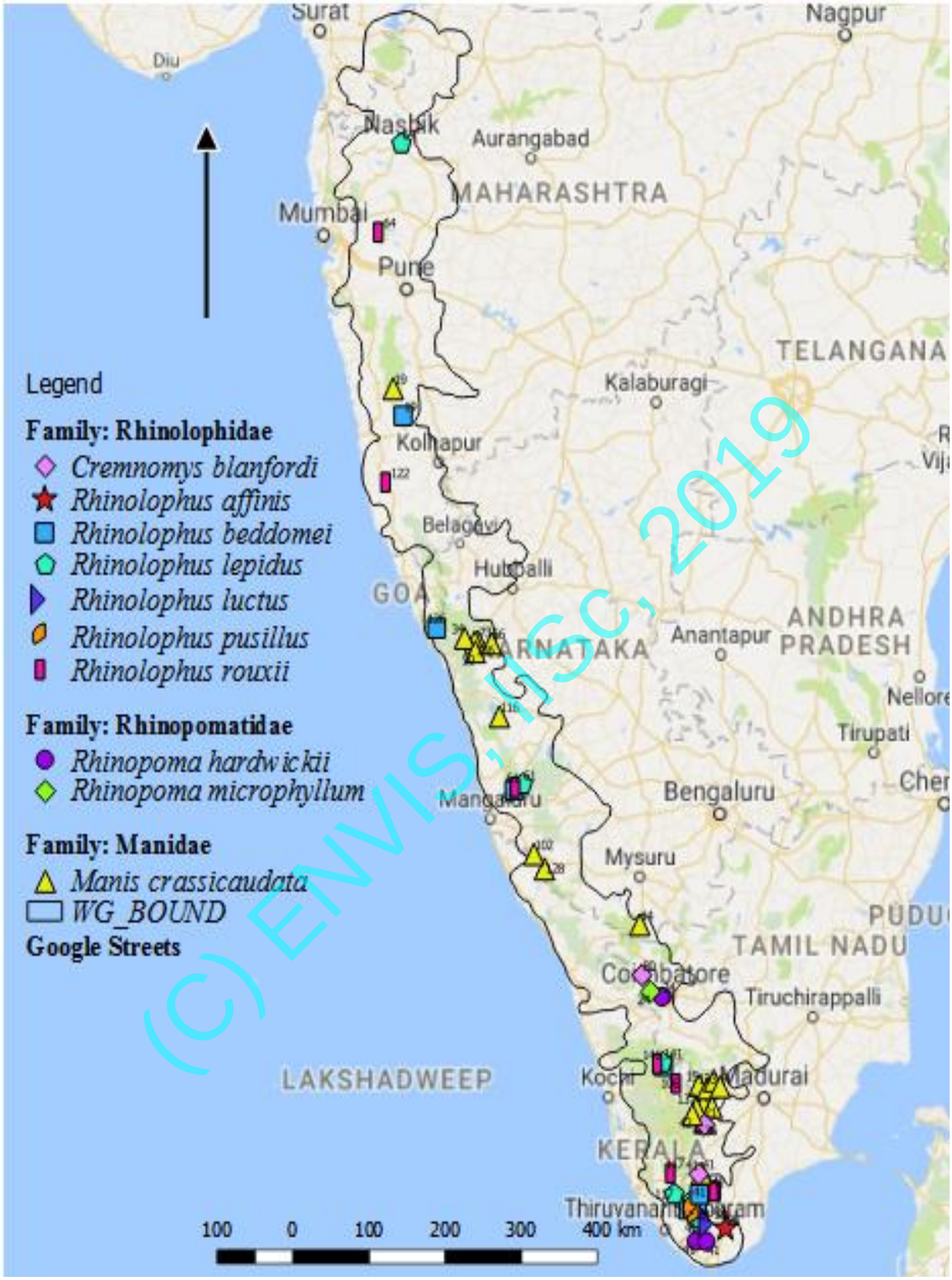


Fig. 6.6.13. Spatial distribution of the Rhinolophidae, Rhinopomatidae and Manidae families.

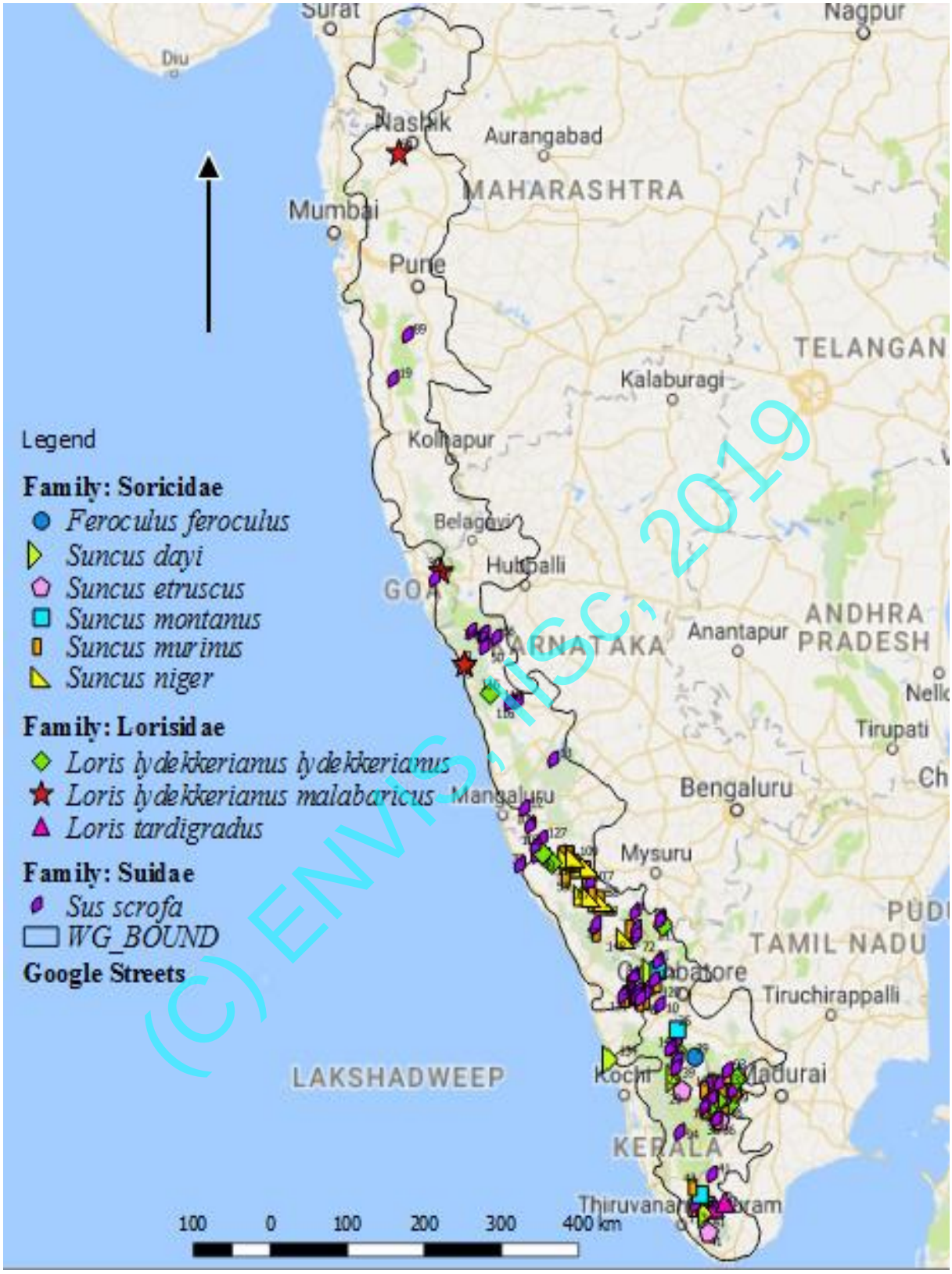


Fig. 6.6.14. Spatial distribution of the Soricidae, Lorisidae and Suidae families.

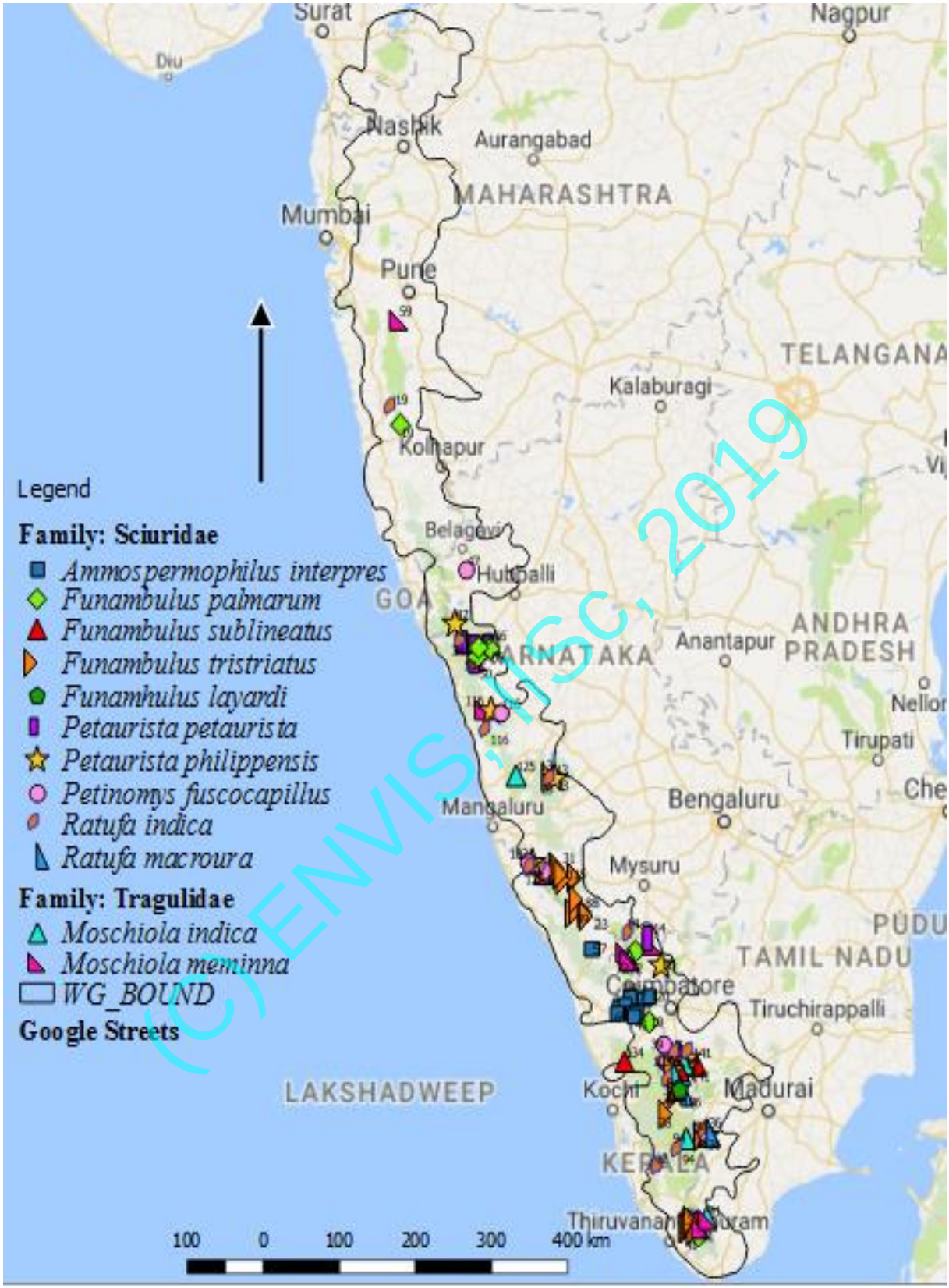


Fig. 6.6.15. Spatial distribution of the Sciuridae and Tragulidae families.

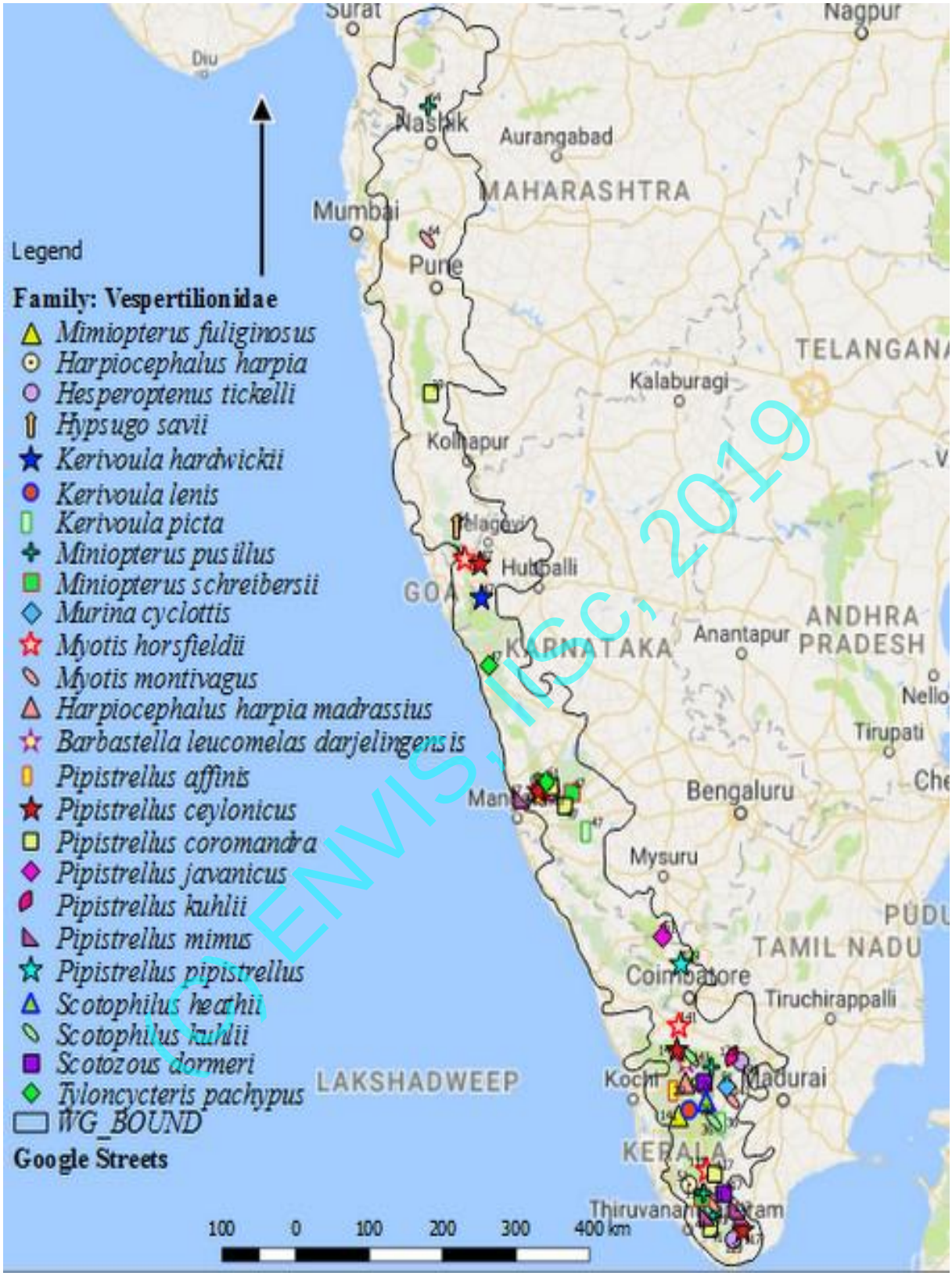


Fig. 6.6.16. Spatial distribution of the Vespertilionidae family.

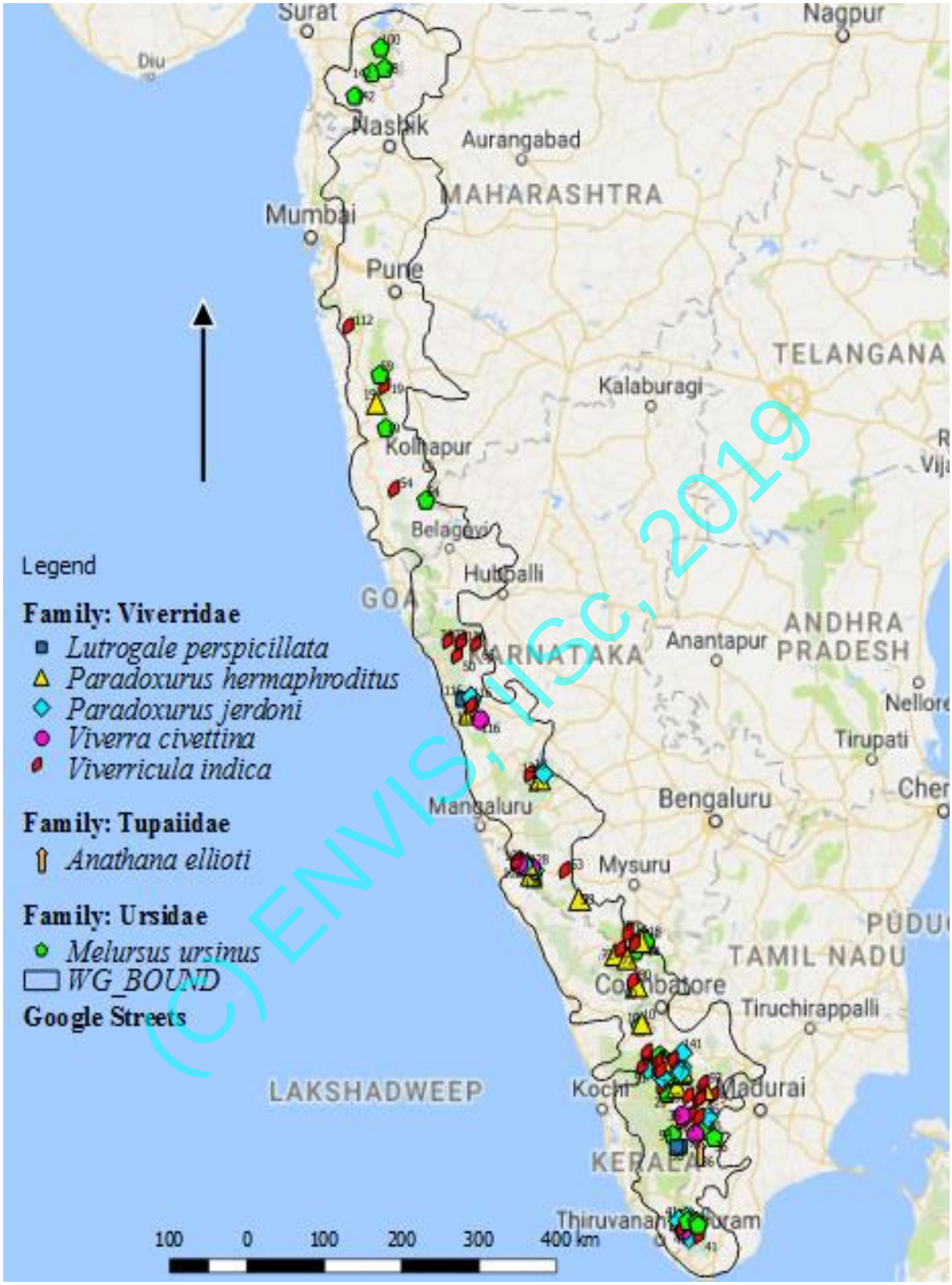


Fig. 6.6.17. Spatial distribution of the Viverridae, Tupaiidae and Ursidae families.

Distribution of endemic species

Among the 161 species of Mammals, 10 species (6%) are Endemic to WG (Fig. 6.6.18 & Fig. 6.6.19). All the 11 families present in the WG region are endemic. *Funambulus tristriatus, Macaca silenus, Martes gwatkinsii, Nilgiritragus hylocrius, Platacanthomys lasiurus, Rattus rattus wroughtoni, Rattus satarae, Suncus dayi, Vandeleuria nilagirica* and *Viverra civettina* are the endemic mammalian species present in WG.

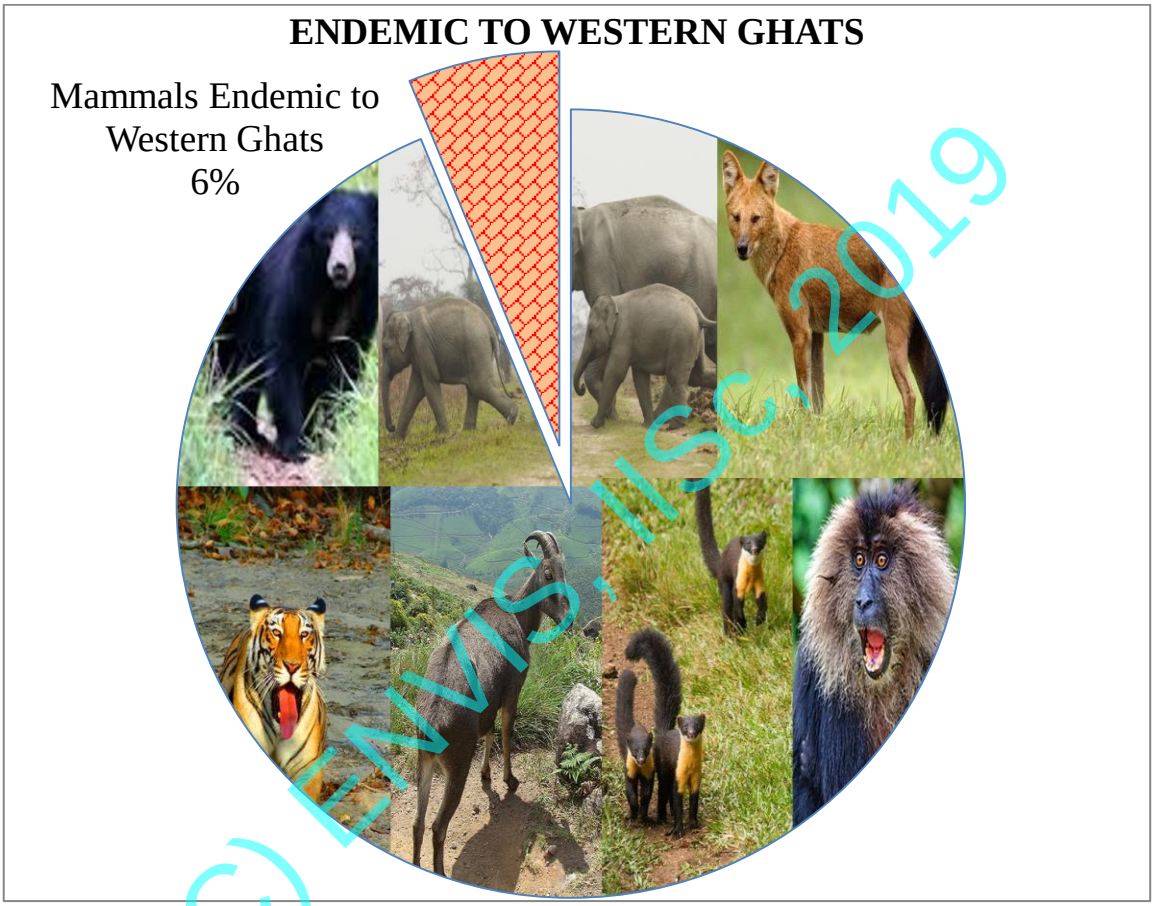


Fig. 6.6.18. Pie chart showing Endemism of Mammals in WG.

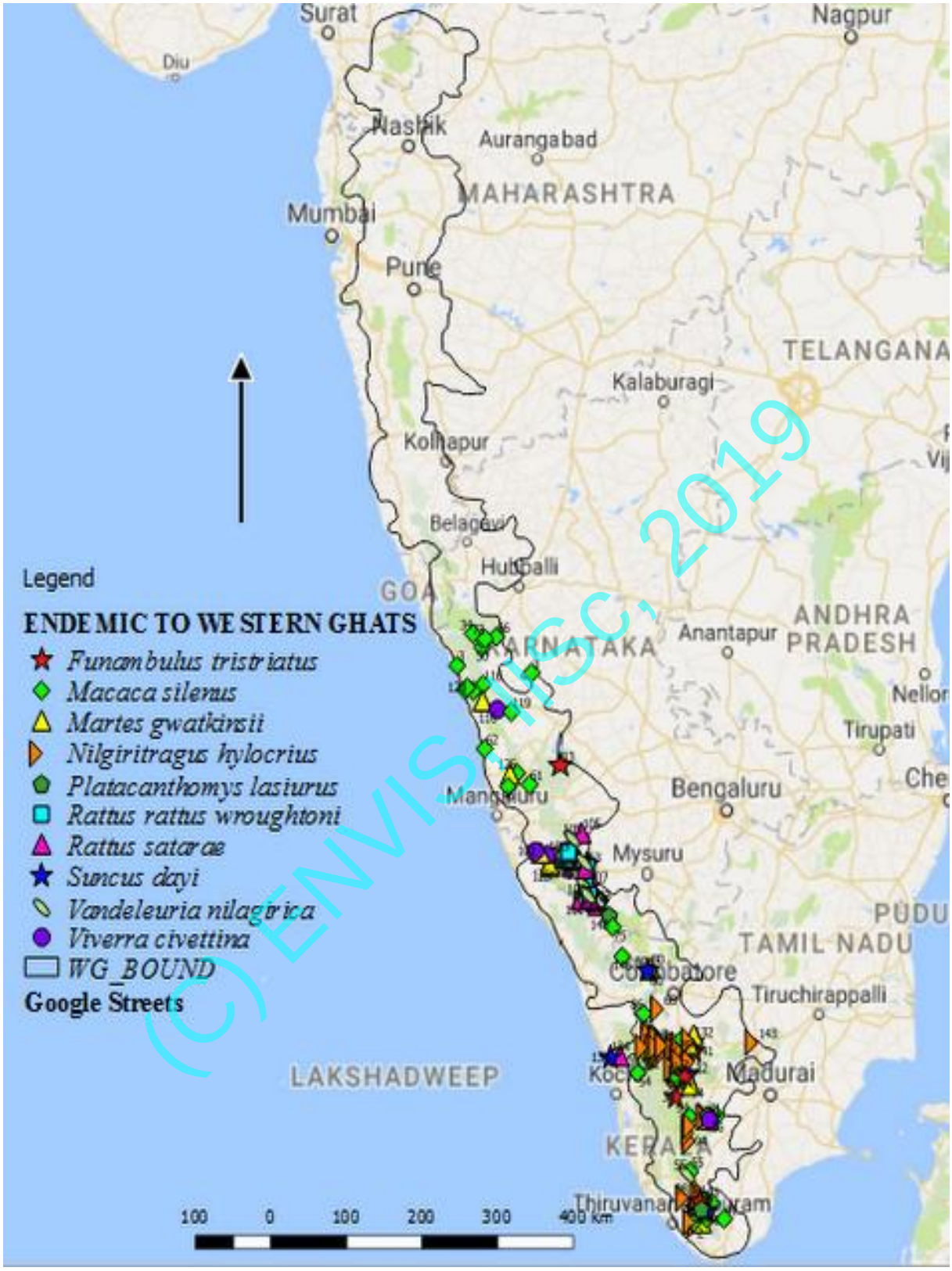


Fig. 6.6.19. Spatial distribution of the mammals endemic to WG.

Distribution based on conservation status

According to the IUCN conservation status, all the mammalian species present in the WG were classified into different categories on the basis of their threat status. Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern, Data Deficient and Not Evaluated are the different categories (Fig. 6.6.20). Among the 161 mammals present in the WG region, 3 species were categorized as Critically Endangered (CE), 14 species were categorized as Endangered (EN), 13 species were considered as Vulnerable (VU), 8 species comes under the category Near Threatened (NT), 95 species were grouped under the Least Concern category and 1 species were categorized under the group Data Deficient (DD). Conservation Status of 27 species of amphibians was not evaluated (Fig. 6.6.21).

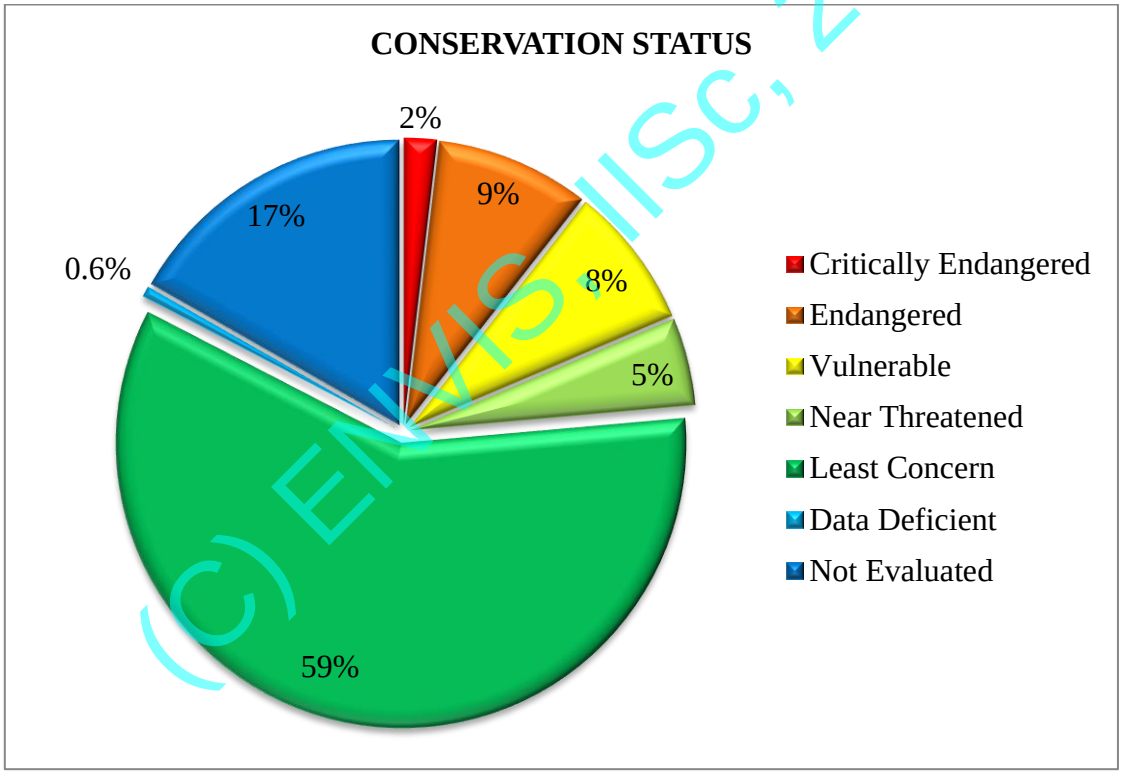


Fig. 6.6.21. Pie chart showing conservation status of Mammals in WG.

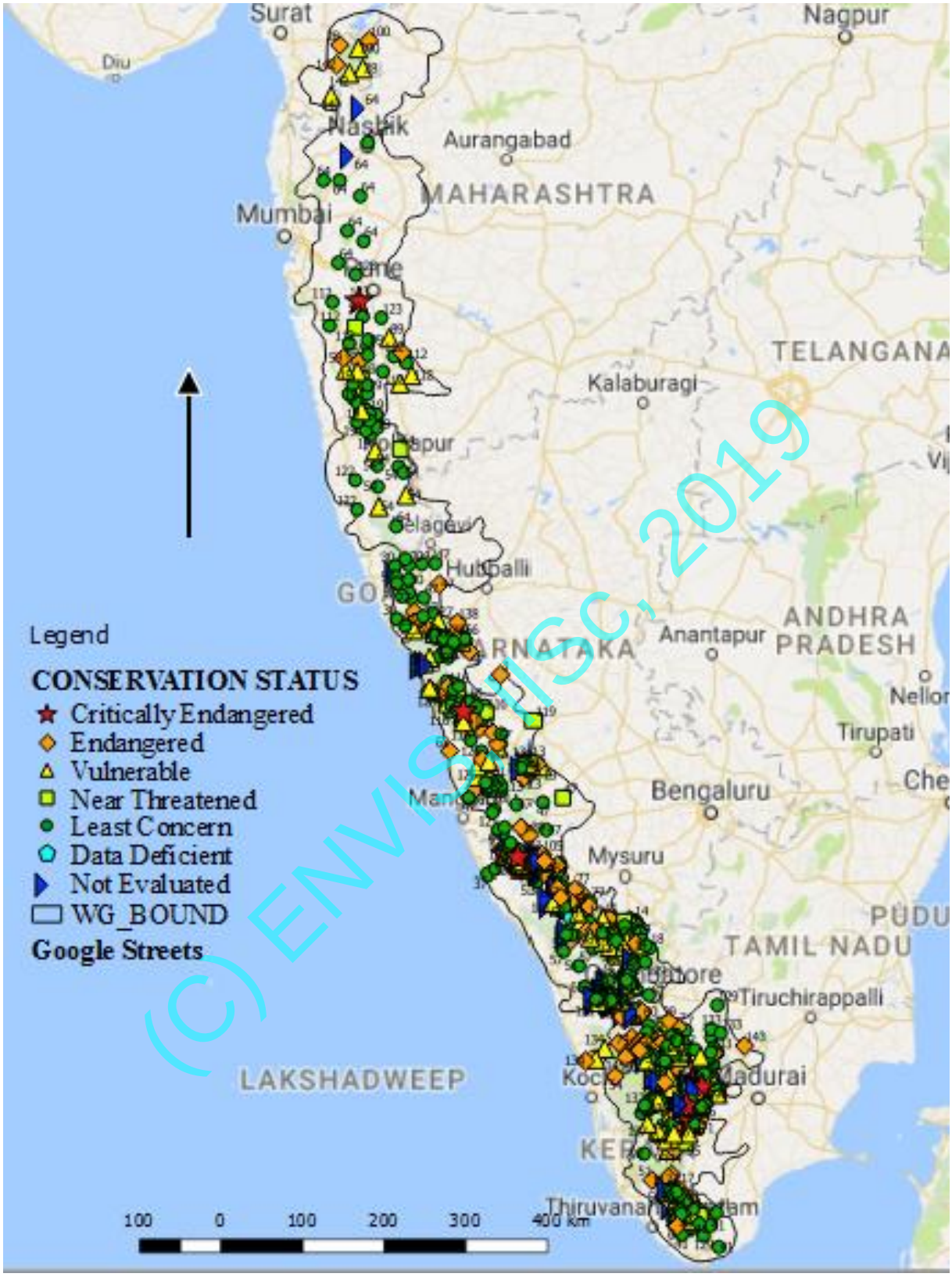


Fig. 6.6.20. Spatial distribution of the Mammalian species according to IUCN status.

Equus africanus, *Millardia kondana* and *Viverra civettina* are classified as critically endangered species by IUCN conservation status (Fig. 6.6.22). As per the literatures, these species shows distribution in the WG regions of Maharashtra, Karnataka, Kerala, and

Tamilnadu. In these *Equus africanus* were reported from the WG region of Tamilnadu, *Millardia kondana* is reported from Maharashtra and *Viverra civettina* shows higher distribution in Karnataka region of WG.

According to IUCN conservation status, 14 mammalian species such as *Bubalus bubalis, Cuon alpines, Elephas maximus, Feroculus feroculus, Latidens salimalii, Loris tardigradus, Macaca silenus, Manis crassicaudata, Mus famulus, Nilgiritragus hylocrius, Panthera tigris, Rattus ranjiniae, Suncus dayi* and *Vandeleuria nilagirica* are the endangered mammalian species present in the WG regions.These species has distributed across the WG regions of Gujarat, Maharashtra, Karnataka, Kerala, and Tamilnadu (Fig. 6.6.23).

WG region has 13 vulnerable mammalian species. That shows 8% of the total mammalian population present in the WG is categorized as vulnerable. *Amblonyx cinereus, Funambulus sublineatus, Lutrogale perspicillata, Martes gwatkinsii, Melursus ursinus, Panthera pardus, Platacanthomys lasiurus, Prionailurus viverrinus, Rattus satarae, Rusa unicolor, Suncus montanus, Tetracerus quadricornis* and *Trachypithecus johnii* (Fig. 6.6.24).These vulnerable species were reported from all regions of WG except Goa.

*Antilope cervicapra, Herpestes brachyurus, Hyaena hyaena, Lutra lutra, Miniopterus schreibersii, Prionailurus rubiginosus, Ratufa macroura*and *Semnopithecus priam* are the 8 mammalian species from the families were considered as Near Threatened (NT) species (Fig. 6.6.25). These species were distributed in the WG regions of Maharashtra, Karnataka, Kerala, and Tamilnadu. These species show higher distribution towards the central and southern regions of WG. According to the conservation status, 95 mammalian species present in the WG were categorized under Least Concern category. Of the total population of mammals in WG, 59% were categorized as Least Concern species (Fig. 6.6.26). These species are reported from 25 families of the WG region of Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu. In the WG region, only 1 mammalian species was categorized under the category Data Deficient (DD). *Otomops wroughtoni* is the species under Data Deficient category reported from the WG region Kerala (Fig. 6.6.27).

Conservation Status of 27 species of mammals was not evaluated, that comprises almost 17% of the total number of species present in the WG (Fig. 6.6.28). The conservation status of the mammals from the families Bovidae, Canidae, Cercopithecidae, Equidae, Felidae, Lorisidae, Muridae, Sciuridae, Soricidae, Tupaiidae, and Vespertilionidae are not evaluated. These species show distribution across all regions of WG except Gujarat.

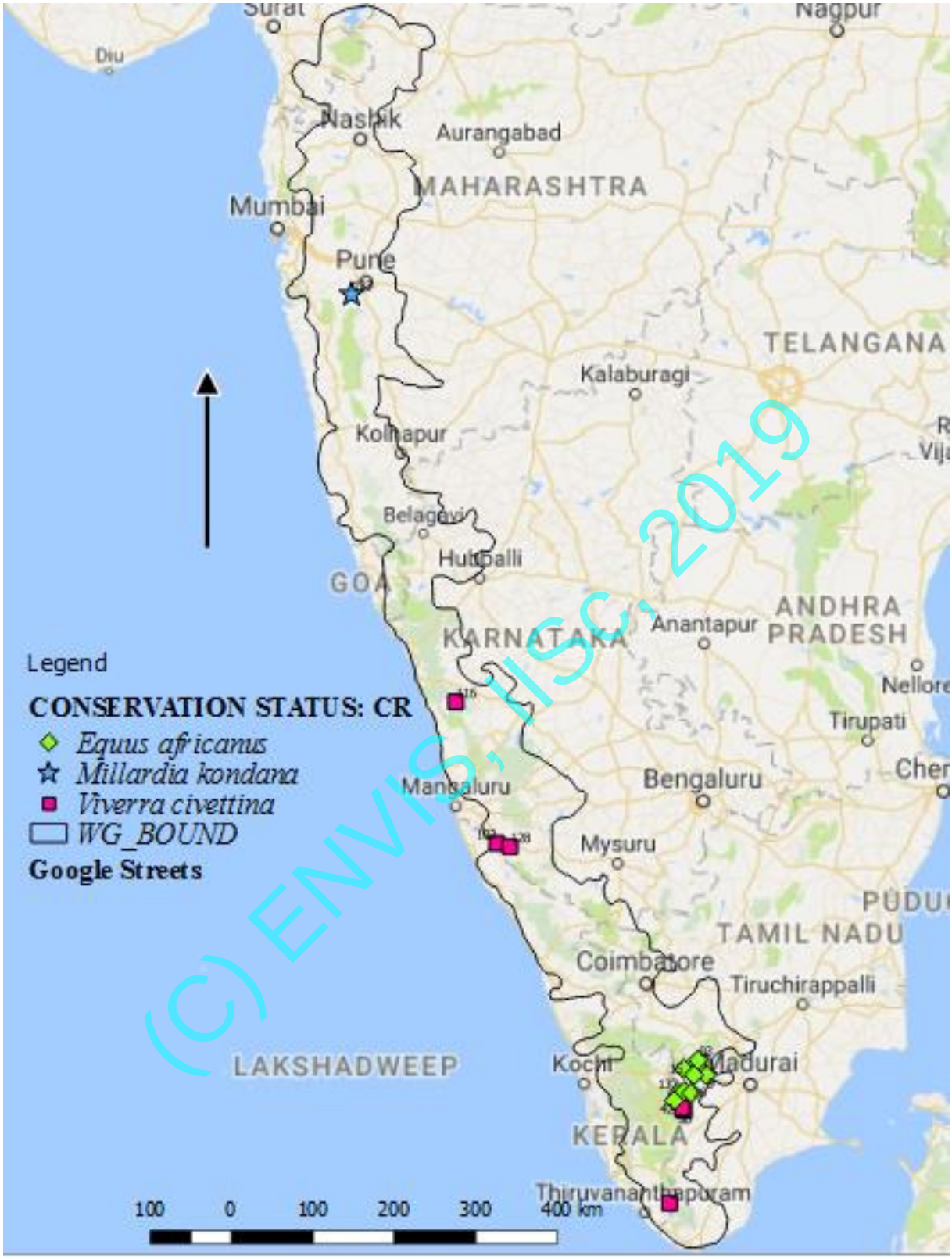


Fig. 6.6.22. Spatial distribution of the Critically Endangered Mammalian species.

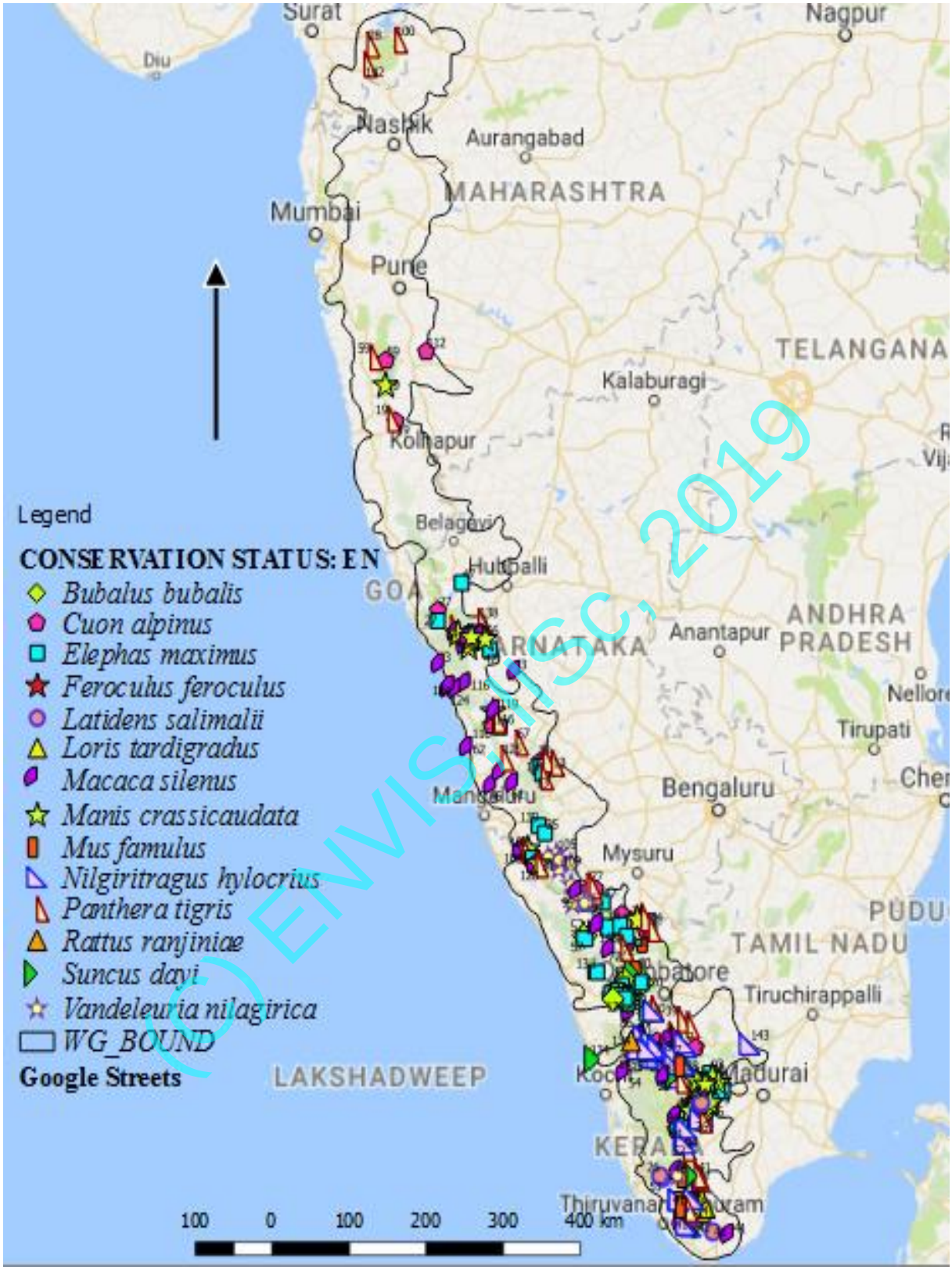


Fig. 6.6.23. Spatial distribution of the Endangered Mammalian species.

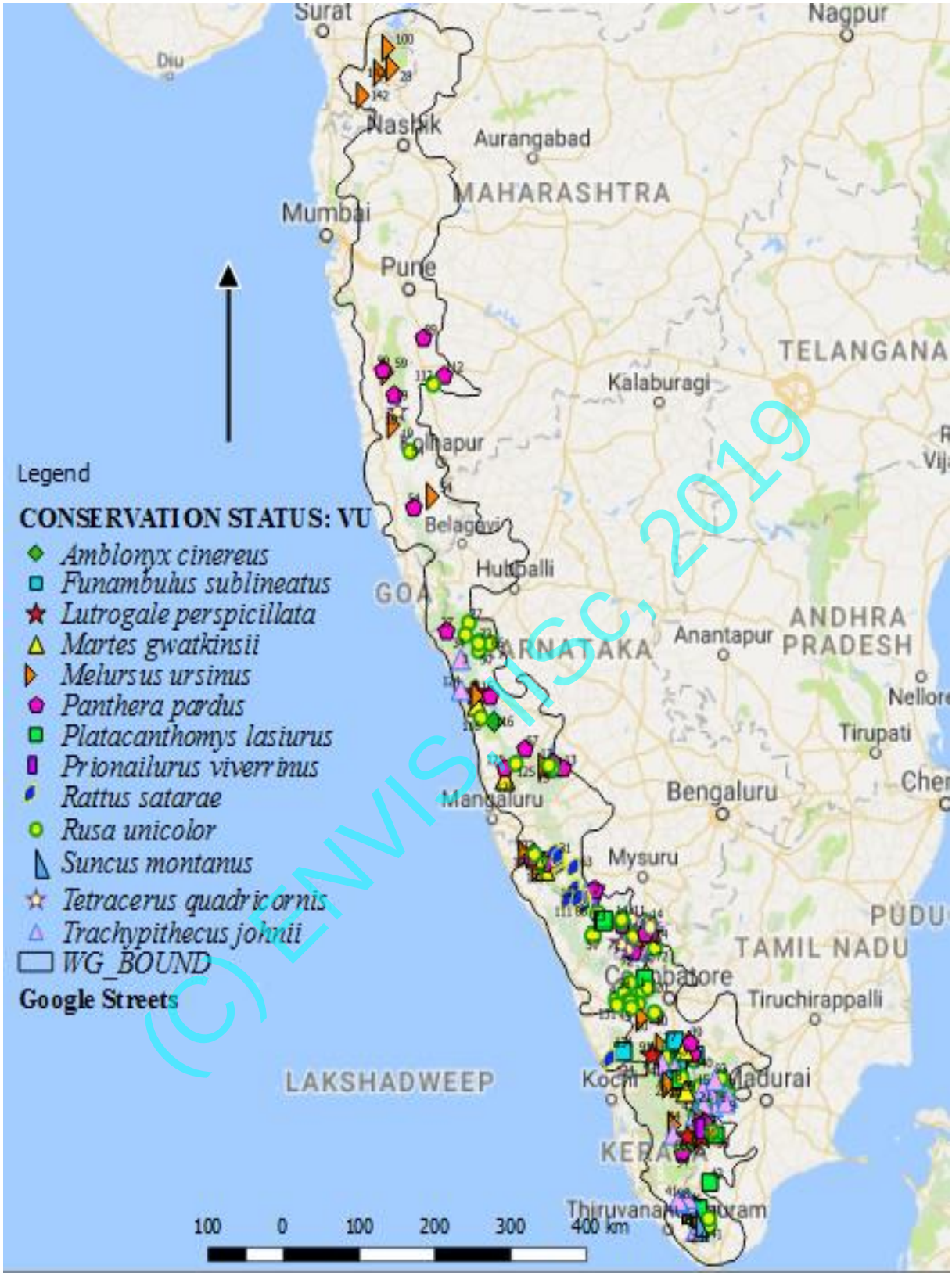


Fig. 6.6.24. Spatial distribution of the Vulnerable Mammalian species.

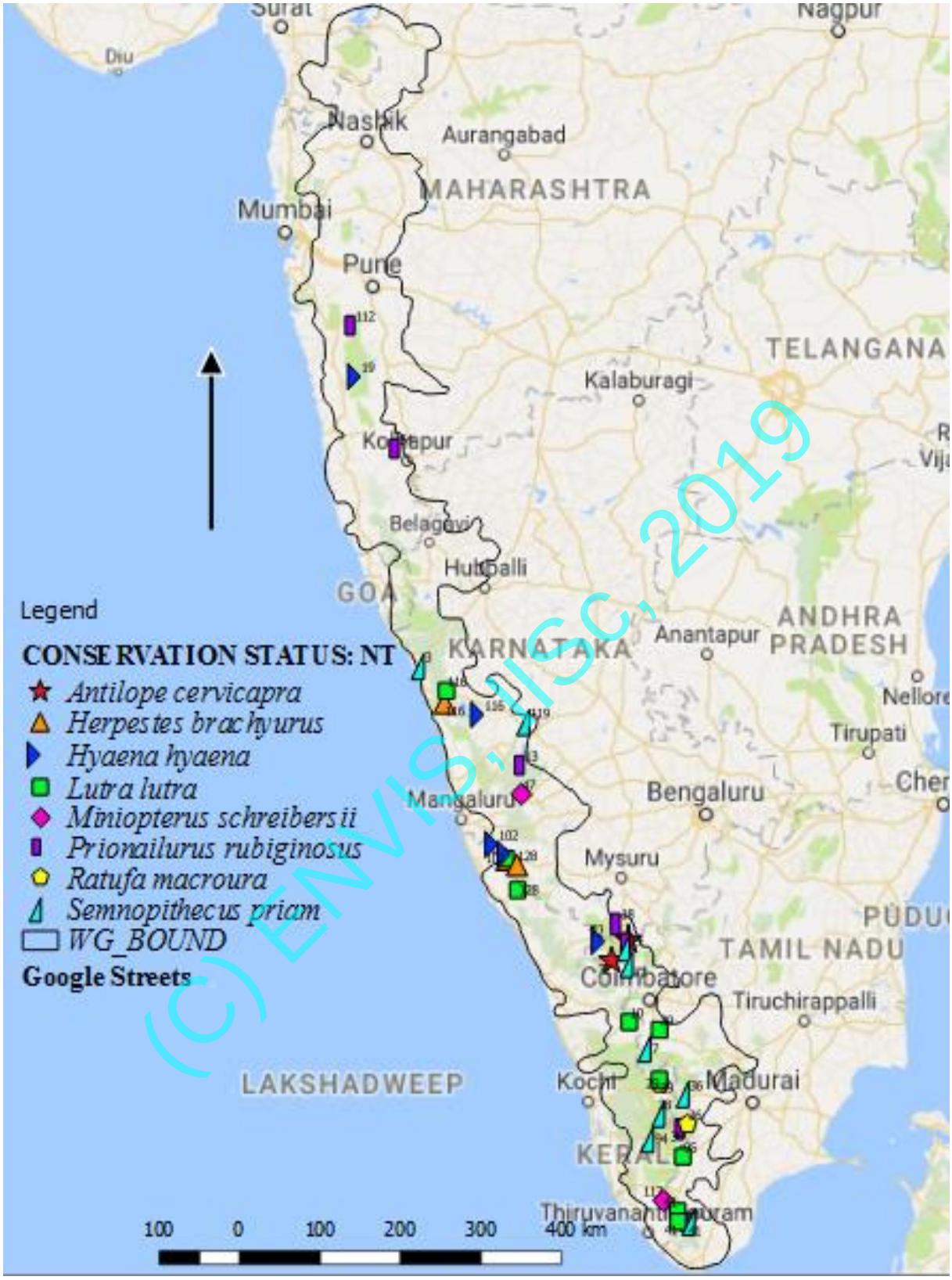


Fig. 6.6.25. Spatial distribution of the Near Threatened Mammalian species.

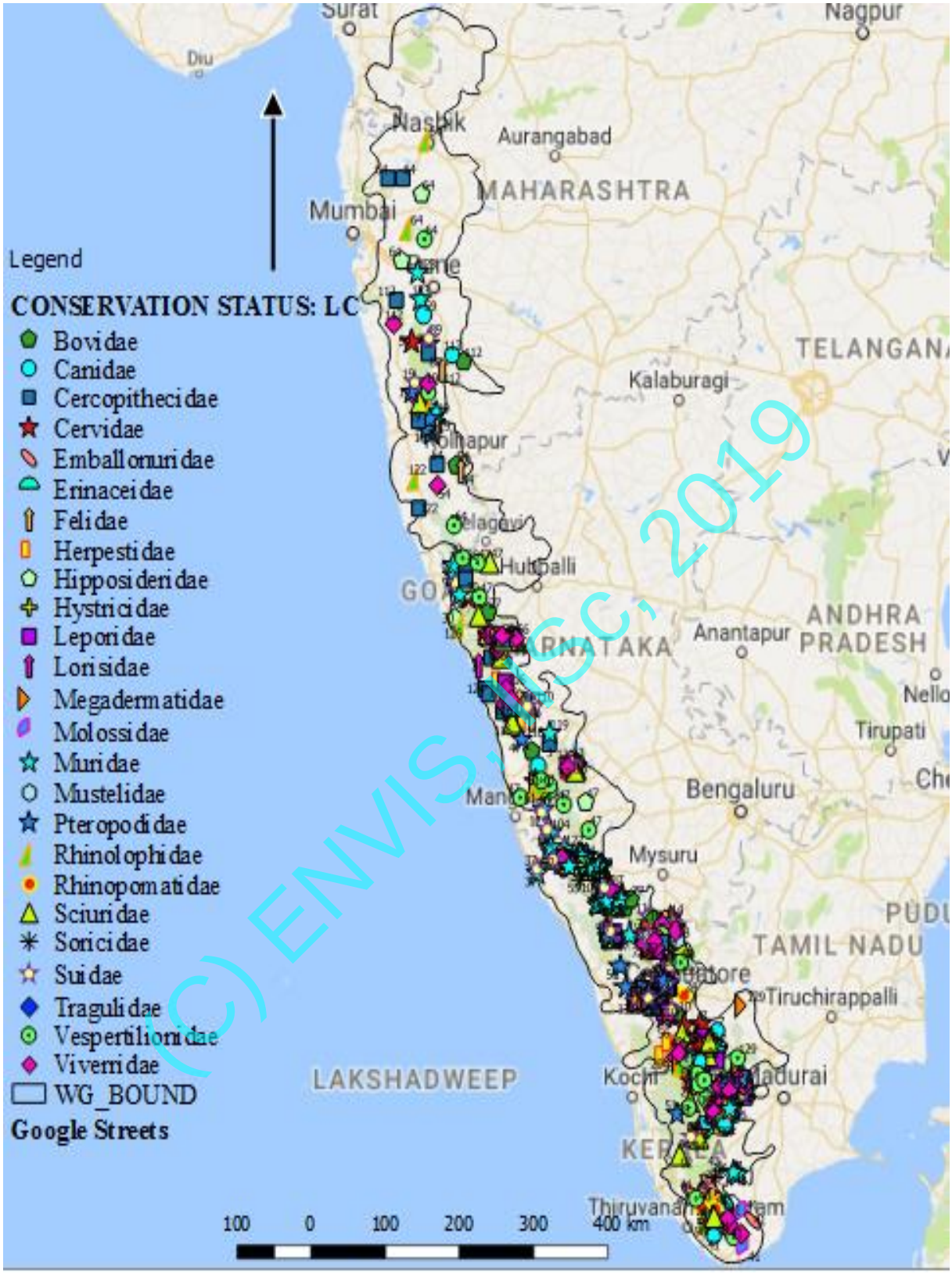


Fig. 6.6.26. Spatial distribution of the Least Concern Mammalian families.

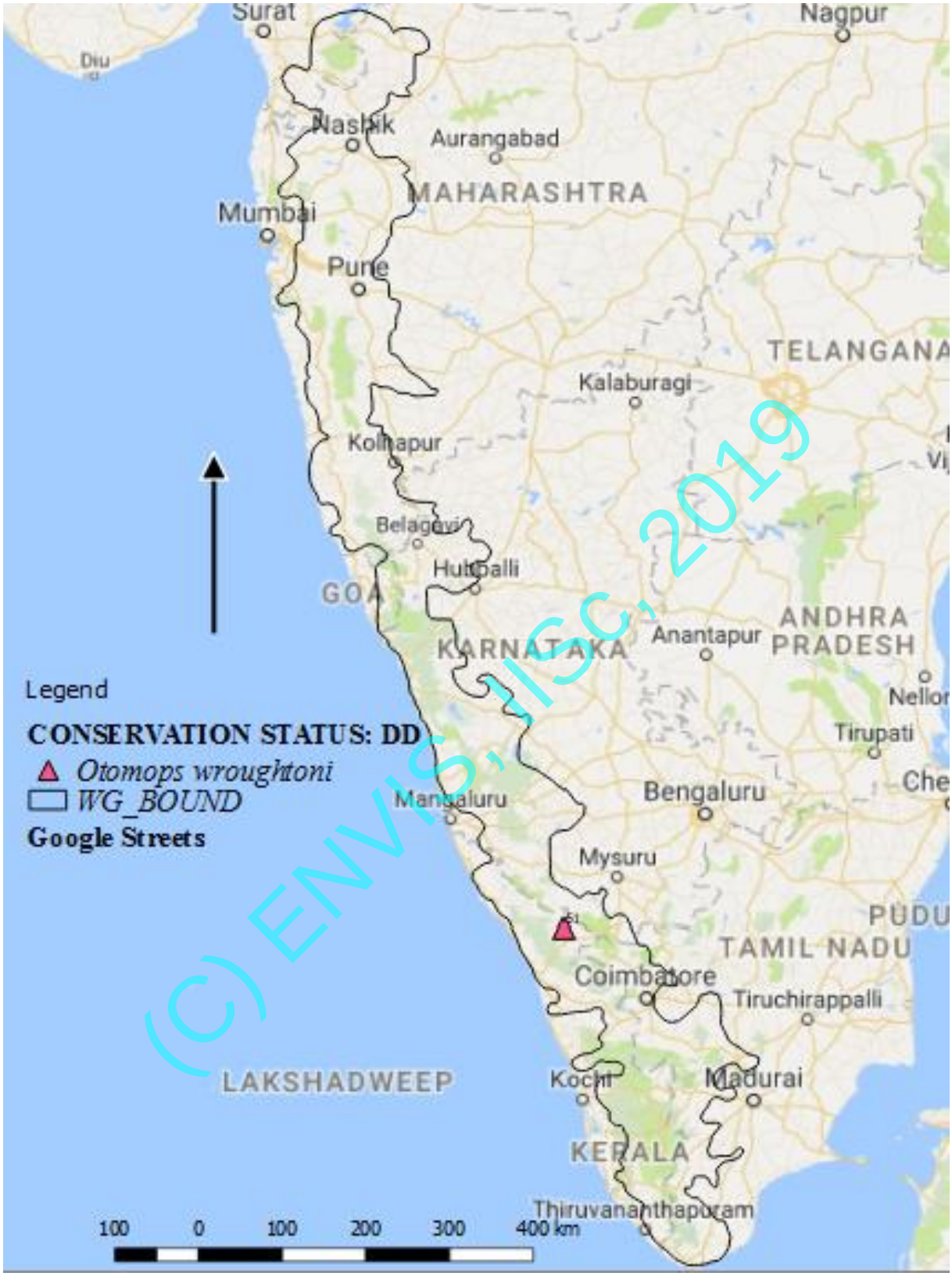


Fig. 6.6.27. Spatial distribution of the Data Deficient Mammalian species.

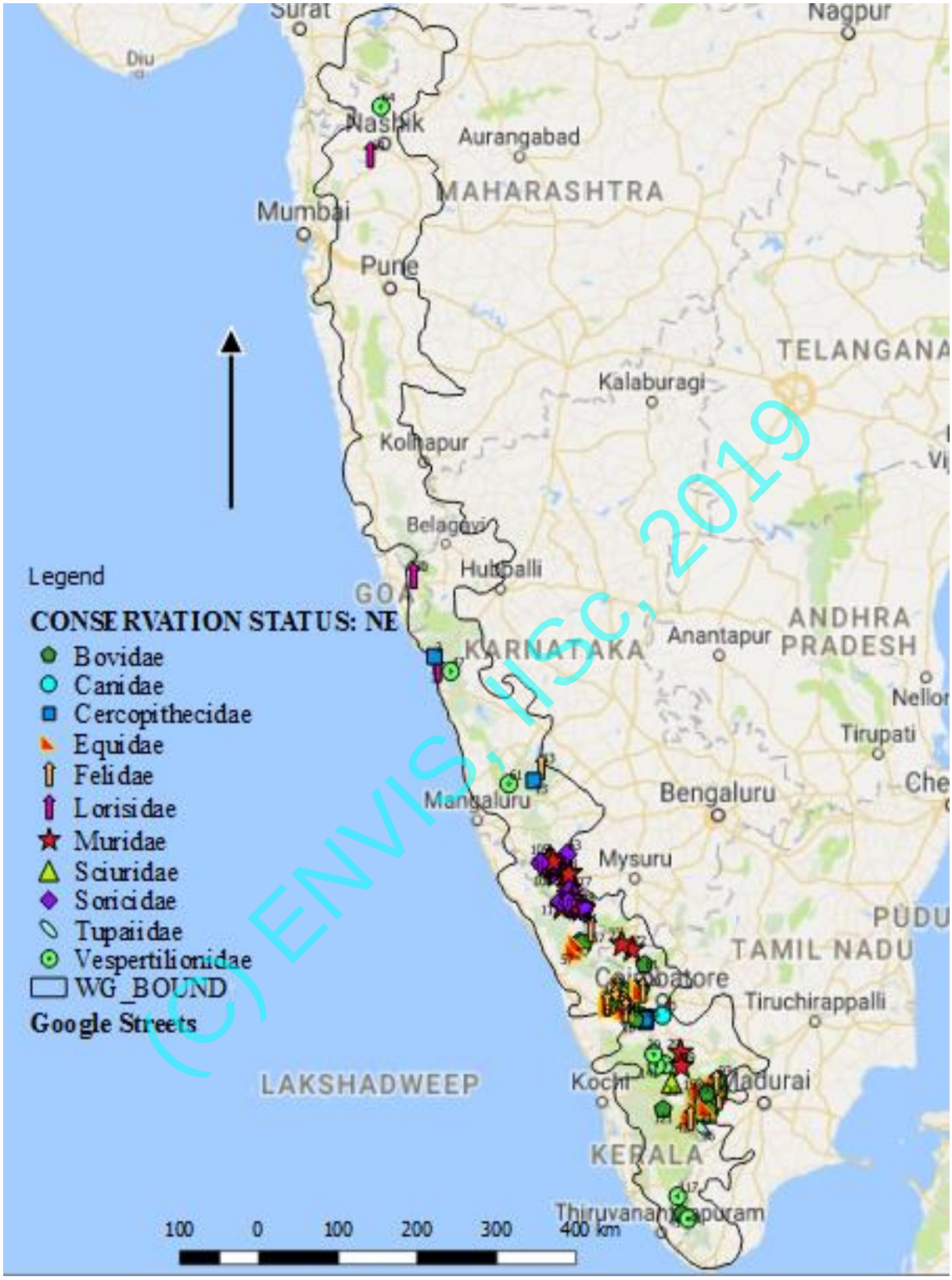
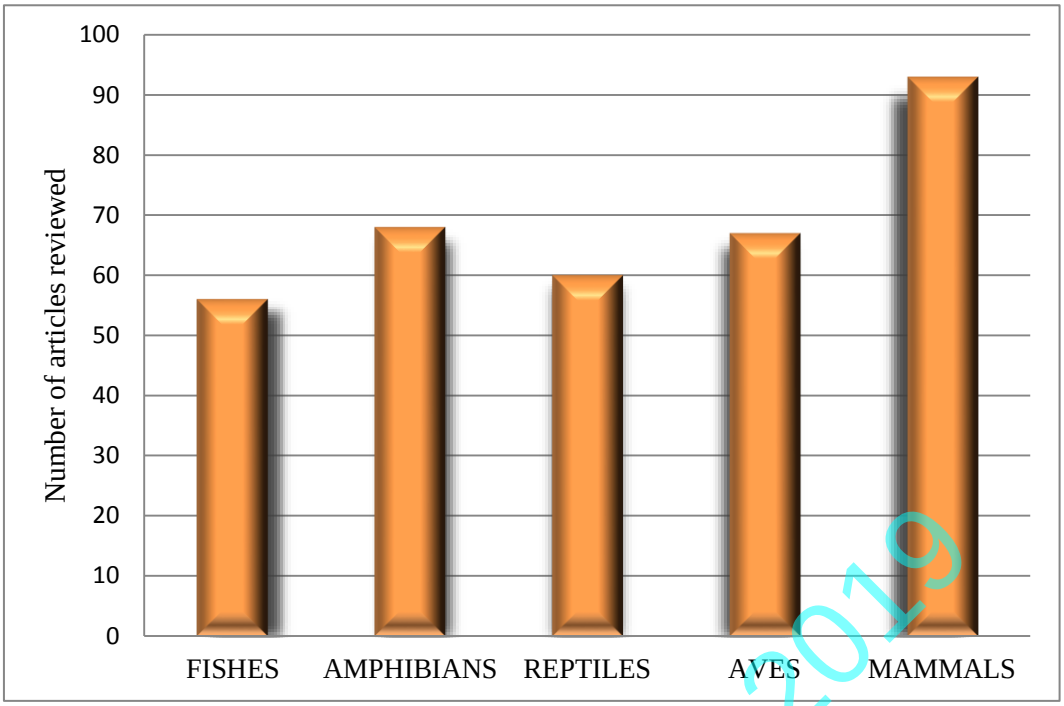


Fig. 6.6.28. Spatial distribution of the Not Evaluated Mammalian families.



FAUNAL GROUPS	EARLIER STUDIES (No: of Species)	As per current study (No: of Species)
FISHES	290	335
AMPHIBIANS	179	248
REPTILES	190	197
AVES	508	529
MAMMALS	139	161

6.7. Endemic fauna distribution across latitude gradients

According to the latitudinal range, Western Ghats region has divided into 14 one-degree grids (110 x 110 sq.km) and 7 two-degree grids (220 x 220 sq.km). Endemic and non-endemic species population and percentage endemism of species per one-degree and two-degree grid were estimated (Table: 6.7.1 & 6.7.2) (Fig. 6.7.1 & 6.7.2). The distribution of Endemic and non-endemic species shows higher diversity in southern WG followed by central and northern WG. Logistic trend lines were fitted to find out the pattern of endemism.

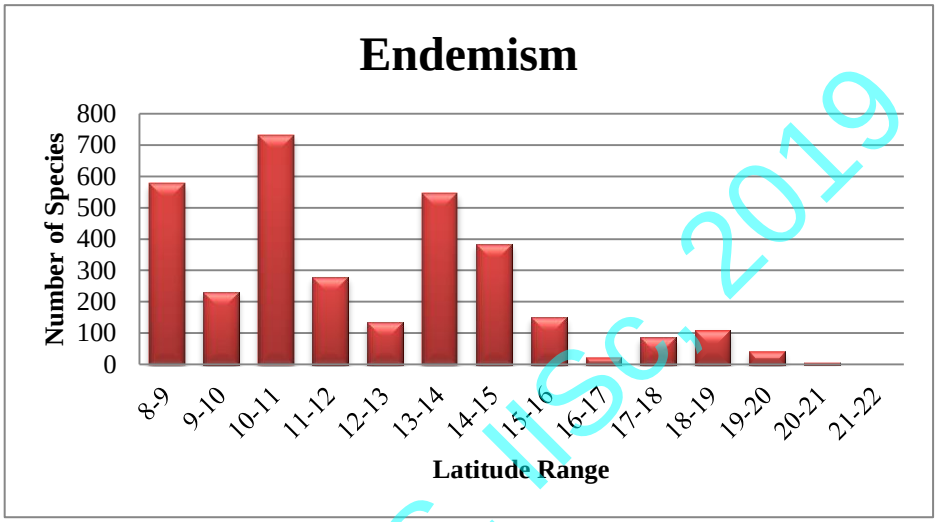


Fig. 6.7.1. Graph showing distribution of endemic fauna per one-degree latitudinal variation.

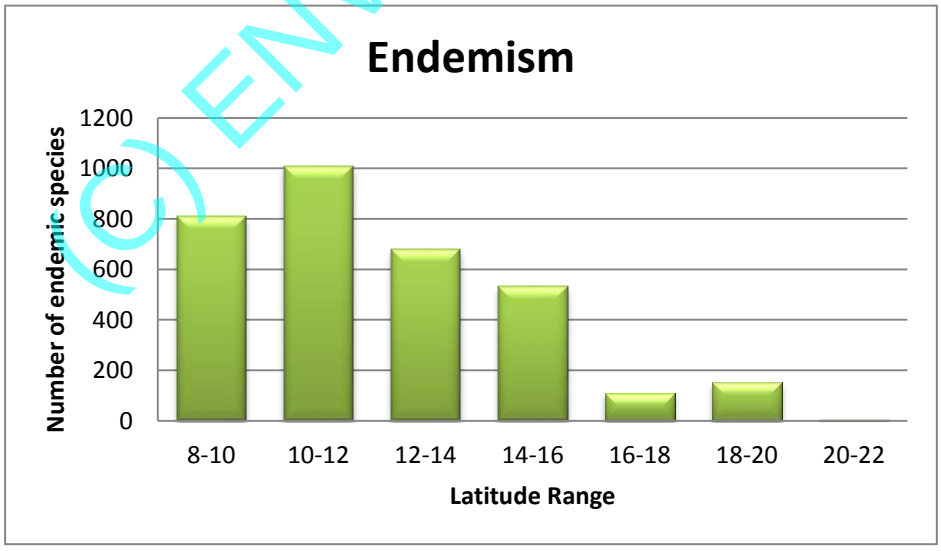


Fig. 6.7.2. Graph showing distribution of endemic fauna per two-degree latitudinal variation.

Fishes

As per the literatures, 40 endemic fishes were reported from the latitudinal grids 10-11^0 and 14-15^0, hence these grids shows higher endemism (45.45%). No endemic species were reported from the latitudinal range of 20-21^0 and 21-22^0 (Fig. 6.7.3).

The endemic distribution of fishes also shows a declining pattern in the two-degree latitudinal grid. The highest percentage endemism is estimated at 10-12^0 (51.13%) latitude range and lowest at 18-20^0 range (20%) (Fig. 6.7.4).

Amphibians

Amphibians show higher diversity in the latitudinal range of 10-11^0 and the least diversity is estimated in the 21-22^0 Latitude. Endemism is also higher in 10-11^0 (44.15% endemism) and least endemism in 20-21^0 (0.64% endemism). The latitudinal range of 21-22^0 shows zero endemism (Fig. 6.7.5).

In two-degree grid, the percentage endemism shows a declining range, higher endemism is estimated at 10-12^0 (35.88%) latitude range and lower at 20-22^0 range (0.4%) (Fig. 6.7.6).

Reptiles

Reptiles show higher diversity and endemism in the latitudinal range of 8-9^0 (53 endemic species and 51% endemism) and the least is estimated in the 21-22^0 Latitude. As per the literatures reviewed, no endemic reptiles were reported from the latitude range of 21-22^0 (Fig. 6.7.7).

In two-degree grid, the percentage endemism and species diversity shows a declining pattern, higher is estimated at 8-10^0 grid, with a diversity of 70 endemic species and 68% endemism. Only 2 endemic species is reported from the grid 20-22^0, hence it is the grid with lowest endemism (1.9% endemism) (Fig. 6.7.8).

Birds

As per the literatures, 24 endemic birds were reported from the grid 10-11^0, hence it shows higher endemism (85%) and no endemic species were reported from the latitudinal range of 16-17^0, 20-21^0 and 21-22^0 (Fig. 6.7.9).

The endemic distribution of birds also shows a declining range in the two-degree latitudinal grid. The highest percentage endemism is estimated at 10-12^0 (89.28%) latitude range and lowest at 20-22^0 range (0%) (Fig. 6.7.10).

Mammals

In mammals, highest diversity and endemism is reported from the latitudinal range of 8-9^0 and 9-10^0 (80% endemism per grid). No endemic mammalian species were reported from the latitudinal range from 16^0 to 22^0 (Fig. 6.7.11).

In two-degree grid, mammalian percentage endemism per grid and species diversity shows a declining pattern, higher is estimated at 8-10^0 grid, with a diversity of 9 endemic species and 90% endemism. From the grids, 16-18^0, 18-20^0 and 20-22^0 no endemic species were reported. Hence these grids show 0% endemism (Fig. 6.7.12).

	Endemic to Western Ghats							Non Endemic						GRAND TOTAL	% Fauna per Grid
Latitude Range	Fishes	Amphibians	Reptiles	Birds	Mammals	Total	% Endemism	Fishes	Amphibians	Reptiles	Birds	Mammals	Total		
8-9	78	226	126	118	29	577	34.53	270	187	109	325	203	1094	1671	12.04
9-10	44	74	81	15	17	231	34.79	119	35	35	55	189	433	664	4.78
10-11	288	158	57	168	60	731	22.35	791	93	59	1162	435	2540	3271	23.56
11-12	34	152	46	31	14	277	23.14	75	68	87	433	257	920	1197	8.62
12-13	4	33	46	6	46	135	24.37	2	20	51	134	212	419	554	3.99
13-14	179	100	246	14	6	545	30.21	737	42	233	172	75	1259	1804	13.03
14-15	157	99	71	41	15	383	19.09	722	66	130	558	147	1623	2006	14.45
15-16	67	76	5	2	0	150	9.76	254	61	11	13	15	354	504	3.63
16-17	2	11	9	0	0	22	34.38	0	2	25	0	15	42	64	0.46
17-18	19	8	47	13	0	87	7.79	97	2	164	711	56	1030	1117	8.04
18-19	70	29	0	11	0	110	14.99	311	16	6	287	4	624	734	5.28
19-20	28	8	3	2	0	41	23.30	117	0	12	1	5	135	176	1.26
20-21	0	3	3	0	0	6	6.00	0	0	67	21	6	94	100	0.72

21-22	0	0	0	0	0	0	0.00	15	0	0	0	1	16	16	0.11
Grand Total	970	977	740	421	187	3295		3510	592	989	3872	1620	10583	13878	

Table 6.7.1: Table showing distribution of endemic and non-endemic fauna per one-degree grid.

Endemic to Western Ghats								Non Endemic						GRAND TOTAL	% Fauna per Grid
Latitude Range	Fishes	Amphibians	Reptiles	Birds	Mammals	Total	% Endemism	Fishes	Amphibians	Reptiles	Birds	Mammals	Total		
8-10	122	300	207	133	46	808	34.60	389	222	144	380	392	1527	2335	16.82
10-12	322	310	103	199	74	1008	22.56	866	161	146	1595	692	3460	4468	32.19
12-14	183	133	292	20	52	680	28.83	739	62	284	306	287	1678	2358	16.99
14-16	224	175	76	43	15	533	21.23	976	127	141	571	162	1977	2510	18.08
16-18	21	19	56	13	0	109	9.22	97	4	189	711	71	1072	1181	8.50
18-20	98	37	3	13	0	151	16.59	428	16	18	288	9	759	910	6.55
20-22	0	3	3	0	0	6	5.17	15	0	67	21	7	110	116	0.83
Grand Total	970	977	740	421	187	3295		3510	592	989	3872	1620	10583	13878	

Table 6.7.2: Table showing distribution of endemic and non-endemic fauna per two-degree grid.

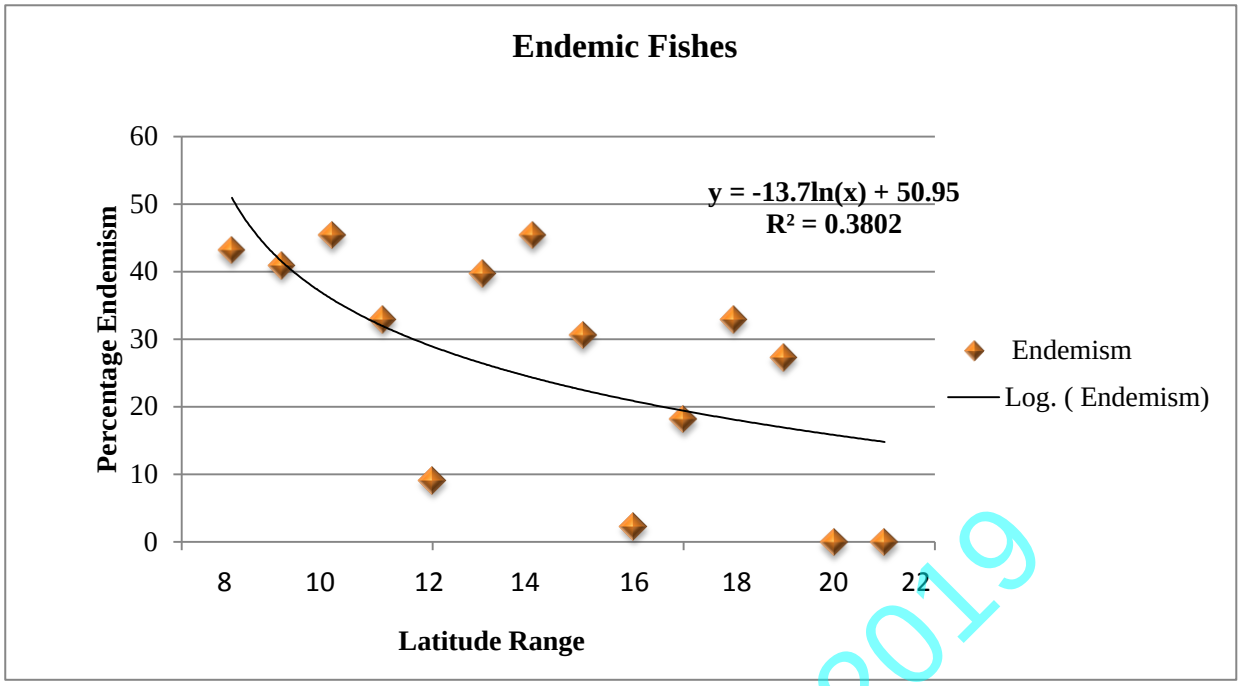


Fig. 6.7.3. Latitude gradient and percentage endemism of Fishes.

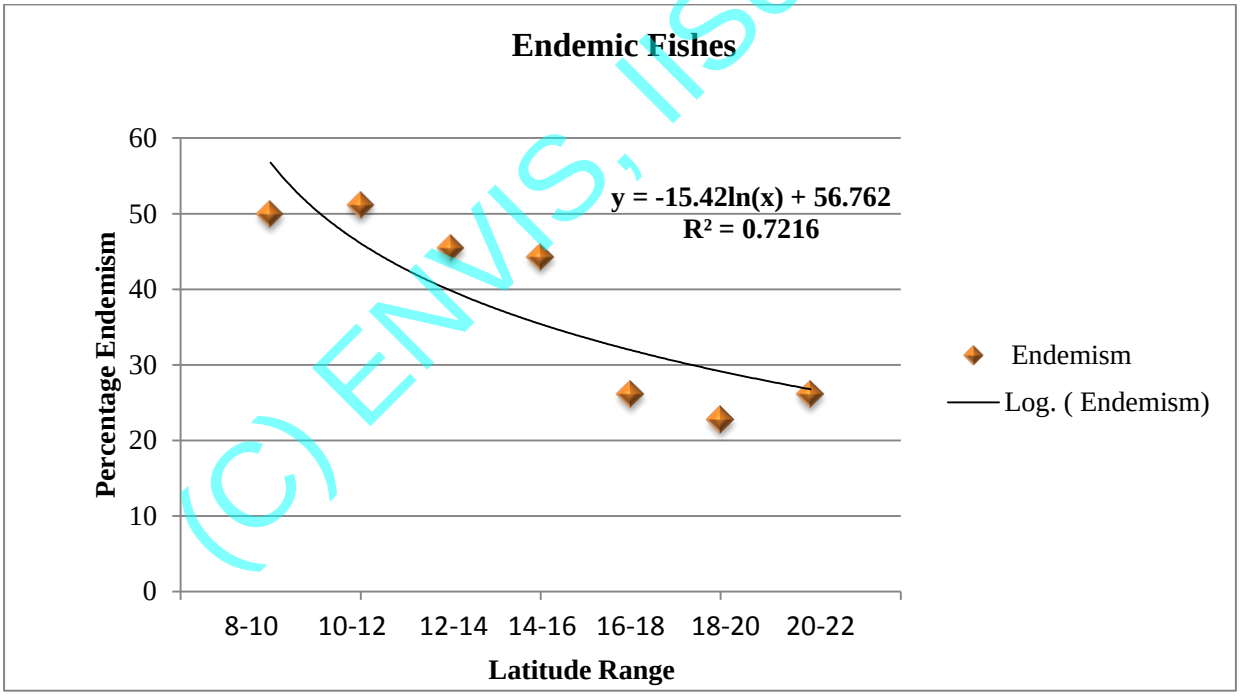


Fig. 6.7.4. Latitude gradient and percentage endemism of Fishes.

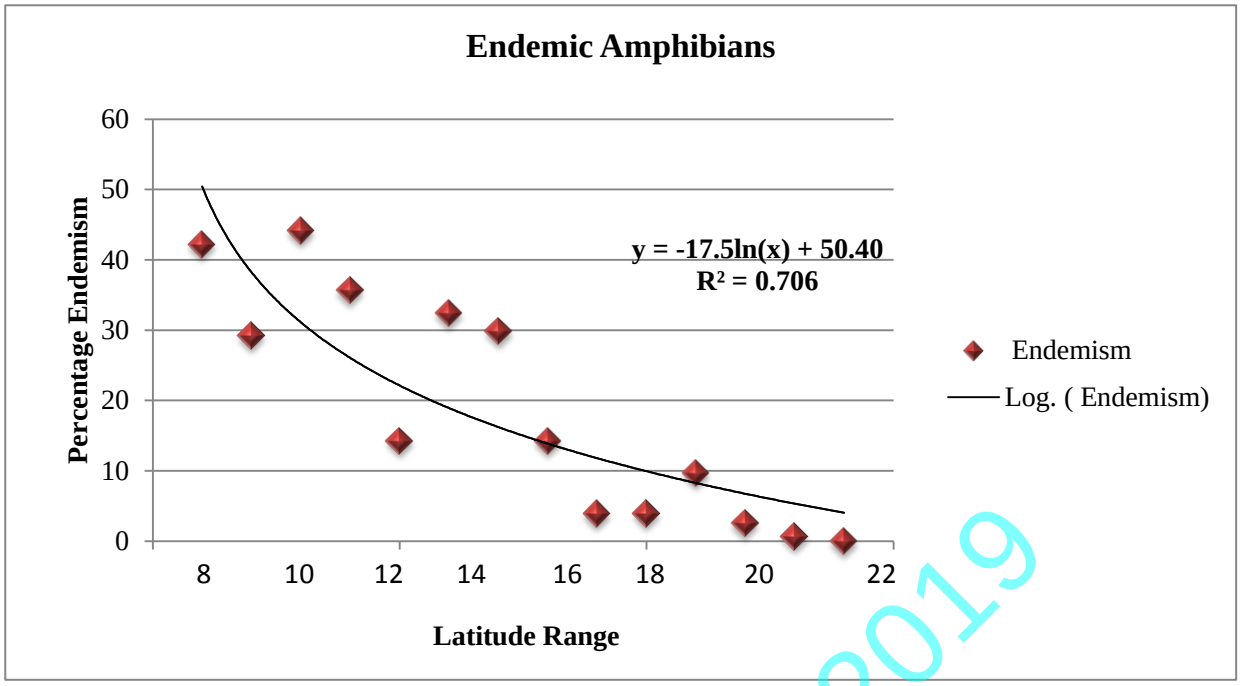


Fig. 6.7.5. Latitude gradient and percentage endemism of Amphibians.

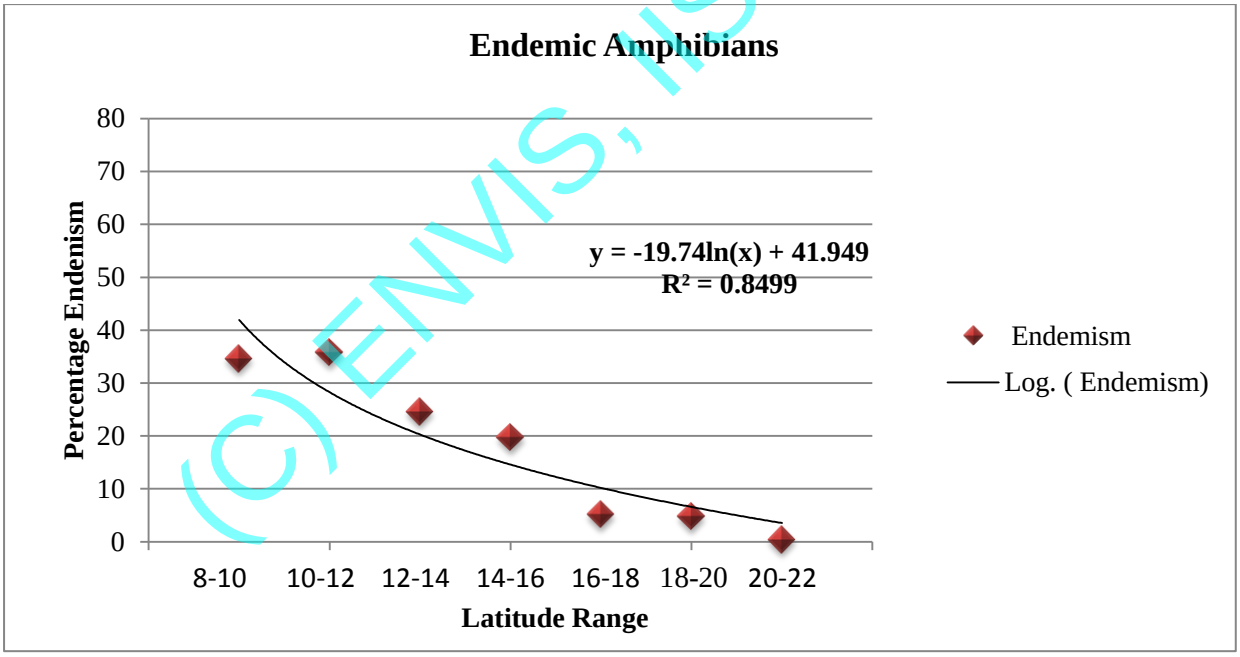


Fig. 6.7.6. Latitude gradient and percentage endemism of Amphibians.

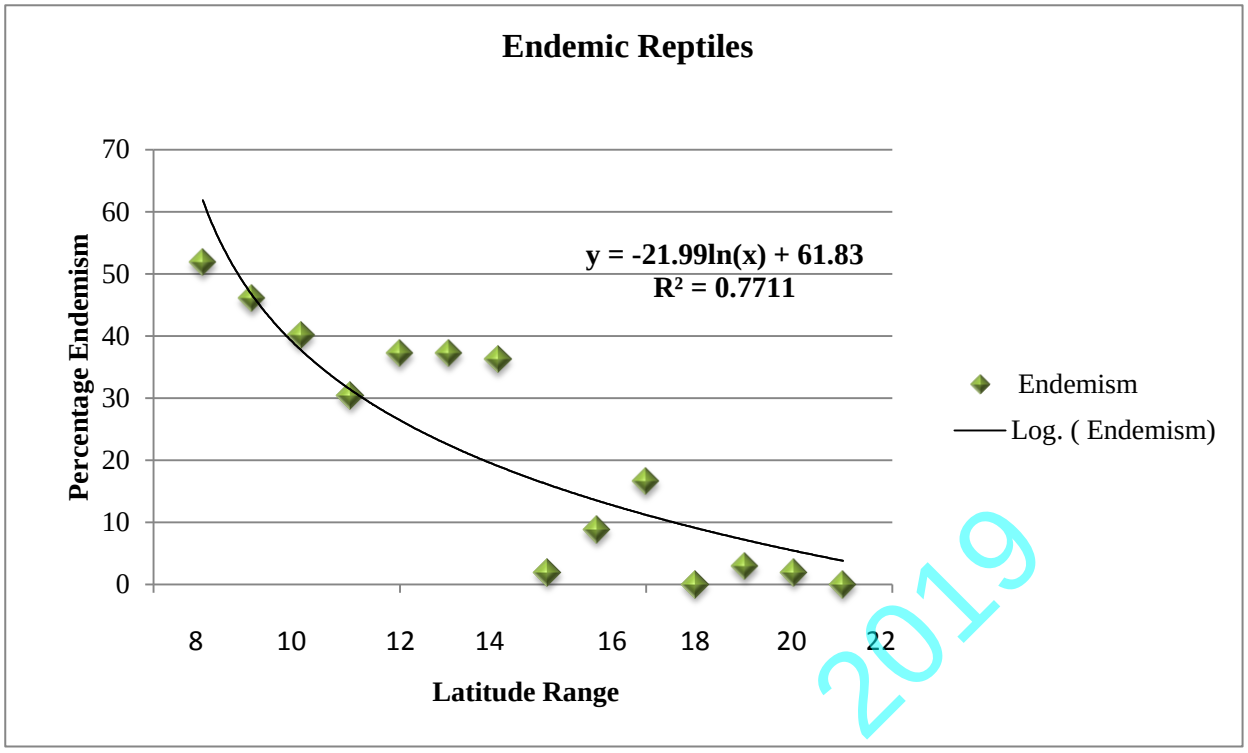


Fig. 6.7.7. Latitude gradient and percentage endemism of Reptiles.

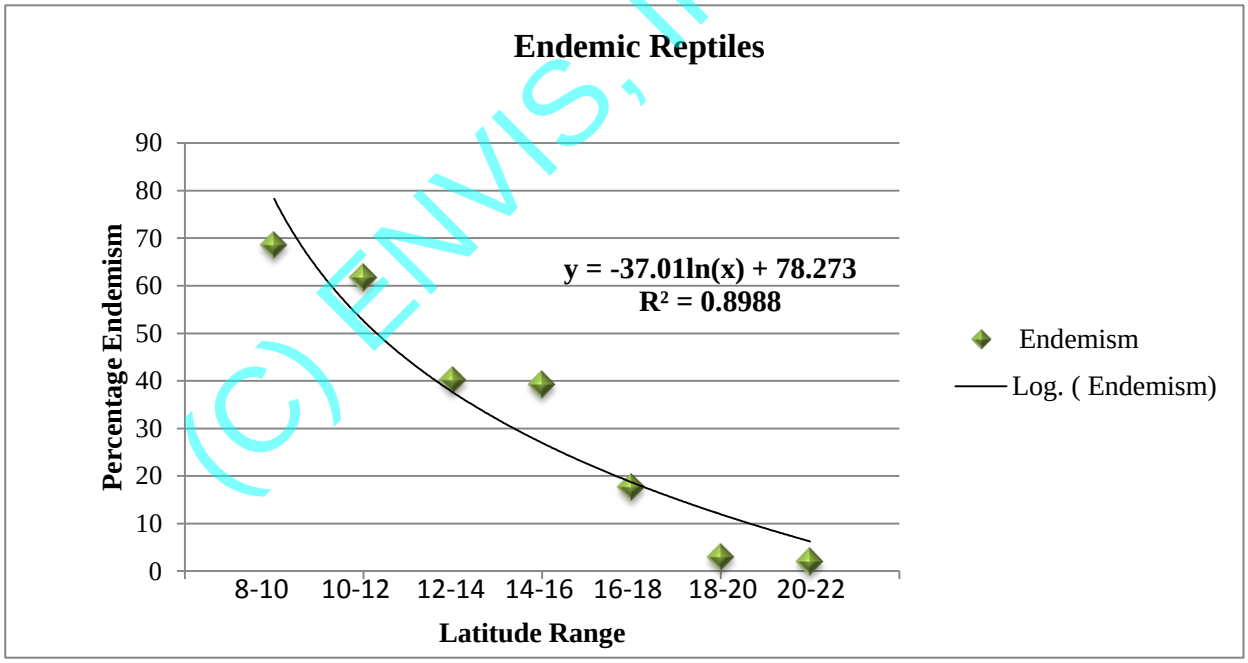


Fig. 6.7.8. Latitude gradient and percentage endemism of Reptiles.

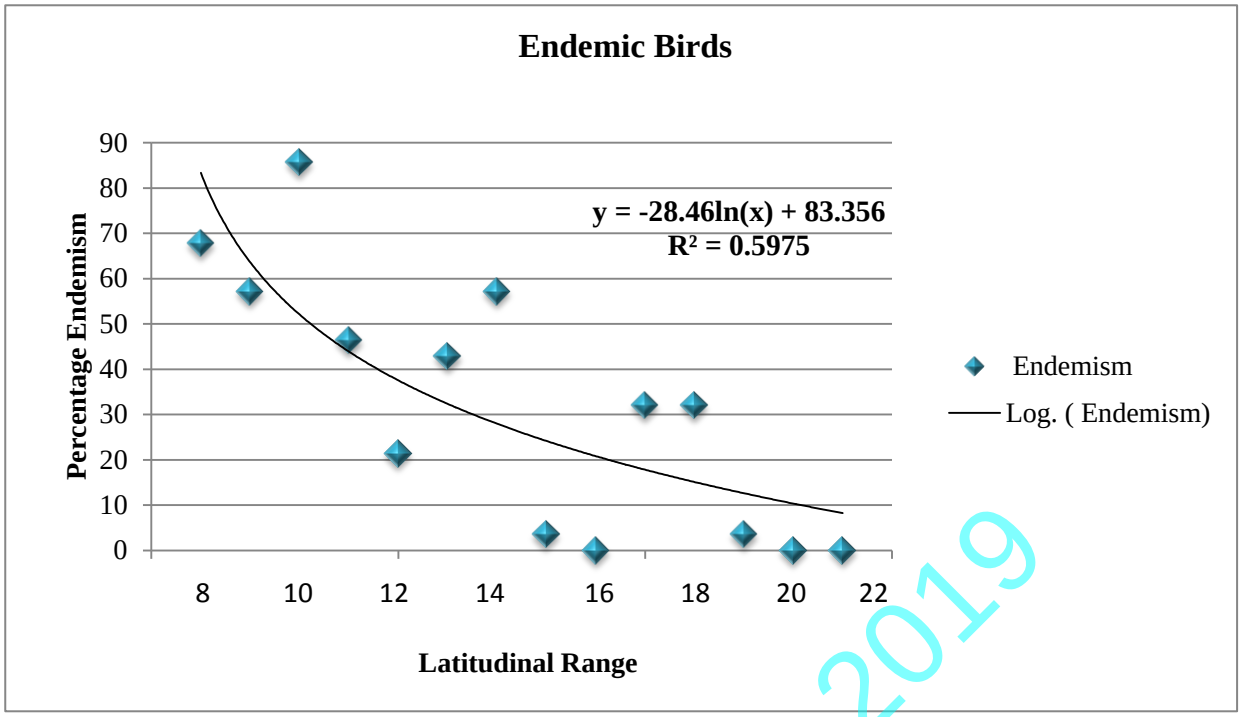


Fig. 6.7.9. Latitude gradient and percentage endemism of Birds.

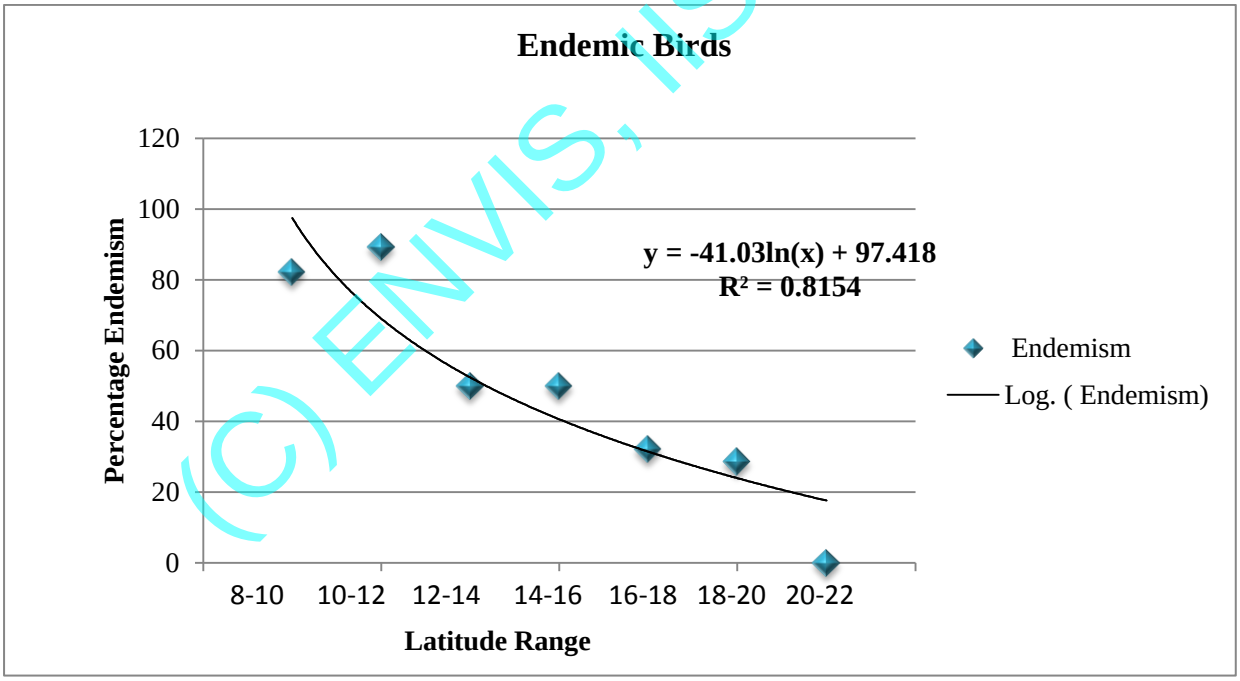


Fig. 6.7.10. Latitude gradient and percentage endemism of Birds.

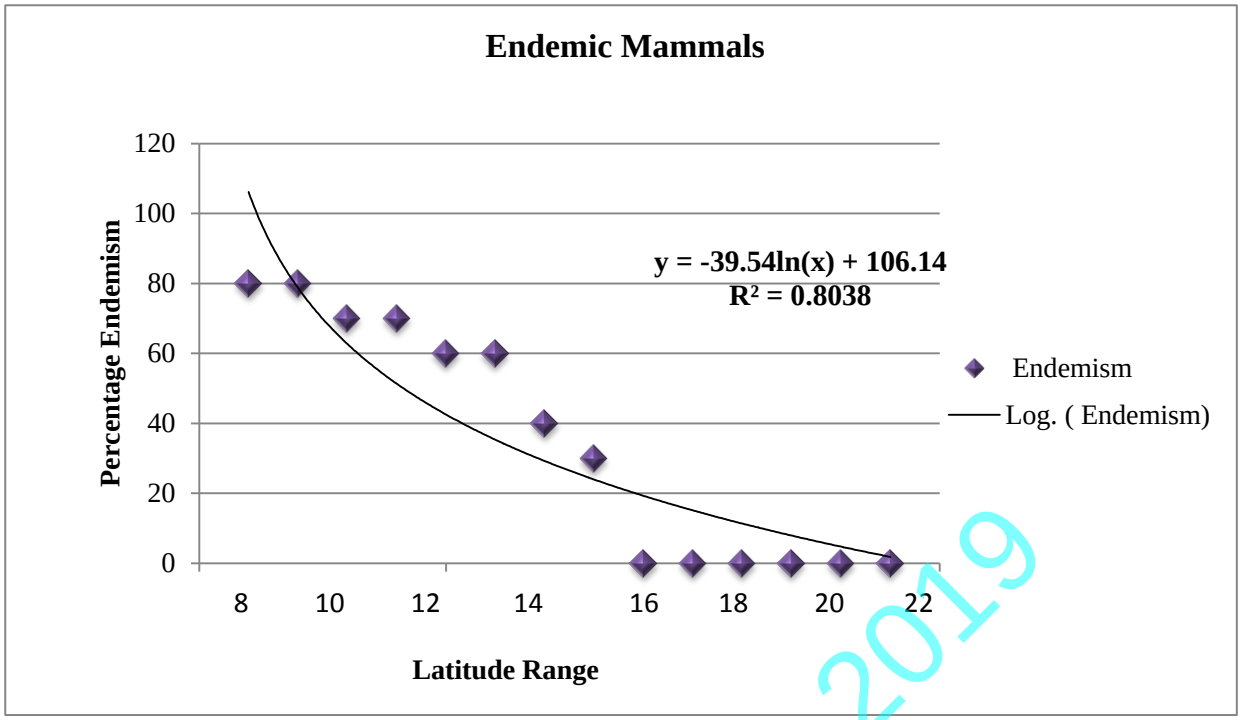


Fig. 6.7.11. Latitude gradient and percentage endemism of Mammals.

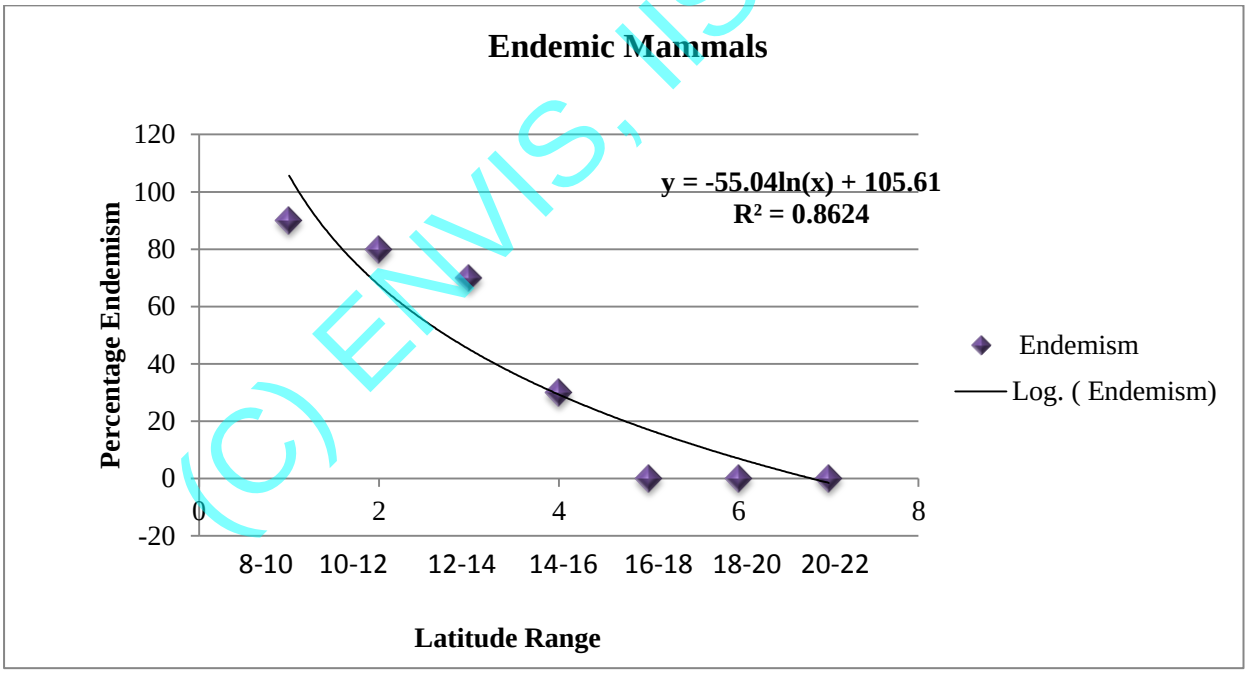


Fig. 6.7.12. Latitude gradient and percentage endemism of Mammals.

SL. NO:	FAUNAL TYPE	RELATION	R^2 VALUE	r VALUE
1	Fishes	y = -13.7ln(x) + 50.95	0.380	0.616
2	Amphibians	y = -17.5ln(x) + 50.40	0.706	0.84
3	Reptiles	y = -21.9ln(x) + 61.83	0.771	0.878
4	Birds	y = -28.4ln(x) + 83.35	0.597	0.772
5	Mammals	y = -39.5ln(x) + 106.1	0.803	0.896

Table 6.7.3. Relationship observed in one-degree latitudinal grid.

SL. NO:	FAUNAL TYPE	RELATION	R^2 VALUE	r VALUE
1	Fishes	y = -15.4ln(x) + 56.76	0.721	0.849
2	Amphibians	y = -19.7ln(x) + 41.94	0.849	0.921
3	Reptiles	y = -37.0ln(x) + 78.27	0.898	0.947
4	Birds	y = -41.0ln(x) + 97.41	0.815	0.902
5	Mammals	y = -55.0ln(x) + 105.6	0.862	0.928

Table 6.7.4. Relationship observed in two-degree latitudinal grid.

CONCLUSION

Western Ghat is a rich biodiversity complex with cultural and heritage significance. Review of international and national peer reviewed literatures and the government policy plans (360 articles) revealed that, the total number of faunal species of each class present in the Western Ghats region has increased. As per the current review, documented faunal species based on new discoveries as follows: Fishes from 290 to 343 species, Amphibians from 179 species to 248 species, Reptiles from 195 to 197 species, Aves from 508 to 529 species and Mammals from 139 to 161 species. Spatial distribution maps depicts faunal distribution is higher in Karnataka, Kerala and Tamilnadu parts of WG. Review shows that, 52 families of fishes were present in WG and Cyprinidae is the largest family with 148 species. In WG region, 11 families of amphibians were present and Rhacophoridae as the largest family comprising 82 frog species. Colubridae is the largest reptilian family (43 species) among the 19 families present in WG. 85 avian families and 32 mammalian families are present in WG. Accipitridae (43 species) is the largest avian family and Vespertilionidae (25 species) is the largest mammalian family.

Spatial distribution with respect to endemism affirmed that, Amphibians shows higher endemism in WG region (62%) followed by reptiles (52%), fishes (26%), mammals (6%) and birds (5%). Similarly, spatial distribution of faunal species based on the conservation status revealed that, 26% of total amphibian population in WG is in higher risk by including in any one of the IUCN red data list categories, extinct, critically endangered, endangered or vulnerable, and then followed by fish population (23%), mammals (19%), reptiles (12%) and birds (5%). Spatial distribution as per the conservation status also reported that birds had the highest number of least concern species (80%), and then mammals (59%), fishes (51%), reptiles (40%) and amphibians had the least number of species under least concern category (15%). Conservation status of 31% of reptilians, 29% of amphibians, 17% of mammals, 17 % of fishes & 10% of birds species were not evaluated.

According to the latitudinal variation of WG, the faunal diversity and endemism is higher in the Southern region followed by Central and Northern WG. Slight deviation in the declining trend in some latitudinal range is due to the presence of protected areas. These increase in diversity and endemism in protected areas shows that conservation is one of the method to preserve diversity in WG. The diversity of species, endemism and presence of globally threatened species in the WG region makes Western Ghats as the 'hottest hotspot of

Biodiversity'. The current communication helps to understand the significance of biodiversity in WG and helps decision makers in effective planning as well as conservation.

SCOPE FOR FUTURE RESEARCH

The present study tries to understand spatial pattern of faunal distribution in Western Ghats and their ecological significance. The current study can be further improved by focusing several other themes that can become very influential objectives in future research. The future research may include;

- To determine the species distribution in accordance to their habitat preference, microbiological studies.
- To estimate the diversity of remaining invertebrate faunal groups present in the WG region.
- To determine the distribution of remaining fauna, present in the WG using spatial visualizing tools.

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