

## Distribution, Habitat of Species of Sauria of Ladakh with Detail of Morphometry of *Altiphylax stoliczkai* (Steindachner), Frontier Bow-fingered Gecko, Baltistan Gecko, or Karakorum Gecko Endemic to South Asia, Recorded after 144 Years from Ladakh(India) & their Conservation Strategies

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**ABSTRACT:** Ladakh is a cold desert with very tough terrain and adverse climate with average annual precipitation of 3 inches (80 mm) only. Fine, dry, flaked snow is frequent and sometimes falls heavily and only few months are suitable to survey the area for reptilian diversity (March to August). In the present study seven species of lizards were reported from Ladakh, Union Territory of India based on extensive survey of 15 days and also based on previous surveys done by scientists of High Altitude Regional Center, Zoological Survey of India and also based on the published literature available. 29 specimens were examined for the study. Morphometry was done for three specimens of *Altiphylax stoliczkai* (Steindachner), collected from Ganglas, Ladakh, recorded after 144 years from Ladakh (Southeast) India. The habitats of the species were described based on observation during survey and also described based on literature. Conservation strategies were mentioned as the region is ecologically very sensitive and fragile.

**Keywords:** Ladakh, sauria, habitat, conservation.

### INTRODUCTION

There is a rapid decline of reptiles noted worldwide and there is an urgent need to take necessary steps for their conservation as mentioned by Gibbons *et al.* (2000). A recent survey of the status of reptiles by Bohm *et al.* (2013) has shown that nearly one of five reptilian species are threatened with extinction and one of five classified as Data Deficient. The decline of reptiles has been influenced by a variety of threats such as habitat loss, degradation and fragmentation, pet trade, invasive species, pollution, diseases and climate change (Bohm *et al.*, 2013; Cox and Temple 2009; Gibbons *et al.*, 2000). Data of population of reptilian species is required for their conservation and also the information of the potential impacts caused by human activities, and this kind of studies are lacking for reptiles (Primack, 2010). Several initiatives were taken to compile the vast biodiversity datasets (e.g. Global Biodiversity Information Facility – GBIF, Encyclopedia of Life – EOL). Ladakh “the land of high mountain passes” is situated in the northwestern part of India, on the slopes of the Great Himalayas. Ladakh is the highest altitude plateau region in India (much of it being over 3,000 m), incorporating parts of the Himalayan and Karakoram mountain ranges and the upper Indus River valley. The ranges of Ladakh, comprising 9,700 sq km, are among the most sparsely populated areas in the world (12 persons per sq km). The Ladakh region is known for its scenic beauty, high-peaked mountains covered with snow, glaciers with

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peculiar lifestyle of the Buddhist culture. There is no general consensus on the height from which the high altitude starts; however, a height of 2,700 m and above is considered a working definition of high altitude. The flora and fauna of Ladakh was first studied by Ferdinand Stoliczka, an Austrian Czech people *Czech paleontologist*, who carried out a massive expedition in the region in the 1870s. The fauna of Ladakh have much in common with that of Central Asia generally and especially those of the Tibetan Plateau. An exception to this is the birds, many of which migrate from the warmer parts of India to spend the summer in Ladakh (Khan, 2015; Pfister 2004 [https://en.wikipedia.org/wiki/Wildlife\\_of\\_Ladakh](https://en.wikipedia.org/wiki/Wildlife_of_Ladakh)). But very few information is available about the distribution of lizards in the area. The present study describes the distribution of seven species of lizards with description of their habitat based on the surveys recently conducted for 15 days from 10<sup>th</sup> August and 24<sup>th</sup> August in 2019 at various localities of Ladakh and also based on the collection present (29 specimens) at High Altitude Regional Center, Zoological Survey of India, Solan, Himachal Pradesh. As *Altiphylax stoliczkai* (Steindachner) was described from a single specimen collected by Ferdinand Stoliczka in 1865 near Karoo, north of Dras, in northern Kashmir (Blanford, 1878). This single specimen was transferred to the Naturhistorisches Museum, Wien (Vienna, Austria), where Steindachner designated it as the holotype (NMW 16756) in honor of its collector. The holotype is

well-illustrated by Szczerbak and Golubev (1986, 1996). Stoliczka collected an additional 46 specimens from the type locality during the Second Yarkand Expedition (1873-1874), and a few localities eastward to Leh in the Indus River valley of central Ladakh, Kashmir. These specimens were subsequently deposited in the Indian Museum, Calcutta (Blanford, 1878).

All specimens were identified by the first author. GIS tool DIVA was used to prepare the distribution map of the species of lizards.

## MATERIAL AND METHODS

Specimens of 29 lizards were examined based on extensive survey of 15 days (from 10<sup>th</sup> August to 24<sup>th</sup> August 2019) and previous surveys done by scientists of High Altitude Regional Center, Zoological Survey of India. The published literature was also used for reporting the species of sauria present in the region. The habitat of the species were reported based on observation and literature. GIS map was prepared by using DIVA for the distribution of the species (coordinates recorded by using GPS of Garmin).

## RESULT AND DISCUSSION

Following species thus reported from Leh District of Ladakh

(i) *Altiphylax stoliczkai* (Steindachner). Common name: frontier bow-fingered gecko, Baltistan gecko, or Karakorum gecko was collected from Ganglas, GPS co-ordinates N 34.20247; E 77.61617 Alt: 3906 m asl, temp 17.1 C, humidity 19%). Three specimens thus collected from the area have morphometry as reported in Table 1. Ganglas is a village between Leh and South Pullu (registration no HARC-ZSI/R ZSI256).

(ii) *Phrynocephalus theobaldi* Blyth, **Theobald's toad-headed agama, snow lizard**. The species is endemic to Asia. Type locality is "Lake Chomoriri" = **Tsho-marari**, Rupshu Province, Tibet.

The species was not collected during current survey but reported based on the collection of HARC, ZSI. 10 kms North East from Tsomarari, Ladakh on 13.01.73 by Dr H.S. Mehta, identified by Archana Bahuguna (2specimen, registration no HARC-ZSI/R 254); from Nyoma along Indus river, Ladakh, collected by H.S. Mehta on 7.09.94 (10 specimens) identified by H.S. Mehta (registration no HARC-ZSI /R 209); from Thungcha, Ladakh on 27.8.94 by H.S. Mehta identified by Archana Bahuguna (3 specimens, Registration number HARC-ZSI/R 268).

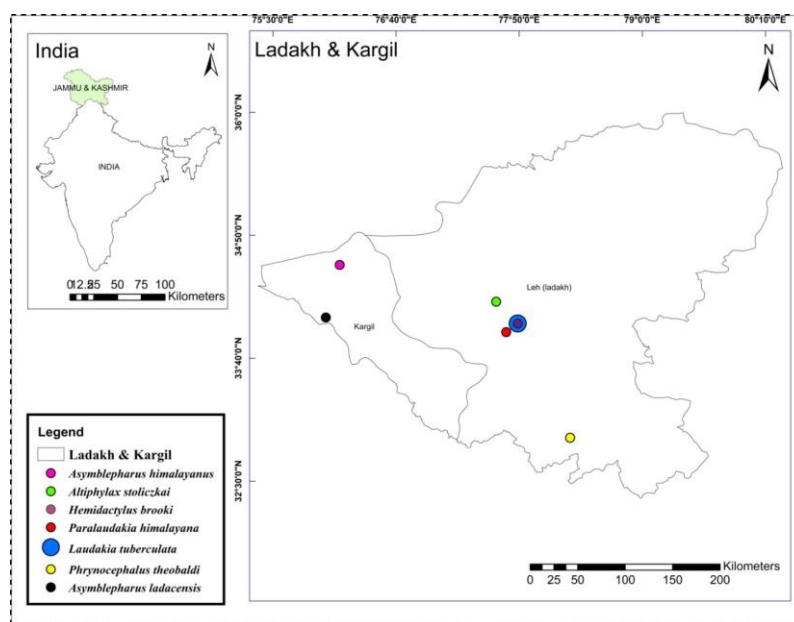
(iii) *Laudakia tuberculata* (Gray), Kashmir rock agama or tuberculated agama collected from Sakti nalla, Ladakh (one specimen) by I.J. Gupta on 7.08.95 (HARC-ZSI/R 251); on 03.08.87 and on 5.08.97 from Hemis National Park, Ladakh (2 specimens, registration no HARC-ZSI/R 247; HARC-ZSI/R 248), identified by Archana Bahuguna

(iv) *Hemidactylus brooki* (Gray) collected from Sakti nalla, Ladakh by I.J. Gupta on 7.08.95 (6specimens), identified by Archana Bahuguna (registration no HARC-ZSI/R 253).

(v) *Paralaudakia himalayanum* (Gray): The species was sighted and photographed at Hemis village (N 33.91421; E 77.71136; Altitude 3589 m asl (temperature 25.3 C, humidity 23%) by Akhil during survey. The area around is mainly scrub land with agriculture field. The region has good population of reptiles.

(vi) *Asymblepharus himalayanus* (Günther): The species is known to be distributed in Suru river area, Kargil district, Ladakh as reported by Borkin *et al.* (2018).

(vii) *Asymblepharus ladacensis ladacensis* (Günther): The species, Ladakh Supple skink was reported from Shey Gompa (4,500m) in the Indus river valley, famous Buddhist monastery situated in Leh district at approximately 1000m (Shrestha, 2001). Constable (1940) mentioned Kharu, Ladakh as the type locality of the species.



Map: Distribution of species of lizards in Ladakh.

**Table 1: Species and their collection data.**

Sr. No.	Species	Classification	Localities in Ladakh
1.	<i>Altiphylax stoliczkai</i> (Steindachner)	Gekkonidae	Ganglas
2.	<i>Phrynocephalus theobaldi</i> Blyth	Agamidae	10 kms North East from Tsomarari; Nyoma along Indus river; Thungcha
3.	<i>Laudakia tuberculata</i> (Gray)	Agamidae	Sakti nalla
4.	<i>Paralaudakia himalayanum</i> (Gray)	Agamidae	Hemis village
5.	<i>Hemidactylus brooki</i> (Gray) complex	Gekkonidae	Sakti nalla,
6.	<i>Asymblepharus himalayanus</i> (Günther)	Scincidae	Suru river are, Kargil
7.	<i>Asymblepharus ladacensis</i> (Günther)	Scincidae	Shey Gompa, Indus river valley; Buddhist monastery in Leh, South Karakorum

**Table 2: Morphometry of species of *Altiphylax stoliczkai* (Steindachner) collected in recent survey.**

Morphological measurements	Specimen no 1	Ratio with respect to SVL	Specimen no 2	Ratio with respect to SVL	Specimen 3	Ratio with respect to SVL
HL	13	0.3	8	0.25	7	0.25
HW	13	0.3	8	0.25	7	0.25
TD	3	0.07	3	0.096	2	0.07
IO	3.5	0.08	3.5	0.113	2.5	0.089
ED	3	0.07	3	0.96	2	0.07
IN	2	0.04	2	0.64	2	0.07
SVL	41		31		28	
Forelimb	12	0.29	10	0.32	10	0.357
Hindlimb	14	0.34	10	0.32	10	0.357
FoL	7	0.17	5	0.16	5	0.178
Finger digital formula	I<II=V<III=IV		I<II=V<III=IV		I<II=V<III=IV	
Toe digital formula	V<IV<I=III<II		V<IV<I=III<II		V<IV<I=III<II	

Himalayas are comprised of five ranges, viz., Pir Panjal, Great Himalayas, Zaskar, Ladhak, and Karakorum. Ladakh is the area of the northwestern Indian subcontinent. Administratively, Ladakh is divided between Pakistan (northwest), as part of the Northern Areas, and India (southeast), as part of Ladakh union territory (until October 31, 2019, part of Jammu and Kashmir state); in addition, China administers portions of northeastern Ladakh. Ladakh covers about 45,000 square miles (117,000 square km) and contains the Ladakh Range, which is a southeastern extension of the Karakoram range, and the upper Indus river valley. Ladakh is one of the highest regions of the world. Its natural features consist mainly of high plains and deep valleys. The high plain predominates in the east, diminishing gradually toward the west. The climate of Ladakh is cold and dry. Average annual precipitation is roughly 3 inches (80 mm); fine, dry, flaked snow is frequent and sometimes falls heavily. Vegetation is confined to valleys and sheltered spots, where a stunted growth of tamarisk (genus *Tamarix*) shrubs, furze (also called gorse; spiny plants of the legume family), and other plants supply much-needed firewood. The principal products are wheat, barley, millet, buckwheat, peas, beans, and turnips. The Ladakh region lies in the northernmost state of India, Jammu and Kashmir, in the Ladhak range. It has a unique cold-arid climate and lies immediately south of the Karakorum range. With scarce water resources, such regions show high sensitivity and vulnerability to the change in climate and need urgent

attention. Blame global warming, and Ladakh is one of those places where it is more evident than elsewhere. Extending from the Siachen glacier to the Himalayas, the picturesque region evokes mental imagery of Buddhist architecture and snow-laden surroundings. Now, both have begun to disappear (Gray *et al.*, 2013). The existence of the habitat of the seven species reported in the present study depends on the climatic condition of the area since the study by Shafiq *et al.* (2019) shows that the climate over Leh has a warming trend with reduced precipitation in the current decade. The reduced average seasonal precipitation might also be associated with some indications of reducing number of days with higher precipitation amounts over the region. *Altiphylax stoliczkai* (Steindachner), Common name: frontier bow-fingered gecko, Baltistan gecko, or Karakorum gecko was collected from Ganglas, GPS N 34.20247, E 77.61617, the area from where the species was reported was humid area. The genus is endemic to Central Asia. The collection was done undertone near to the stream. The area was surrounded by the village with backyard farming. It has lush green agriculture field along with huge plantation of popular trees. Several streams pass through the village, providing sufficient water for irrigation This habitat of *Altiphylax stoliczkai* (Steindachner) is very fragile and sensitive to climate condition of the area as this is the only green patch present in Ganglas and rest is a grass land with fragmented habitat because of road construction. Thus, in future for conservation of this

species special strategies need to be adopted and also awareness programmes also need to be initiated for the villagers and local people of Ganglas so that the habitat of the species will be maintained and conserved. The species is endemic to South Asia. Three species of agama, rock lizard are reported from the area these are *Phrynocephalus theobaldi* Blyth, The obald's toad-headed agama, snow lizard. *Laudakia tuberculata* and *Paralaudakia himalayanum* (Gray).

Theobald's toad-headed agama is endemic to Asia. Type locality is "Lake Chomoriri" = Tshomarari, Rupshu Province, Tibet. The species was not collected during current survey but reported based on the collection of specimens in High Altitude Regional Center, ZSI. 10 kms North East from Tsomarari, Ladakh on 13.01.73 by Dr H.S. Mehta, identified by Archana Bahuguna (2 specimen, registration no HARC-ZSI/R 254); from Nyoma along Indus river, Ladakh, collected by H.S. Mehta on 7.09.94 (10 specimens) identified by H.S. Mehta (registration no HARC-ZSI/R 209); from Thungcha, Ladakh on 27.8.94 by H.S. Mehta identified by Archana Bahuguna (3 specimens, Registration number HARC-ZSI/R 268). The habitat of the species could be affected by climate change in future because of increased flood thus awareness programme need to be initiated to control the inflow of tourists to these sensitive areas and also to regulate sand mining in Indus river and also strategies need to be adopted to prevent the glacier melting in Ladakh. Venugopal (2010) reported that Bobrov (2005) pointed out that distribution records of species of reptiles pre and post partition of British India have not been distinguished resulting in erroneous inclusion of many species into the checklist and for this Bobrov (2005) mentioned an example of *Phrynocephalus reticulatus* Eichwaldt, the species reported from Ladakh (Smith 1935). This single finding was later mentioned in every publication on the herpetofauna of India, Kashmir and Ladakh without any details of locality. Thus there is need to do more extensive surveys to various unexplored localities of Ladakh and also of Jammu and Kashmir to prove the existence of *Phrynocephalus reticulatus* Eichwald in the area. Hussain and Tantarale (2021) documented the first records of *Platycephalus ladacensis* from Kargil District, Ladakh, India in 2020 adding extension of the range of distribution of the species with an elevational range of 350–3,700 m asl (Whitaker and Captain 2004; Schätti *et al.* 2014) thus such kind of study on snakes and also on lizards adding reptilian distribution range in Ladakh. *Paralaudakia himalayanum* (Gray) sighted and photographed at Hemis by Akhil during survey. Hemis is a small village situated 40 kms from Leh (N 33.91421; E 77.71136; Altitude 3589 m asl, temperature 25.3 C, humidity 23%), the village is developed around an old Monestary established in 1672 AD. The area around is mainly scrub land with agriculture field, the habitat suitable for survival of *Paralaudakia himalayanum*(Gray). The region has good population of reptiles thus need special attention for conservation of species. Major threat to the area is construction of hotels and human settlements as the

area is situated near to Hemis National Park. *Laudakia tuberculata* (Gray), Kashmir rock agama or tuberculated agama collected from Sakti nalla, Ladakh on 7.08.95 (2 specimens) with registration no HARC-ZSI/R 251, HARC-ZSI/R 252). The habitat of the species is a rocky area with surrounding vegetation of grass and scrub land. The species of agama are known to feed mainly on insects. *Hemidactylus brooki* Gray collected from Sakti nalla, Ladakh on 7.08.95 (2 specimens), identified by Archana Bahuguna (registration no. HARC-ZSI/R 253). It is a wide spread species of the Gekko.

*Asymblepharus himalayanus* (Günther) was observed by Borkin *et al.* (2018) at altitudes between 1113m and 3724 m in many localities in Kargil area of Ladakh.hey found the species in a large artificial heap of stones piled on a grass roadside as a result of local road reconstruction. This species was described by Gunther (1864; 86) under the name "*Eumeces himalayanus*" based on specimens collected by Messrs v. Schlagintweit in the Himalayas. Sahi *et al.* (1986, 1996) mentioned *Scincella himalayanum* from Kargil, Bodh Kharbu and Lah in Ladakh although Gruber (1981); Ouboter (1986) assigned ground skinks from this region to *A.l. ladacensis*. But Borkin *et al.* (2018) found *A. himalayanus* near Parkachik village, Suru river region (Kargil, Ladakh 34.078303 N and 75.933478 E) at an altitude of 3375m

Ladakh Ground Skink or Ladakh Supple skink *Asymblepharus l. ladacensis* (Gunther) is a species of skink, known to be distributed in China (Tibet) N Pakistan, Western Himalaya (South Karakoram) India (Kashmir, Himachal Pradesh, Uttar Pradesh) West Nepal. The skink was described under the name "*Eumeces ladacensis*" by Gunther (1864:88) from Ladakh. The single specimen was obtained from Messrs, von Schlagintweit. Constable (1940) mentioned Kharu Ladakh as the type locality of the species. According to various authors the lizard is widely distributed in Ladakh from Kargil in west along the upper Indus River to Hemis in the east at an elevation of 2710-3700m (Steindachner 1867; Boulenger 1890; Gruber 1981; Ouboter 1986). In all localities investigated by Gruber (1981), except Hemis, these skinks were quite common. According to Sahi *et al.* (1996) the species is very rare.

The preliminary species distribution maps provided in this study allow, nevertheless, for further analysis on distribution patterns of abundance, rarity, richness and assemblage composition at larger spatial scales (Elith *et al.*, 2010, Baselga *et al.*, 2012). The distribution data are also valuable for conservation planning and modeling species distribution at regional and global level (Sillero, 2005). As already mentioned the decline of reptiles has been influenced by a variety of threats such as habitat loss, degradation and fragmentation, pet trade, invasive species, pollution, diseases and climate change (Bohm *et al.*, 2013; Cox and Temple 2009; Gibbons *et al.*, 2000) and Ladakh has very fragile ecosystem, thus special attention to be given for restoring and maintaining the ecosystem of the area hence the habitat of lizards.

**Conservation strategies for the species:** More data of population of reptilian species is required for their conservation and also the information of the potential impacts caused by human activities in the region due to tourism and road construction and also due to climate change. The rapid development of a road network, to provide access to all main settlements within the region, has come with an environmental cost mainly for the areas of high natural value. It is estimated that some 11 tons of wood are used for each kilometre of road being constructed in the Himalaya (Burman, 1987). Most comes from local sources and is used for asphalt production and for cooking and heating by construction workers. These laborers live on the construction site and use the resources of the land. Tree and bush cutting as well as wildlife poaching are thus common problems around such sites. Impacts are particularly severe in fragile and biodiversity rich areas like wetlands, riverine shrubland and areas of juniper forest where destruction of natural woodland and wildlife population decline have been reported (Fox *et al.*, 1994; Humbert-Droz, 2001a,b). These losses have been partly offset by tree plantation by private land owners and the Forest Department and wood production appears to have increased in the past decades especially in the Indus Valley. Still, such plantations comprising mostly of exotic willows and poplars, do not seem to have reduced biomass extraction in natural woodlands or shrubland and are actually often developed at their expense. Neither do they harbour the varied flora and fauna typical of natural woodlands (Ahmed, 1946). According to the study done by Thayyen of India's National Institute of Hydrology that winter

temperatures are rising and glaciers are losing mass adding to the evidence that global warming is disturbing water cycles on the roof of the world, and in unpredictable ways. Snow cover is shrinking, glaciers are melting, the monsoon season changing and permafrost is at risk, all with drastic consequences for a region whose ice fields hold the largest freshwater reserves outside the poles (<http://www.bloomberg.com/features/2020-indus-river/>). The Nubra valley was once a part of the ancient Silk Road trading route that connected Asia with Persia and Europe. Now it's a staging post in the inexorable advance of climate change. Nubra and Shyok rivers both of which feed the Indus are having flash floods almost every year for the past decade and this pattern will accelerate in future. A study published by Columbia University's Lamont-Doherty Earth Observatory reported that Himalayan glaciers melted twice as quickly in 2000-2016 as they did from 1975 to 2000 (<http://www.bloomberg.com/features/2020-indus-river/>). It indicates that the habitat of the lizards dwelling in this region particularly in Nyoma, Indus valley area are under threat and so the existence of the species residing here. Thus more awareness programmes need to be initiated for the region with the control and regulation of tourists and their vehicles. All nearby places of Ladakh like Himachal Pradesh and Jammu & Kashmir have to control and regulate vehicles numbers. Afforestation programmes need to be strongly implemented in Himachal Pradesh and Jammu & Kashmir to keep the temperature in control.



**Fig. 1.** Indus river.



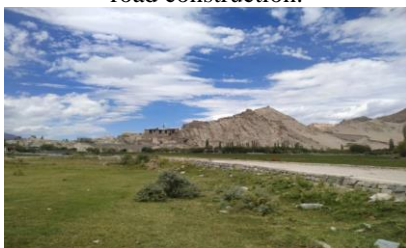
**Fig. 2.** Locality Ganglas: habitat of *Altiphylax stoliczkai*.



**Fig. 3.** Locality Ganglas, fragmentation of habitat due to road construction.



**Fig. 4.** Locality Nyoma.



**Fig. 5.** Locality Shey.



**Fig. 6.** *Altiphylax stoliczkai* (Steindachner).



Fig. 7. *Hemidactylus brooki* Gray.



Fig. 9. *Asyblepharus ladacensis* (Gunther).



Fig. 11. *Laudakia tuberculata*(Gray).



Fig. 8. *Asyblepharus himalayanus* Gunther.



Fig. 10. *Paralaudakia himalayanum* (Gray).



Fig. 12. *Phrynocephalus theobaldi* Blyth.

## CONCLUSIONS

Seven species reported from Ladakh is an updated information about the distribution of lizards in Ladakh with details of habitat types and localities. The distribution maps presented in this paper provide visualized occurrence records to fill a gap in the knowledge of biodiversity of saurians in Ladakh, the Union Territory of India and will help the prioritization of conservation efforts and the identification of important conservation areas for lizards. *Altiphylax stoliczkai* (Steindachner), frontier bow-fingered gecko, Baltistan gecko, or Karakorum gecko was collected from Ganglas, is a new record for India from Ladakh (Southeast).

## FUTURE SCOPE

This study is a first step in updating the database of lizards of Ladakh, the Union Territory of India with the goal to make scientific biodiversity data available and useful for the International community. More localities of the area especially from Kargil need to be explored for extending the range of the distribution of the lizards and for adding more species to the checklist of reptiles of Ladakh. This will help in effective conservation strategies for flora and fauna.

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Himachal Pradesh for providing facilities to carry out the study.

**Conflict of Interest.** None.

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