

[Research]

Review of the morphology, ecology, and distribution of geckos of the genus *Cyrtopodion*, with a note on generic placement of *Cyrtopodion brachykolon* Krysko et. al., 2007

M. Sharif Khan

Herpetological Laboratory, Rabwah, 35460, Pakistan
E-mail: typhlops99@hotmail.com

ABSTRACT

The genus *Cyrtopodion* is the most widely distributed of the four gekkonid genera of the angular-toed geckos that inhabit Pakistan and the contiguous Palearctic Region (Szczerbak & Golubev 1996), from the Indus Valley to the eastern borders of the Caspian Sea. Longitudinal rows of trihedral tubercles characteristically line the dorsum of these angular-toed geckos. They primarily inhabit arid badland strips with sparse vegetation, and secondarily extend into rocks and man-made structures.

The generic affinities of recently described; sub-Himalayan gecko *Cyrtopodion brachykolon* Krysko et.al., 2007 from northern Pakistan, are commented upon.

Keywords: Geckos, *Cyrtopodion*, Morphology, Ecology, Distribution.

INTRODUCTION

The clayey-silt strips of badlands fringing, the foothills of the western Himalayas and the major Eastern Palearctic mountain ranges provide a special habitat for the angular-toed, trihedral-tuberculated, ground geckos of the genus *Cyrtopodion* (Khan and Rösler 1999). The genus is represented by seven taxa in the Indus Valley: *C. k. kachhense* (Stoliczka 1872), *C. k. ingoldbyi* Khan 1997, *C. kohsulaimanai* (Khan 1991), *C. montiumsalsorum* (Annandale 1913), *C. potoharensis* Khan 2001, *C. scabrum* (Heyden 1827), and *C. watsoni* (Murray 1892). Three additional species *Cyrtopodion caspius* (Eichwald 1831), *C. fedtschenkoi* (Strauch 1887), and *C. turcmenicus* (Szczerbak 1978) occur in the Palearctic Region.

The clayey-silty mudflats are divided into intricate mazes of narrow ravines, gorges, and holes carved by the torrential water coming from the mountains. These irregularities provide retreats for several terrestrial animals like foxes, rodents, mongooses, snakes, and especially angular-

toed, trihedral-tuberculated, ground geckos (Khan and Rösler 1999). Similar habitat is scattered throughout the Indus Plains, fringing cultivated lands and major deserts.

The angular-toed geckos have a checkered taxonomic history. Annandale (1913) and Smith (1935) grouped them under genus *Gymnodactylus* Spix 1823, while Underwood *Gymnodactylus* (1954) restricted to South American geckos moving European and Asian forms into the genus *Cyrtodactylus* Gray (1827) accepted by several subsequent herpetologists (Minton 1966; Mertens, 1969; Khan 1986, 1989). Later Szczerbak and Golubev (1984, 1996) erected a new genus; *Tenuidactylus*, for the Palearctic angular-toed species. They placed Pakistani species and an undefined "Tibeto-Himalayan group" in its subgenus; *Mesodactylus*. Khan (2003b) organized the "Tibeto-Himalayan group" into two highland genera; *Altigekko* and *Siwaligekko* and placed the rest of the angular-toed, Pakistani geckos, into the sandstone genus; *Indogekko* and the widely distributed ground geckos of the genus; *Cyrtopodion*.

Cyrtopodion geckos are the most widely distributed in the circum-Indus part of the Oriental Region and in the Palearctic Region.

The present paper examines the morphology in detail, natural history, reproduction of widely distributed circum-Indus and Palearctic *Cyrtopodion* geckos. *C. agamuroides* does not extend in Indus Valley; it is confined mainly to the lower Balochistan highlands (Fig. 1).

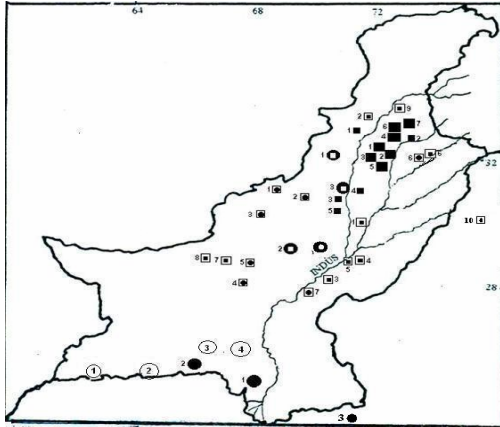


Fig 1. Circum-Indus distribution of Pakistani *Cyrtopodion* geckos:

Cyrtopodion agamuroides: (○): 1. Turbat, 2. Pasni, 3. Siro, 4. Khan Berar; *C. k. kachhense* (●): 1. Karachi, 2. Las Bela, 3. Kachh Peninsula, India (extra limited); *C. k. ingoldbyi* (◻): 1. Ladha, 2. Khar Garden, 3. Maal Pattan; *C. kohsulaimanai* (◐): 1. Sakhi Sarwar; *C. Montiumsalsorum* (◑): 1. Dandot, 2. Rohtas Fort, 3. Pir Peahai, 4. Goalpur, 5. Iskinderabad; *C. potoharensis* (◒): 1. Chingi village and Rest House, 2. Nazampur, 3. Jhangir Dhari, 4. Jaffer City, 5. Soan Sakesar, 6. Malal, 7. Lawrencepur; *C. scabrum* (◓): 1. Bakkhar, 2. Makerwal, 3. Sadiqabad, 4. Dera Nawab, 5. Uchh Sharif, 6. Rabwah, 7. Khzrina, 8. Naushki, 9. Akhora khattak, 10. Ijsselmeer, Rajasthan (extra limital); *C. watsoni* (◔): 1. Quetta, 2. Peshin, 3. Pang Pehai, 4. Khuzdar, 5. Karazi North and Mastung, 6. Rabwah, 7. Rahimyar Khan.

MATERIALS AND METHODS

Geckos from the Indus Valley were collected during the summers of the years 1984-1996. They habitually emerge from their daytime hiding holes just after sunset. Geckos were caught by hand, and euthanized with ether before fixing in 10% formalin.

The following data were recorded for each specimen: Snout-vent length = from tip of snout to the anterior border of the vent; Tail length = from posterior border of vent to the tail tip; the number of midabdominal scales = scales (larger than laterals) counted in straight line across mid-belly; number of midventral scales = scales between the first pair of postmental and the anterior border of

vent counted in midventral straight line of the body.

The data reported in Table 1 for the Palearctic geckos are taken from Szczerbak and Golubev (1996) and are supplemented with them from a few specimens which were available for morphological comparison through the courtesy of Dr. M. L. Golubev (Appendix 1).

The geckos forming the basis of the present study bear the author's personal acronym MSK and are now housed in the Natural History Museum, Government College University, Lahore, Punjab, Pakistan.

Description of the genus *Cyrtopodion*

The thirteen species of the genus *Cyrtopodion* studied have similar morphology and habitat preferences (Table 1), except that the Palearctic species are larger and more robust (snout-vent length 41-80 mm) than the Pakistani species, (snout-vent length 30-60 mm).

Rows of trihedral-to-flat tubercles characteristically adorn the dorsum of the body. They little differ in size and morphology from species to species. In the Indus species (*Cyrtopodion watsoni*, *C. kachhense*, *C. montiumsalsorum*, *C. kohsulaimanai*, and *C. scabrum*, Fig. 2), the tubercles are medially-directed trihedral, trifaceted pyramids with straight-sloping sides meeting dorsally in an indistinct keel, except in *C. kachhense ingoldbyi*, where sides of the pyramids are collapsed at the base of the tubercle giving prominence to the keels (Khan 1997). In *C. caspius* the tubercles are angular cones with the posterior keel jutting out as a spine (Fig. 3); the tubercles are large, flat, square plates with indistinct low keels in *C. fedtschenkoi* (Fig. 4); while in *C. turcmenicus*, tubercles are extremely flat pear-shaped plates with a narrower anterior end and flared posterolateral sides, the keels are low and indistinct (Fig. 5). The tubercles become smaller, less trihedral, and flat towards the sides of the body merging with lateral granules.

In the Indus species the inter-tubercular granular scales are elongated, strongly imbricate, fine-tipped, and keeled, while those in the Palearctic forms are short, broad, flat, and smooth. Tubercles in the median two rows are almost in contact with each other in *C. montiumsalsorum* and *C. kohsulaimanai* become subtrihedral to round on

head and neck and flatter at the snout. A group of subtriangular postfemoral tubercles is usually present, but is absent in *C. kohsulaimanai* and *C. agamuroides*.

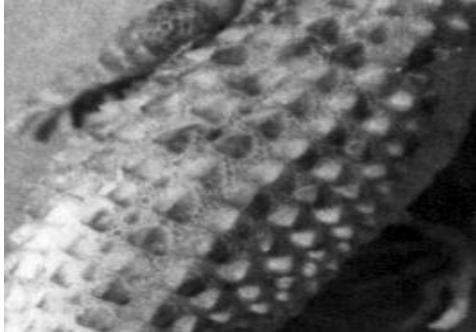


Fig 2. *Cyrtopodion montiumsalsorum*: typical morphology of the dorsal tubercles of the circum-Indus geckos, x 6.

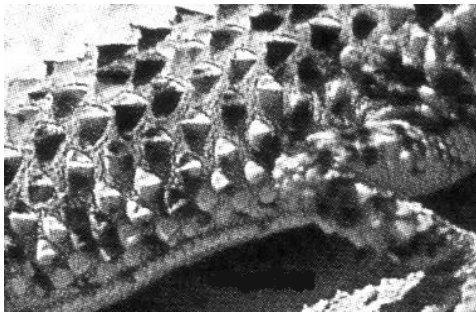


Fig 3. *Cyrtopodion caspius*, morphology of the dorsal tubercles, x 8.

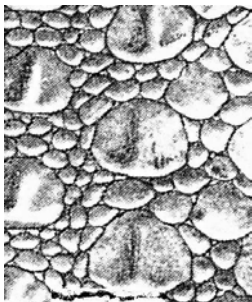


Fig 4. *Cyrtopodion fedtschenkoi*: morphology of the dorsal tubercles, x 8.

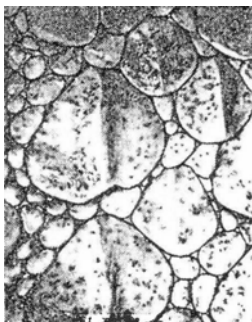


Fig 5. *Cyrtopodion turkmenicus*: morphology of the dorsal tubercles, x 8.

The body and tail subequal in length, tail strongly segmented, fragile at any point, moderately depressed, square in cross section, with a gradual taper; 3-4 dorsolateral rows of strongly keeled caudal tubercles run along the tail, gradually becoming smaller and indistinct towards the tail tip. Tail segments with 4-6 whorls of large strongly keeled scales, those of last row larger, flatter, and mucronate, overlapping laterally, except in *C. kachhense* where the tubercles are smaller, narrower, and feebly keeled.

Subcaudals are twice as broad as long, arranged in a single row, two to a segment; however, in *C. kachhense* they are longer than broad, disposed in two rows, four to a segment.

Precloacal pores are present in *Cyrtopodion scabrum*, *C. watsoni*, *C. potoharensis* and *C. kachhense*, while a series of precloacal and femoral pores are present in a series in *C. montiumsalsorum* and *C. kohsulaimanai* as well as the Palearctic species. Mostly the pore-bearing scales are indistinct, except in *C. watsoni*, *C. potoharensis*, and *C. agamuroides* where the scales are larger than abdominals (Khan 2006).

Color and dorsal pattern

Dorsum brown of various hues: *Cyrtopodion caspius* is pale sandy gray with 5-6 dark transverse, M-shaped bands on body, and 8-12 on tail. *C. turmeric's* is ochre with 5 washed out transverse bands on body, 10 on tail; *C. fedtschenkoi* is light coffee-brown with dark brown bands on the body and tail. The Indus species are light gray to brown or bluish, with sparse brownish suffusion and may have five to seven light to dark-brown transverse rows of round, square spots, dashes or blotches, usually arranged in M-shaped bands or crescents. In *C. montiumsalsorum* and *C. kohsulaimanai* alternating light/dark tubercles form a variegated pattern.

The labials and frontal part of the head spotted with light brown, rarely barred, a dark band from nasal through eyes and ear, converges at the temporals to meet at back of the head. Tail barred with 10-12 dark cross bars; limbs and digits similarly barred, the pattern is more pronounced in juveniles. The ventrum is white to dirty-white, in older specimens with suffusion of fine dark dots along ventro-lateral sides of the body.

Feeding habits

Cyrtopodion are nocturnal and are especially attracted to light posts to feed on photophilic insects. They avoid resident *Hemidactylus* geckos, which dominate in the Indus Valley. *Cyrtopodion* geckos stay at the preferably lighted areas, picking up occasional insects coming into range. Food becomes abundant during warm humid rainy evenings, when the geckos gorge themselves and accumulate fat (Szczerbak and Golubev 1996; Khan 2006).

The diet includes ants, winged termites, dipterous insects, small beetles, katydids, grasshoppers, moths, and mayflies. Juveniles sometimes fall prey to the adults. The menu becomes more varied during the rainy season. Large insects like katydids, roaches and grasshoppers are subdued by thrashing them several times against the substrate, to break the exoskeleton and crush them between the jaws. The prey is engulfed whole, head first. Sometimes the lizard works hard to get down an exceptionally large prey, often it has to discard half engulfed prey as it does not pass through narrow throat. Ants soon get onto the discarded dead prey, pushing and pulling it toward their hole; the movement of the dead prey attracts the gecko, which runs to escape when chased by a mob of fierce ants.

Breeding habits

The mating season extends from mid-March through August, 2 to 3 clutches of one or usually two (rarely three in *C. kohsulaimanai*, Khan 1991) eggs are laid in a protected, relatively dark place: spaces between the stacks of books, under the piles of wood, vegetation, between stacks of clothes, masonry, etc. However, *C. caspius* and *C. fedtschenkoi* are known to use communal egg-laying sites (Szczerbak and Golubev, 1996), also reported for species of genus *Indogekko* (Khan 2006).

Mating has been observed in three species of the genus *Cyrtopodion*; *scabrum*, *C. kachhense* and *C. watsoni*. The following description of *C. scabrum* is essentially similar to the rest of the species: in one summer evening in 1987, I was looking for geckos by torch light in a remote recess of a dilapidated building of Rohtas Fort, Punjab, Pakistan (Khan and Tasnim 1990). Suddenly my attention was drawn by low coughing

sounds “kakkh, kakkh, kakkh,” as I turned to look, it came from a *scabrum* with swollen neck, who later proved to be a male. The receptive female lurked nearby, I noticed her running away when the male moved towards her, she scrambled away, and the calling male closely followed her. Ultimately she stopped in a darker corner, about a meter away, and turned to face the male, lashed her tail sideways. The male responded by similar tail movements, slowly approaching her, and then lunging to bite the side of her neck. She waggled her body for some time. As she calmed down, the male mounted her immediately bending his pelvic region around under her pelvic region, until his cloaca reached hers. Gentle shivering of the bodies of the pair indicated successful intromission. Pairing lasted probably for 5-10 minutes, when suddenly the female broke and ran away. She licked her cloaca for some time, as did the male until his genitalia were withdrawn into the body. The pair appeared not to have been distracted by the torch light and my presence, and continued normal activity.

Gravid female retreated in some secluded place, laying and leaving a pair of rounded, hard-shelled white eggs in some remote, protected and relatively humid recess. Juveniles hatch within about 30-40 days and are frequently encountered from mid-July onward. They start feeding on ants and mosquitoes within about 3-4 hours of hatching. They are quite agile; however, most of them fall prey to adults or are eaten by birds, lizards, snakes, and frogs, only a few reach maturity.

The apparent sex ratio varies from 1 male to 3 females (*Cyrtopodion scabrum* 28 specimens) to 1:2 (*C. kachhense* 12; *C. watsoni* 29) to 1:4 (*C. potoharensis* 9, *C. montiumsalsorum* 30, *C. kohsulaimanai* 12). However, the sex ratio is 1:1 in *C. turcmenicus* and *C. fedtschenkoi*, 1.4 to 2.1 in *C. caspius*. Sexual maturity is reached in males at a snout-vent length of 35-40, and in females 40-45 mm, attained by the next breeding season.

Habitat and ecology

Cyrtopodion geckos are ecosympatric, primarily inhabiting crevices in arid badland mudflats, overgrown with sparse grasses etc., which support a variety of insect prey. These geckos are solitary and strongly territorial,

occupying a particular hole, leaving it at dusk and returning at dawn. The hole is defended against intruders. The gecko usually stays close to the opening during the day, picking up occasional passing insects and retreating deep inside when disturbed (Khan 1989).

These geckos secondarily invade rocks and houses if available in the vicinity; however, *scabrum* is house gecko in small settlements of thatched stone huts scattered in the Indus Valley, submontane areas (Khan 1993a), while other Indus Valley species invade inhabited houses, where are confined to the boundary walls, away from *Hemidactylus flaviviridis*, the dominant house gecko in the buildings. The dilapidated buildings in Rohtas Fort, the Jhelum River Valley (central Punjab), are inhabited by *scabrum* and *montiumsalsorum* along with sympatric *Hemidactylus* species *H. flaviviridis* and *H. persicus* (Khan and Tasnim, 1990; *C. agamuroides* has been collected from the scrub rocky areas along the Makran coast (Fig. 1).

Taxonomy

With the recent descriptions of several new gekkonids from Pakistan (see Khan 2006 for listing and keys) the angular-toed geckos of Pakistan have been distinguished in four following genera (Khan 2003b):

1. Distinct large trihedral keeled tubercles on body and tail, arranged in longitudinal rows; *Cyrtopodion*
Nontrihedral small tubercles on body and tail, arranged in less regular rows; 2
2. Body and tail plump and round, with smooth or slightly keeled tubercles, interorbitals 21-35, midventrals 149-205; *Siwaligekko*
Body and tail flat, dorsal tubercles flat, oval, slightly or not keeled, interorbitals 13-20, 3
3. Tail longer than body, caudal segments distinct, subcaudals twice broader than long, in a single row, limbs and toes long and thin, preanal or both preanal and femoral pores present, interorbitals 13-18, midventrals 129-132; *Indogekko*
Tail shorter than body, unsegmentation, subcaudals indistinct, in several rows, limbs and toes short and thick, no preanal and femoral

pores, interorbitals 16-20, midventrals 117-150; *Altigekko*

Key to Pakistani species of *Cyrtopodion* geckos

Table 1. *Cyrtopodion* species may be diagnosed using following key and comparing their morphometric interspecific variations given.

1. Dorsal tubercles trihedral, conical or pyramid-like	2
Dorsal tubercles subtrihedral, flat	8
2. Only precloacal pores present in male	3
Precloacal and femoral pores present in male	6
3. Subcaudals in a single series	4
Subcaudals in a double series	<i>C. kachhense</i>
4. Less than 25 scales across midabdomen	<i>C. scabrum</i>
More than 25 scales across midabdomen	5
5. Scales across midabdomen 26-3; caudal mucronate	<i>C. potoharensis</i>
Scales across midabdomen 30-40; caudals nonmucronate	<i>C. watsoni</i>
6. Interorbital scales less than 12	<i>C. caspius</i>
Interorbital scales 12 or more	7
7. Scales across midabdomen 20-23; midventral 112-115	<i>C. montiumsalsorum</i>
Scales across midabdomen 27-28; midventrals 120-138	<i>C. kohsulaimani</i>
8. Dorsal tubercles small, subtrihedral, about half the inter-tubercular-space; 2-4 pre-anal pores	<i>C. agamuroides</i>
Dorsal tubercles flattish, much larger than inter-tubercular space, precloacal and femoral pores present in male	9
9. Dorsal tubercles flat more or less circular plates with low keels; mostly two postmental scales	<i>C. fedtschenkoi</i>
Dorsal tubercles flat 'heart-shaped', low keel; mostly three postmental scales	<i>C. turcmenicus</i>

Zoogeography

Cyrtopodion scabrum is the most widely distributed species in the genus, ranging from the African coastal side of the Red Sea, through the Arabian Peninsula, Iraq, Syria, southern Turkey, Iran, Afghanistan, Pakistan and localities in Rajasthan Desert, India, between 13° to 40° N and 34° to 70° E. (Szczerbak and Golubev 1996; Khan 2006). It overlaps the ranges of *C. caspius* and the rest

of the circum-Indus species, which are mostly restricted to the Indus Valley (Fig. 6). *Cyrtopodion caspius* is the next most widely distributed species, ranging from northern Caspian coast to the Aral Sea (30° to 47° N and 47° to 71° E), overlapping the range of *C. scabrum* in the south and of *C. turcomenicus* (34° to 37° N and 62° to 71° E) and *C. fedtschenkoi* (37° to 42° N and 63° to 70° E) in the northeast (Fig. 7).

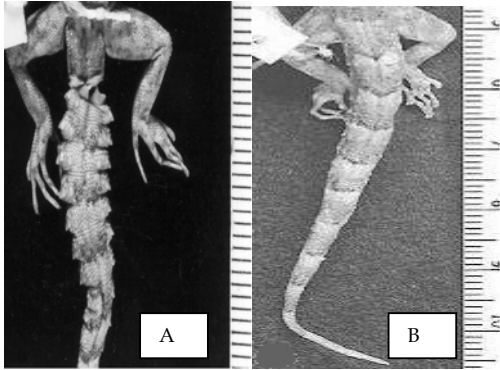


Fig 6. Morphological comparison of hind limbs and tail of *Altigekko stoliczkai* (A) and *Altigekko brachykolon* (B).

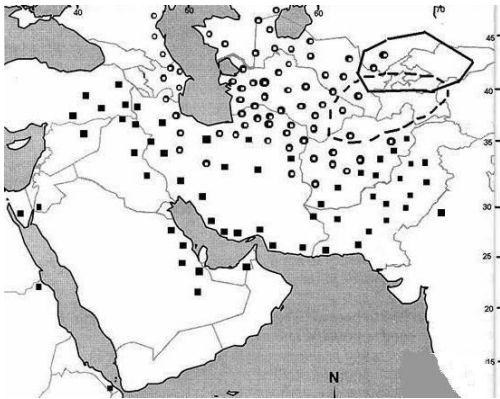


Fig 7. *Cyrtopodion* geckos: Indo-Palearctic distribution: ●: *C. caspius*; —: *C. fedtschenkoi*; ■: *C. scabrum*; - - : *C. turcomenicus*.

Earlier reports of *C. caspius* and *C. fedtschenkoi* from the Salt Range and elsewhere in Pakistan (Stoliczka 1872; Boulenger 1890; Constable 1949; Minton 1966; Mertens 1969; Khan 1987) have proven to be misidentified *C. montiumsalsorum* (Khan, 1989, 1991); moreover, Pakistan does not fall in the zoogeographical range of the Palearctic forms (Fig. 6).

Blanford's (1874) *C. brevipes* (type locality: Aptana, near Bampur, Jaz Murian Depression, Balochistan, southeastern Iran), from Nushki and Kirta, Balochistan by Murray

(1892:68), has no subsequent record from the area (Khan and Ahmed, 1987). I, like most other herpetologists (Mertens 1969:7; Anderson 1999:155; Khan 2003a), am skeptical of Murray's locality records.

A note on taxonomic position of *Cyrtopodion brachykolon* Krysko et al., 2007

Table 1 compares the morphometrics of the *Cyrtopodion* geckos, so far known from the circum-Indus and the Palearctic Regions. Morphologically the new species *Cyrtopodion brachykolon* falls within the range of morphology of *Cyrtopodion* (sensu Khan 2003b). However, it differs markedly from other *Cyrtopodion* geckos: (character states in parentheses pertain to *brachykolon*) rows of distinct dorsal trihedral keeled tubercles adorn body, limbs and tail (tubercles small, roundish, smooth, sometimes indistinctly keeled); interstitial granular scales pointed, keeled, flat, imbricate, transversely disposed (smooth, roundish, bead to flat, arranged in rosettes); tail squarish in transverse section, strongly segmented, caudal tubercles large, flat, keeled, overlapping each other (tail dorso-ventrally compressed, not segmented, a median dorsal groove, caudal tubercles small blunt smooth cones); subcaudals wide, extending almost across the tail ventrum (enlarged, narrower than tail breadth); dorsum with 5-7 light to dark brown transverse rows of round, squarish, dashes or blotches (net work of fading, thick blotches on body, dark transverse bars on tail); body and tail moderately depressed; preloacal pores four or more than four (always four).

On the other hand, the new species *brachykolon* is closer morphologically to the high altitude genus *Altigekko* Khan 2003b, differing from it in tail morphology and shorter limbs (Fig. 6. A, B), these two characters also differentiate it from *Mediodactylus walli* known from neighboring Chitral region (Khan 1992).

I tentatively place the new species in genus *Altigekko* because of the above-mentioned morphological features.

With the addition of the new species, the geckos of northern Pakistan now consist of eight species: *Altigekko baturensis*, *A. boehmei*, *A. brachykolon*, *A. stoliczkai*, *A. yarkandensis*, *Mediodactylus walli*, *Siwaligekko dattanensis*, and *S. battalensis* (Khan 2006).

APPENDIX 1

Species studied during preparation of the present report:

Altigekko baturensis BMNH 1990.3 (MSK 007887), CAS 170529 (MSK 0769.87); *Altigekko stoliczkai* NMW 16756; *Altigekko yarkandensis* BMNH 72.3.22.4; *Cyrtopodion k. kachhense* BMNH 1990.7; *Cyrtopodion kachhense ingoldbyi* BMNH 1931.6.18.1-2, UF 71794, FMNH 235535; *Cyrtopodion caspius* SR 2546:16713-14; *Cyrtopodion fedtschenkoi* SR 1078:8837-8; *Cyrtopodion montiumsalsorum* BMNH 1904.11.19.1, USNM 257535, MSK 014.86; *Cyrtopodion turcmenicus* SR 961:8016-17; *Indogekko longipes voraginosus* CAS 130323; *Indogekko l. longipes* CAS 115944, SR 307:3267-68; *Indogekko fortmunroi* BMNH 1990.4 (MSK 0626.90); *Mediodactylus walli* BMNH 1910.7.12.1; *Mediodactylus chitralensis* BMNH 1946.8.23.19; *Siwaligekko dattanensis* MNHN 1979-7745; *Siwaligekko battalensis* BMNH 1990.2 (MSK 0764), SR 3046:20252 (MSK 0737.89), NMW 31720 (MSK 0762.89), CAS 170533 (MSK 0766.89), USNM 284135 (MSK 0767.89), FMNH 235534 (MSK 0765.89), MSK 0763.89.

Abbreviations used

BMNH= Natural History Museum, London; CAS=California Academy of Sciences, California, USA; FMNH=Field Museum of Natural History, Chicago, USA; MSK=Herpetological laboratory, 15/6 Darul Saddar North, Rabwah 35460, Pakistan (author's personal collection, now deposited in Natural History Museum Government College University, Lahore, Pakistan); NMW=Naturhistorisches Museum Wien, Austria; SR=Institute of Zoology, Academy of Sciences, Kiev, Ukraine; UF=Florida State Museum, Gainesville, USA; USNM=National Museum of Natural History, Washington, D.C.

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