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BEHAVIORAL ECOLOGY AND MICROHABITAT USE BY *Lyriocephalus scutatus* (LINNAEUS, 1758): A MONOTYPIC GENUS IN SRI LANKA (REPTILIA: AGAMIDAE: DRACONINAE) WITH NOTES ON THE TAXONOMY

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Lyriocephalus scutatus is an endemic, relict and near threatened arboreal agamid lizard species representing a monotypic genus, *Lyriocephalus* of Sri Lanka, which is found in forests, plantations and home gardens in the wet and intermediate zones below 900 m a.s.l. This work is mainly based on examination of Iconotype, WHT collection as well as published literature and our observations in last decade. The analysis of habitat data has shown that this species is widely spread within the well shading natural forested areas and poorly in the home gardens. The results of this survey indicate that *L. scutatus* lays about 2 – 4 eggs in range 23.1 – 25.1 mm (mean 24.2 ± 0.55) long and 14.6 – 15.3 mm (mean 15.0 ± 0.22) wide from February – April and October – December. These lizards' natural predators are arboreal colubrid snakes, slender loris, civet cats, toque monkeys and many birds of prey. The current habitat destruction is the huge threat to this species. The paper present parameters may helpful in *ex situ* conservation of *L. scutatus*, especially in captive breeding programs.

Keywords: biology; conservation; distribution; habitat; hemipenis; iconotype; predator; territory.

INTRODUCTION

Sri Lanka is a tropical island located in the Indian Ocean, off the southern tip of peninsular India, at 5°55′ – 9°51′ N 79°41′ – 81°54′ E and 65,610 km^2 in extent and consists of three peneplains; lowland (up to 300 m a.s.l.), midland (300 – 900 m a.s.l.) and highland (>900 m a.s.l.) (Cooray, 1967; Greller and Balasubramaniam, 1980; Werner, 1982). According to the annual rainfall, three major climatic zones are recognized; dry zone (<1900 mm), wet zone (>2500 mm), and the intermediate zone (1900 – 2500 mm) (Cooray, 1967). The island also contains three distinct mountain ranges; central highland, Rakwana hills and the Knuckles massif (Erdelen, 1989). Favorable environmental factors such as high rainfall and humidity and the high density of undergrowth found in this region support a rich biodiversity, which includes high herpetofaunal diversity (Bossuyt et al., 2004; Meegaskumbura et al., 2002; Myers et al., 2000).

There are 98 species of saurians including 74 (75.5%) endemic to the island. Among them 18 species are agamid lizards which include 3 relict and endemic genera (*Ceratophora*, *Cophotis*, and *Lyriocephalus*). Out of 18 agamid lizard species 15 (83%) species are endemic to the island (Ananjeva, 2010; Somaweera and Somaweera, 2009). All the 18 lizard species belong to the subfamily Draconinae and it consists of 6 genera: *Calotes*, *Ceratophora*, *Cophotis*, *Lyriocephalus*, *Otocryptis*, and *Sitana* (Manthey, 2008, 2010). The monotypic genus *Lyriocephalus* represents *Lyriocephalus scutatus* which is near threatened (IUCN-SL and MENR-SL, 2007) and its evolutionary history dated at least to the Pliocene (Schulte et al., 2002). Also *Lyriocephalus scutatus* was first tetrapod reptile species described from Sri Lanka by Linnaeus as *Lacerta scutata* in 1758 along with *Calotes calotes*. In Sri Lanka, *L. scutatus* (Lyre head or Hump snout Lizard) known as "Gáta Hombü katüssä or Káramál Bôdiliyä" in Sinhalese (Das and De Silva, 2005). This agamid lizard was poorly known and lacks of good understanding of its ecology and biology as well as behavior. Therefore we believe this publication may fill gaps in various aspects of *L. scutatus*.

MATERIAL AND METHODS

The material examined is deposited at the Wildlife Heritage Trust, Colombo, Sri Lanka. Diagnoses and de-

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scriptions are based on external morphology. This work is mainly based on examination of Iconotype and WHT specimens as well as published literature and our observations. The locality records for each species include WHT specimen data, published locality records as well as our observations during past decade. We have examined 52 main locations belong to 11 Districts (Badulla — 1, Colombo — 2, Galle — 9, Kalutara — 12, Kandy — 4, Kegalle — 1, Kurunegala — 2, Matale — 3, Matara — 4, Monaragala — 2 and Ratnapura — 12), also we gathered reliable published distribution data and unpublished data on personal communications. A total of 109 individuals (males: 67; females: 29; juveniles: 13) were recorded during the study period. The specimens were examined, sexed, measured before released back to the same habitats. Maturity was defined from the rostral knob development, gular sac and nuchal hump, hemipenis developments and SVL (<60 mm in juvenile; 60 – 100 mm in subadults; >100 mm in adults). Principal components and cluster analyses were performed using PC-ORD 4.17 for Windows (MjM software, Glenden Beach, Oregon, USA) (Tables 1 and 2).

TABLE 1. The Summary of Results Obtained from Principal Component Analysis of Morphometric Characters (Variance Extracted from the First Three Axes)

Axis	Eigen-value	% of Variance	Cumulative, %	Broken-stick Eigen-value
1	2.793	93.101	93.101	1.833
2	0.182	6.059	99.160	0.833
3	0.025	0.840	100.000	0.333

TABLE 2. The Summary of Results Obtained from Principal Component Analysis Morphometric Characters (Eigen-Vectors for the First Three Axes)

Sp. No.	ID No.	Axis 1	Axis 2	Axis 3
1	M1	–0.8644	–0.1487	0.0435
2	M2	–0.2390	–0.6742	–0.0798
3	M3	–0.1747	–0.8718	–0.1045
4	M4	–0.6377	–0.3463	–0.1038
5	M5	–0.8316	–0.3075	0.0214
6	M6	–0.4760	–0.2823	0.0210
7	M7	–0.6564	–0.3880	–0.0960
8	M8	–0.7106	–0.3625	–0.1122
9	F1	–1.2195	0.3233	–0.0170
10	F2	–1.6597	0.1435	0.0615
11	F3	–1.5239	0.2104	0.0665
12	F4	–1.4454	0.2747	0.0530
13	F5	–1.1496	0.4867	–0.0002
14	F6	–1.4788	0.3426	0.0884
15	F7	–1.3855	0.3334	0.0421
16	F8	–1.4455	0.4800	0.0390
17	J1	2.6845	0.2719	–0.1025
18	J2	2.4746	0.7832	–0.5297
19	J3	2.7178	0.0959	0.1671
20	J4	2.6128	0.0496	0.3227
21	J5	2.7759	0.2729	0.2364
22	J6	2.6328	–0.6870	–0.0167

The lizards were identified and verified by using the descriptions and figures given by Deraniyagala (1953), Günther (1864), Manthey (2010), Smith (1935), Somaweera and Somaweera (2009), and Taylor (1953). All measurements were taken to the nearest 0.1 mm with dial calipers (accuracy ±0.05 mm). Scale counts: SUP, supralabials were counted from the first scale anterior to that at angle of gape, not including the median scale (when present); INF, infralabials were counted from first scale posterior to mental, to angle of gape; MBS, mid body scales were counted from center of mid-dorsal row forwards and downwards across ventrals (this count is, however, made unreliable by the unequal size and uneven arrangement of the lateral scales); MVS, mid ventral scales were counted from first scale posterior to mental, to last scale anterior to vent. Measurements: SVL, snout-vent length (distance between tip of snout to anterior margin of vent); HL, head length (distance between posterior edge of mandible and tip of snout); HW, head width (maximum width of head); AG, axilla-groin length (distance between axilla and groin); TAL, tail length (measured from anterior margin of vent to tail tip). The data's were analyzed according to the time, microhabitats, elevation, temperature, humidity, canopy cover and clutch size vs. SVL as well as major habitats use patterns (Fig. 1).

TAXONOMY

Iconotype. Seba's Museum. [Vol.] I. page 173. pl.. 109. Fig. 3. Prodigious shielded lizard from Ambon Habitat in Asia (see Fig. 28, Plate 4 of Amarasinghe et al., 2009b).

Description of iconotype. Based on Linnaeus (1758), iconotype, Boulenger (1890), Deraniyagala (1931, 1953), Günther (1864), Smith (1935), and WHT collections. Snout with a rostral knob in adult which is larger in the male (Fig. 2) than in the female and covered with smooth, subequal scales. Canthus rostralis of 14 – 17 compressed scutes, prominent and continued as a compressed supraocular ridge ending in a triangular compressed spine above hind end of orbit. A pair of blunt spines on occiput. Tympanum absent. Upper head scales very unequal, irregular, feebly carinate, sides of head with enlarged tubercles. 12 – 16 supralabials, nasal above 3rd and center of eye above 11th scale. 12 – 16 infralabials. The first tooth in upper and lower jaw canin-

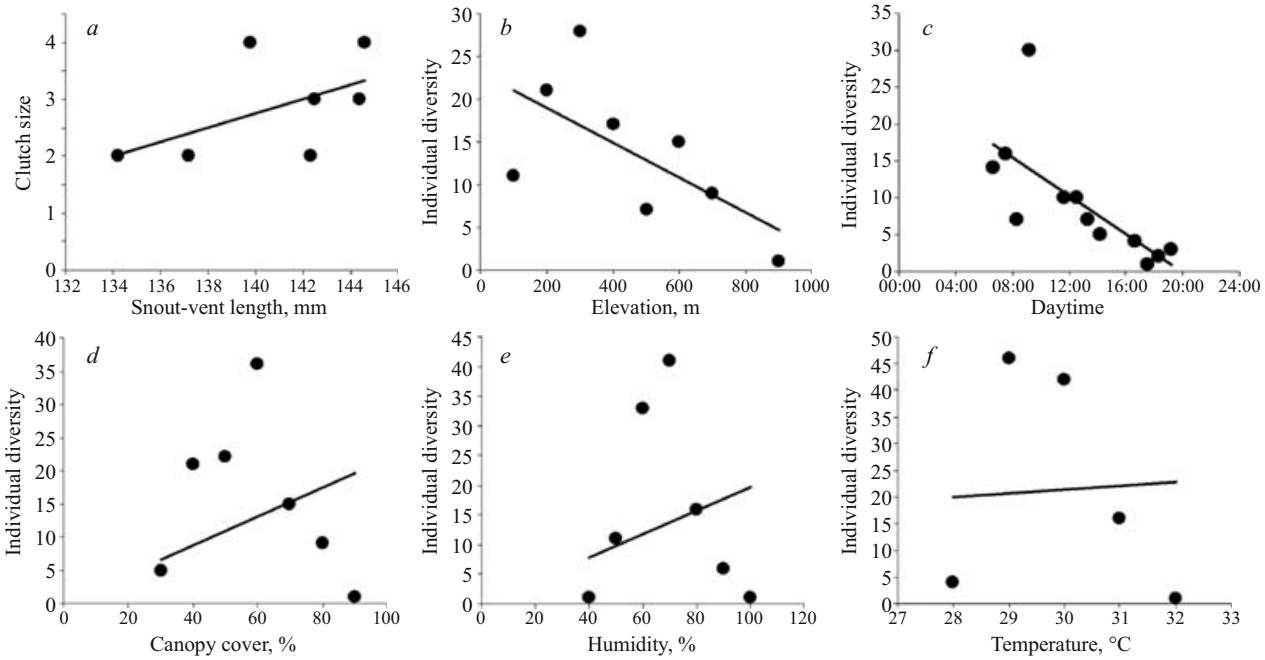

Fig. 1. Relationship between individuals and physical parameters: *a*, snout-vent length and clutch size; *b*, elevation range and individuals; *c*, time period and individuals; *d*, percentage of canopy cover and individuals; *e*, humidity and individuals; *f*, temperature variance and individuals of *L. scutatus*.

oid, rest compressed, trituberculate. Nostril in a circular nasal scale. 14 supraciliaries. 18 – 20 osseous plates below eye from snout to just beyond hind edge of gape, the last two or three plates circular and largest.

The gular sac developed and more prominent in male which also possesses a nuchal hump. Gular scales large unicarinate pointing downward, largest near carina. An enlarged row of 13 – 16 plate-like lateral gulars along edge of lower jaw. Nuchal crest of close set triangular, compressed, short scales extends to above shoulders posterior to this, the dorsal crest consists of widely placed fleshy unicarinate scales which are closer together on hips and tail. Body strongly compressed sides and back have small, smooth, pointing upwards and backwards scales with three regular longitudinal rows of enlarged scales from head to midbody and about 7 vertical irregular rows of enlarged trihedral scales on body. Ventral scales trihedral, large along outer edge. Tail strongly compressed, with bluntly rounded tip covered with large scales and a crest dorsally. Supracaudals unequal. Subcaudals strongly carinate, equal. Limbs above with unequal, carinate scales, enlarged tubercles on thighs, fourth toe extending well beyond the third. The hind limb reached to the neck.

Remarks. Description of color pattern is based on Linnaeus, 1758; Iconotype, Boulenger (1890), Deraniyagala (1931, 1953), Günther (1864), Smith (1935), Somaweera and Somaweera (2009) and observations on living specimens. Body color changes from cinnamon brown to green. Leaf green above, whitish below (Fig. 3). Gular sac and antehumeral fold yellow in life, the enlarged scales of the sac green or black; numerous dark brown

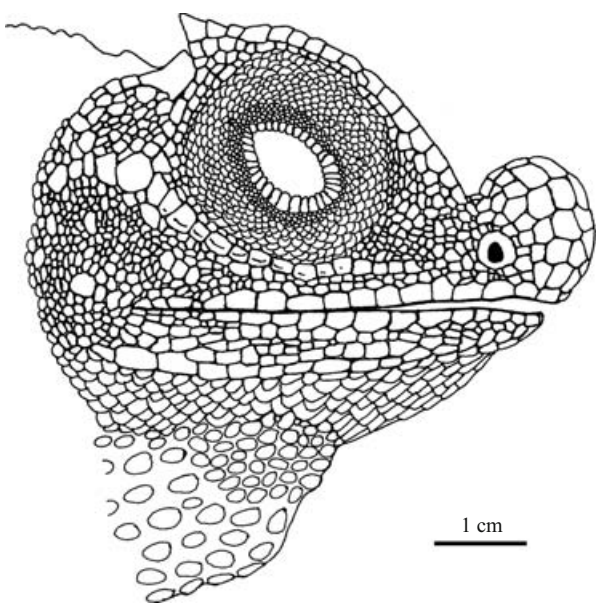

Fig. 2. Line drawing of the head of *L. scutatus*, WHT 6232; male.

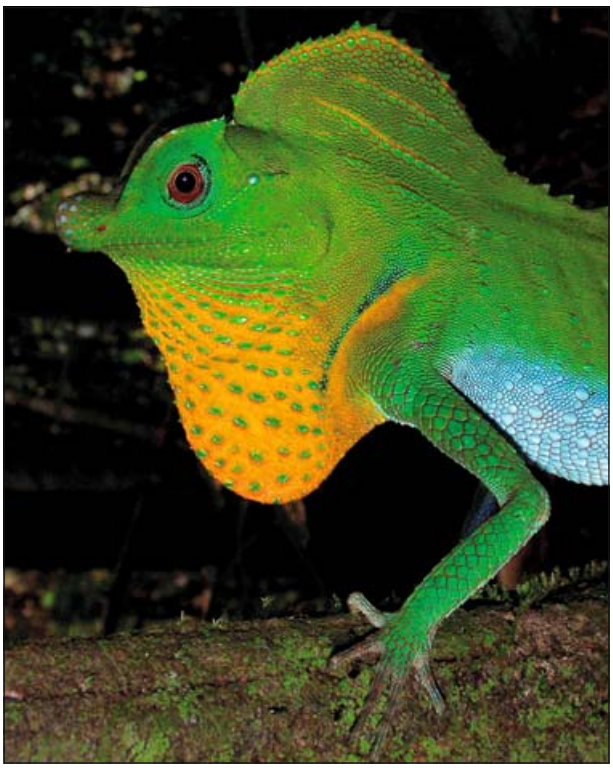

Fig. 3. Super male of *L. scutatus* in Kanneliya forest (showing green, yellow and blue colors).

lines radiate from eye. Belly sometimes bluish (in some morphs another color: green/cream/white (Figs. 4 and 5) and all juveniles are dull cored (Fig. 6). Limbs and tail banded with brown. The external measurements show three clear different clusters according to the age group (juvenile/sub adult/adult) as well as gender (male/female) (Fig. 7) this has been recorded for the first time for agamids. Males are larger than females [SVL 136.3 – 152.5 mm (mean 145.6 ± 5.59)] and females [SVL 134.2 – 148.7 mm (mean 141.2 ± 4.53)] (Table 3).

DISTRIBUTION

According to our study on this species was recorded from 20 – 900 m a.s.l. elevations. Among 109 individuals 86.2% (n = 94) recorded from wet zone while 13.8% (n = 15) from intermediate zone (Fig. 8). Even some researchers (Deraniyagala, 1953; Smith, 1935) considered this species as montane and distributed in hilly districts, according to our records only 9.2% of the individuals recorded above 600 m a.s.l. Therefore we can consider this species as mainly lowland species but occasionally sub montane species. The sub montane population also isolated in to small forest patches, but we can assume this species was well distributed in montane areas 60 years

Fig. 4. Adult female, green color morph in Kithulgala (note the chest color and blue lateral margin).

Fig. 5. Immature female, brown color morph in Kottawa, note irregular green color dots.

back. Cruze and Nugaliyadde (1978), Manamendra-Arachchi and Liyanage (1994), Bambaradeniya et al. (1997) and Somaweera and Somaweera (2009) state this species recorded up to 1524, 1650, 1524, and 1600 m a.s.l., respectively. However we failed to record this species above 900 m a.s.l., also they did not provide any locality data to prove 1600 and 1650 m a.s.l. During our study we could record one individual at Lunugala for the first time from Badulla district (320 m a.s.l.).

According to the distribution analysis this species is well distributed in Ratnapura District and it was 32.1% (n = 35) of total number of individuals (Fig. 9). In addition Kalutala 19.3% (n = 35), Galle 12.8% (n = 14) and Matale 12.8% (n = 14) Districts also recorded higher densities while Badulla 0.9% (n = 1), Colombo 1.8% (n = 2) and Kurunegala 1.8% (n = 2) districts show the least abundant. The highest number of individuals (n = 7) recorded from Pitawala (Matale District) and Sinharaja (n = 6), Gilimale (n = 5), and Kukulugala (n = 5). According to our survey the female sex ratio is low comparatively to the males (males: n = 67, females: n = 29, and juveniles: n = 13) and this is less than half of the male population. The highest number of males was recorded from Ratnapura District (n = 17) and also the number of females highest in Kalutara (n = 12) District. Additionally we have to noted several new locations subsequent to this study.

HABITAT TYPES

L. scutatus is subarboreal agamid lizard found on tree trunks in cool shaded areas (Vidyalankara and Bandara, 2004) with a dense canopy (Manamendra-Arachchi and Liyanage, 1994). Deraniyagala (1953) considered it as "a ground dwelling form which sometimes ascends trees" even Somaweera and Somaweera (2009) consid-

Fig. 6. Juvenile morphs: *a*, brown color (sleeping at the night); *b*, black color (live near forest flow).

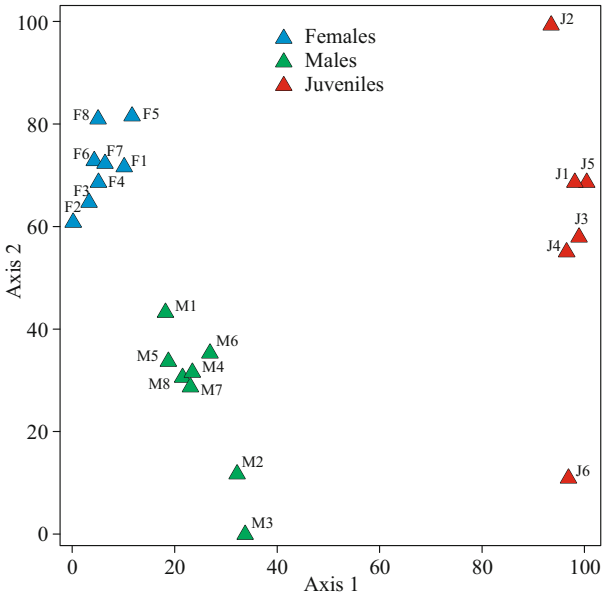

Fig. 7. Results of the Principal Components Analysis, against sexes and life stages.

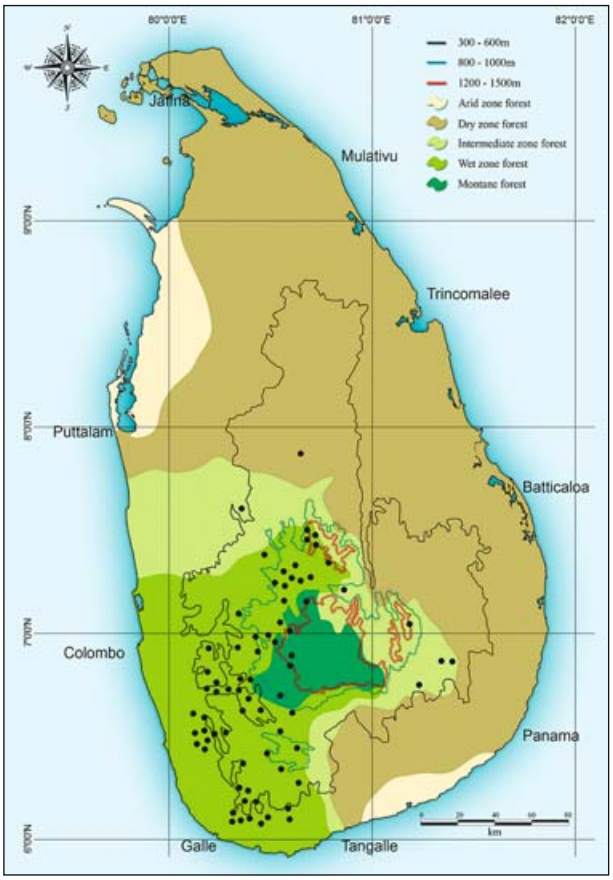

Fig. 8. Known current distribution pattern of *L. scutatus* in different climatic zones and elevation in Sri Lanka.

ered it as arboreal species. This species was not found in warm sunny sites (Vidyalankara and Bandara, 2004). According to our study 91.1% ($n = 51$) of males and 56.5% ($n = 13$) of females preferred tree trunks as the micro habitat and the girth at breast height (GBH) of these trunks varies from 12 – 18.5 cm, however at night they prefer trunks with smaller GBH between 40 – 58 mm and select places 2.5 – 4.5 m above ground level (Fig. 10). Juveniles and sub adults preferred dry branch ends without leaf cover. According to major habitat preference 27.5% ($n = 30$) recorded from natural forests, 26.6% ($n = 29$) from forest edges, 24.8% ($n = 27$) riverine forests, 11.0% ($n = 12$) home gardens, 7.3% ($n = 8$) rubber plantations and 2.8% ($n = 3$) from cocoa plantations as an arboreal habitat preference '$r^2 = 0.6604$' (Fig. 11). More than 50% of the individuals preferred 60 – 66% humidity, 54 – 63% canopy cover and 28.5 – 29.5°C temperature. Many individuals recorded from home gardens showed many physical damages such as limb and tail amputation, desquamation and laceration of epithelium of head and wet gangrene formation of limbs and tail.

According to De Silva (1990) and Senanayake et al. (1977) both were noted the value of lowland rain forest and its habitats for many endemic or vanishing agamid lizards, our results also supporting to determine to above data (e.g., Good canopy cover, proper humidity and temperature). According to microhabitats preference they use 83.5% ($n = 91$) tree bark, 9.2% ($n = 10$) ground, 5.5% ($n = 6$) branches and 1.8% ($n = 2$) on the stones '$r^2 = 0.8714$' (Fig. 12). After pooling our habitat data, it

TABLE 3. Few Measurements of the *L. scutatus* Different Sex Stages and the Juveniles at Sri Lanka

Measurements	Males ($n = 10$)		Females ($n = 10$)		Juveniles ($n = 6$)	
	range	mean ± S.D.	range	mean ± S.D.	range	mean ± S.D.
HL	45.1 – 55.2	49.4 ± 3.21	42.3 – 47.3	45.0 ± 1.71	22.4 – 25.6	23.4 ± 1.15
HW	32.5 – 36.4	34.2 ± 1.35	29.5 – 33.6	32.0 ± 1.21	24.6 – 26.6	25.8 ± 0.83
AX	78.6 – 88.6	83.7 ± 3.50	78.5 – 88.6	83.6 ± 3.90	24.1 – 26.7	25.9 ± 0.98
SVL	136.3 – 152.5	145.6 ± 5.59	134.2 – 148.7	141.2 ± 4.53	50.1 – 58.6	54.1 ± 3.02

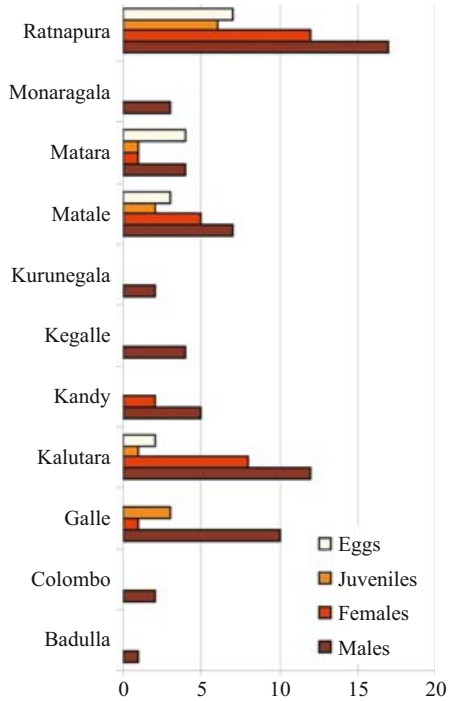

Fig. 9. Eleven district areas were searched for *L. scutatus* distribution in this study. Note: life stages and sexes.

Fig. 10. Mature male on a tree trunk at night (note: mosquitos on the body).

shows more than 80% locations have a good rain fall (>3000 mm) average throughout the year. Wet zone forests of Sri Lanka harbors more than 60% of the indigenous fauna, and high percentage of endemism can be seen in the southwest lowland forests where almost 90% of the endemic vertebrates are concentrated (Bambaradeniya et al., 2003; Das and De Silva, 2005; Wijesinghe and Dayawansa, 2002). The other sympatric agamid lizard species are *Calotes liolepis*, *Ceratophora aspera*, *Otocryptis wiegmanni*, and *O. nigristigma*. According to our study more than 80% locations are sympatric with *O. wiegmanni* in the wet zone. Also *Calodactylodes illingworthorum* in the intermediate zone, *Cnemaspis molligodai*, *C. silvula*, *C. podihuna*, *C. kumarasinghei*, *Geckoella triedrus*, *Gehyra mutilata*, *Hemidactylus depressus*, *H. frenatus*, and *H. parvimaculatus* sympatric with *L. scutatus*.

REPRODUCTION

There have been only few attempts to use hemipenis morphology as a taxonomic tool for agamid lizards although there is a considerable amount of structural diversity (Maduwage et al., 2008). The hemipenis of *L. scutatus* completely differentiated as compared to *Calotes* species (see Amarasinghe et al., 2009, 2011; Karunarathna et al., 2009). The pedicel is considerably shorter than the head; below the head, it is broadened out in to two shallowly concaved shoulders, flounces absent; there are no spines. The head is globular in shape and length of the organ not greater than its width. It is shallowly divided longitudinally in to four lobes, two being very slightly larger than the others, but not divided for more than half

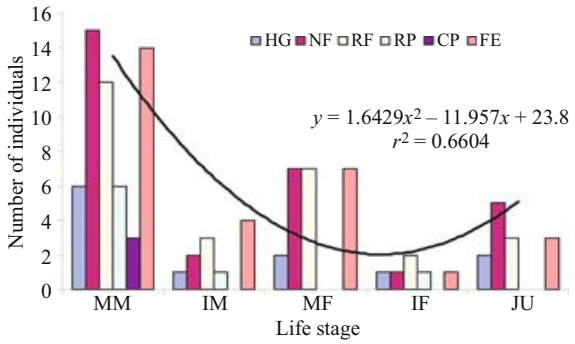

Fig. 11. Major habitats preference of *L. scutatus* in different life stages: HG, home gardens; NF, natural forest; RF, riverine forest; RP, rubber plantations; CP, cocoa plantations; FE, forest edges.

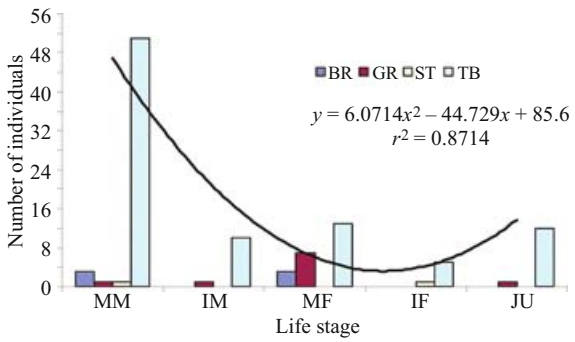

Fig. 12. Microhabitats preference of *L. scutatus* in different life stages: BR, branches; GR, ground; ST, stones; TB, tree barks.

of its length. The surface of the head is most reticulatedly pitted, the pits being larger on the outside and diminishing in size towards the divisions between the lobes (Fig. 13).

During our study, we observed several cases of mating behavior of this lizard. Here describe one observation in Sinharaja (6°25′26.04″ N 80°21′41.23″ E; 315 m a.s.l.). We observed one mature female with bright colors on a tree trunk (GBH: 96 cm) 2 m above ground level. Another mature male observed another tree trunk 2 m away. This male looked at the female around 10 min and then climbed down from the tree and on the ground moved to the tree the female stays. After that the male close to the female and both individuals changed their colors in to bright green. Then the male shake his body two times and female came close to the male. Then suddenly the male jumped forward and caught her neck with the nuchal hump from his mouth and griped her using his body. Then the female lifted its tail and the male put its anterior parts under the tail and angle slight the body (this position is exactly similar to mating possession of house geckos, *Gehyra mutilata*), then inserted the hemipenis

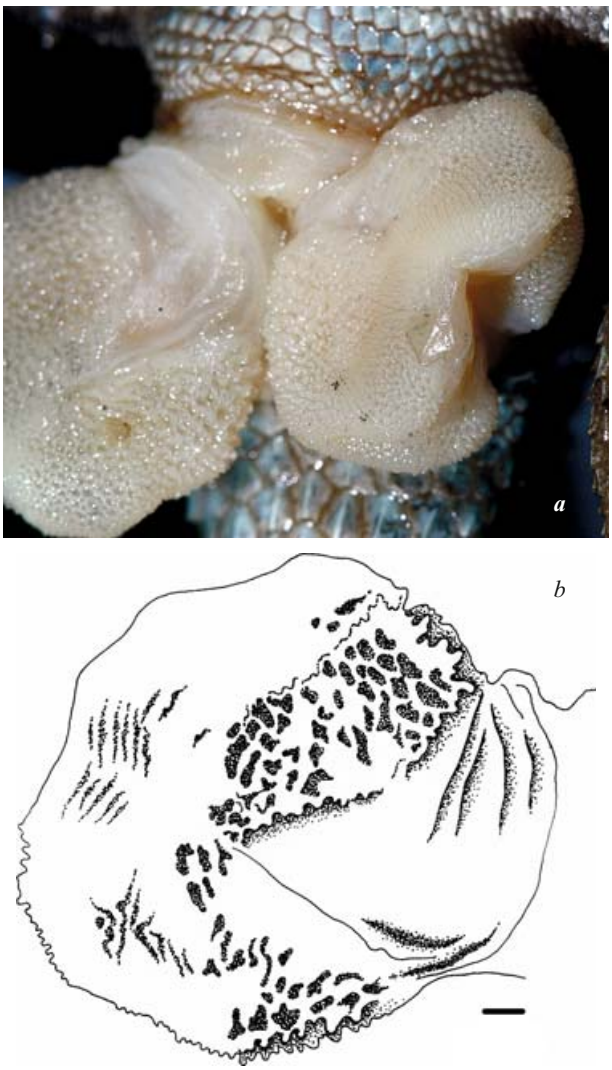

Fig. 13. Hemipenis of *L. scutatus* WHT 6232; *a*, left lobe with granules; *b*, right lobe with corrugated.

(we observed the hemipenis in bright pink color) and mate for around 5 min. After that male release the female and rested for another 2 h.

During this time we observed the cloaca in bright red color. However just after the mating their body colors suddenly changed in to the tree trunk color. The female digs a nest hole in the ground (Deraniyagala, 1953) with the aid of its snout and limbs were about 65 mm deep and 40 mm in diameter (Bambaradeniya et al., 1997). During our study we observed 8 nesting sites and but only 6 nesting were document (Table 4). All the observations were done during rainy season while drizzling (February – April and October – December) as Bambaradeniya et al. (1997) also mentioned. All hole-nests dug 40 – 70 cm

TABLE 4. Some Ecological Parameters During the Oviposition and Nest-Hole Description of the *L. scutatus* at Six Locations in the Lowland Forest Areas of Sri Lanka (table modified after Karunarathna et al., 2009 and 2011)

Ecological Data	Locations					
	Gilimale	Mulatiyana	Atweltota	Sinharaja	Karavita	Ilukkumbura
Month, year	Feb. 2007	Apr. 2005	Oct. 2004	Dec. 2006	Dec. 2005	Oct. 2006
Zone	Wet	Intermediate	Wet	Wet	Wet	Wet
Weather	Misty/Rainy	Misty/Rainy	Misty/Rainy	Misty/Rainy	Misty/Rainy	Misty/Rainy
Time	10:23	08:20	08:25	08:26	08:46	09:15
Soil/color	Hard/dark	Hard/dark	Hard/dark	Hard/dark	Hard/dark	Hard/dark
Leaf-litter thick, mm	22	24	25	22	30	25
Canopy cover, %	50	55	50	70	60	60
Cloud cover, %	40	35	30	35	45	30
Habitat	Riverine	Forest edge	Riverine	Forest	Forest edge	Home garden
Elevation, m a.s.l.	210	170	400	380	355	580
Air temperature, °C	29.1	28.5	28.5	28.4	29.5	29.8
Relative humidity, %	80	88	75	92	78	85
Body-pit, mm	150	160	140	140	160	150
Angle of nest, °	50	60	55	50	55	50
Depth of nest, mm	60	68	65	70	60	65
Nest diameter, mm	50	45	50	50	48	50
Clutch size, the number of eggs	3	4	2	2	2	3

TABLE 5. Egg Measurements of the *L. scutatus* (n = 16) in Six Locations (table modified after Karunarathna et al., 2009 and 2011)

Month	Year	Location		EL, mm	EW, mm	ToL, mm
October	2004	Atweltota	1	24.3	15.1	39.4
			2	25.1	15.3	40.4
	2006	Illukkumbura	3	23.3	14.9	38.2
			4	24.3	14.6	38.9
			5	23.8	15.1	38.9
April	2005	Mulatiyana	6	23.6	14.7	38.3
			7	23.1	14.8	37.9
			8	24.7	15.2	39.9
			9	24.6	15.3	39.9
December	2006	Sinharaja	10	24.3	14.8	39.1
			11	24.2	14.9	39.1
	2005	Karavita	12	24.7	14.9	39.6
			13	24.7	15.2	39.9
February	2007	Gilemale	14	23.9	14.9	38.8
			15	24.6	14.7	39.3
			16	24.1	14.8	38.9
			Mean	24.2	15.0	39.2
			S.D.	0.55	0.22	0.69

Fig. 14. Mature female of *L. scutatus* laying eggs on gravel flow (note: the body pit, egg hole with tree eggs).

distance from a large tree with a dense canopy. The depth of the hole-nests varies from 60 – 70 to 45 – 50 mm in diameter. When they make the body pit they use forelimbs and move round the hole-mouth to take leaf litter, stones and sticks out. According to Somaweera and Somaweera (2009), this lizard deposits about 1 – 16 eggs in June, September and October. However we recorded the maximum 4 eggs per time (Fig. 14).

Eggs ranges are 23.1 – 25.1 mm (mean 24.2 ± 0.55 mm) long and 14.6 – 15.3 mm (15.0 ± 0.22 mm) wide (Table 5). According to Günther (1864) these eggs are similar to the Sparrows eggs. Eggs were secured in March, May, June and December (Deraniyagala, 1953). Hatchlings emerged after 35 – 36 days 46 – 48 mm in SVL (Bambaradeniya et al., 1997). However the whole nesting behaviors of *L. scutatus* different from other

Calotes species (see Amarasinghe and Karunarathna 2007, 2008, Gabadage et al. 2009, Pradeep and Amarasinghe 2009; Karunarathna et al., 2009, 2011). While they on the ground they change body color in to ground colors (Fig. 15), but when disturbed they can change body color to dark or light green.

BEHAVIOR

L. scutatus is slow moving species (Manamendra-Arachchi and Liyanage 1994), they spending most of its time resting. During night time, it changes its position and goes higher up in to trees (Vidyalankara and Bandara 2004). Non aggressive defensive strategies observed include reliance on cryptic coloration, feigning death and inflation of the body with air (Vidyalankara and Bandara, 2004). When alarmed it opens its mouth displaying its red interior (Deraniyagala, 1953). Captive and wild specimens bite when handled (Bambaradeniya et al., 1997).

Territorial. During the morning their locomotor behaviors increasing (from 7:00 to 11:00) and after 17:00 they are completely inactive (Fig. 16). This species is highly territorial and can be observed aggressive territorial behaviors. There are no publishing materials on their territorial behaviors except Bandara and Meegaskumbura (2010) and Bandara (2012). Therefore here we describe one observation in Kanneliya forest (6°16′05.02″ N 80°21′02.34″ E; 195 m a.s.l.). We observed one mature male (A) on a tree trunk, and suddenly another mature male (B), but quite smaller size jumped on to the same branch. Then they had 1 m gap and both individuals expanded their gular sacs, nuchal humps, also both individuals compressed and expanded the gular sac few times. Furthermore, at this time we observed most bright colors of their bodies. Then the invader (B) moved slowly toward the (A), and then it ran two rounds around the trunk towards the ground.

After that, male (B) also chased rapidly by showing its red colored mouth. Then both individuals opened their mouths and threatened each other and again started running rounds and rounds on the trunk towards top. Suddenly (A) fallen down and then ran in to another tree, (B) won the territory. Here we did not observe any struggling and savaging behaviors, sometimes may be arboreal species may not show those steps as terrestrial species described by Karunarathna and Amarasinghe (2008). We normally found one male for 100 × 100 m area, but females and juveniles scattered. In the morning (7:00 – 10:00) we observed sun basking on tree trunks, after that they move to find foods. According to different light conditions, they change their habits. They come to the

Fig. 15. Dark body color of *L. scutatus* while nest creation on the ground in the rainy season.

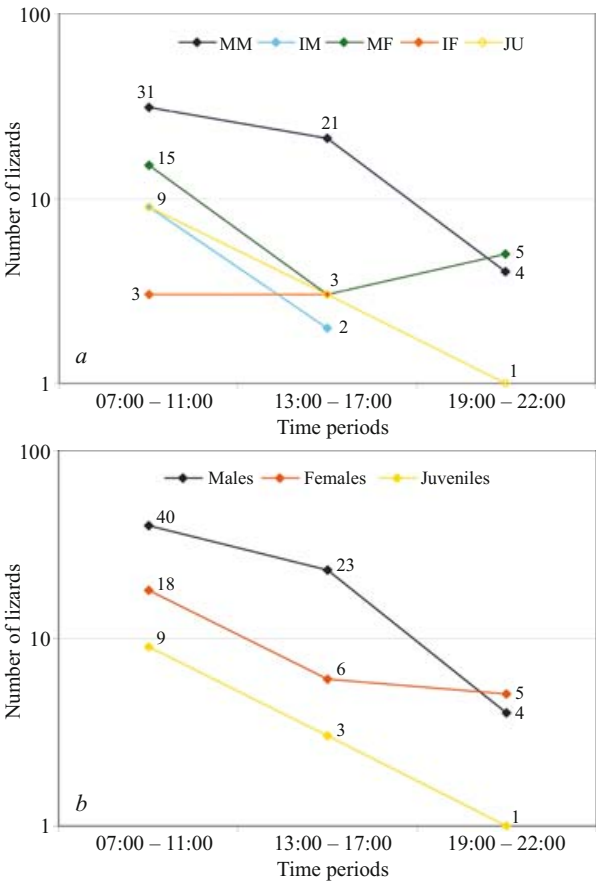

Fig. 16. Activity patterns of *L. scutatus* in different time periods: *a*, between life stages; *b*, between sexes (MM, mature males; IM, immature males; MF, mature females; IM, immature females; JU, juveniles).

ground to find food and during the feeding time, they change the body color in to grayish brown.

Predation. The main predators of this lizard are black eagle (*Ictinaetus malayensis*) and gray hornbill (*Ocyceros gingalensis*) (Bambaradeniya et al., 1997) mountain hawk eagle (*Nisaetus kelaarti*), common coucal (*Centropus sinensis*) and domestic fowl (de Silva, 1996). According to our study we observed shikra (*Accipiter badius*), slender loris (*Loris* sp.), toque monkeys (*Macaca sinica*), civet cats (*Paradoxurus* sp.), bronze back (*Dendrelaphis* sp.) and cat snakes (*Boiga* sp.) fed on this lizard. Also endemic red faced malkoha (*Phaenicophaeus pyrrhocephalus*) (Salgado, 2006) and blue magpie (*Urocissa ornata*) (Thandula Jayarathna, personal communication, 2010) feed on this lizard. As de Silva (1996) mentioned, we also recorded domestic cat (*Felis cattus*) caught this species twice (Fig. 17). Remnants of *L. scutatus* founded from the caves of prehistoric Balangoda Man in 35,000 to 40,000 BC and indicate that *L. scutatus* was consumed by the prehistoric habitants (Manamendra-Arachchi and Adikari, 2011).

Fig. 17. Dead mature male due to the domestic cat (*Felis cattus*) predation at home gardens.

Food pattern. Mostly young shoots and buds (Deraniyagala, 1953) worms (Somaweera and Somaweera, 2009), fruit and other vegetable matters and boiled rice in captivity (Smith, 1935), ants, termites, mosquitoes, small butterflies, moths (Bambaradeniya et al., 1997). According to our study they mostly feed on moth larvae, small spiders and earth worms (up to 20 cm). Also mature individuals feed on coleopteran beetles, newly born butterflies, centipedes, wild cockroaches, mole crickets, dragon flies. When they eat coleopterans, it crushes the beetle using its teeth, and earth worms cut in to several pieces and then eat one by one. However we never ob-

Fig. 18. Undisturbed natural riverine forest habitat in Samanala nature reserve, Ratnapura (note: crystal clear water).

Fig. 19. Natural lowland forest habitat in Kanneliya forest reserve, Galle (note: well growing forest flow with tree ferns).

served they feed on plant materials as Deraniyagala (1953), Smith (1935) and Somaweera and Somaweera (2009) mentioned, and it is interesting to study.

CONSERVATION STATUS

L. scutatus is assessed as Endangered (EN) (Manamendra-Arachchi and Liyanage, 1994), threatened (Wijesinghe et al., 1993) and Vulnerable (VU) (Bahir and Surasinghe, 2005). More than a few untouched forest areas "like a Samanala Nature Reserve" have good agamid population (Figs. 18 and 19). According to the 2007 Red List of Threatened Fauna and Flora of Sri Lanka, *L. scutatus* is listed under Near Threatened (NT) category. This species is protected by the Fauna and Flora Protection Ordinance (DWC), but not listed in CITES (Somaweera and Somaweera, 2009). At the present, the biodiversity as well as *L. scutatus* of Sri Lanka is threatened by unplanned developments and growing human population Following threats were observed during the study period: natural forest clearing (Fig. 20), dumping garbage, unplanned plantations and invasive species. Smuggling and illegal captive pet trade of *L. scutatus* (Fig. 21) has been continuing during pas few decades and this species lives under captivity in many countries even the Department of Wildlife Conservation (DWC) and the Biodiversity Protection Unit of the Department of customs showing that they are in action to protect this species. In 1980's, these lizards were captured by local peoples, then sold it to foreigners and collectors for LKR 25 to 50 per specimen (Karunaratne, 1986). These forest areas are managed by Department of Wildlife Conservation (DWC) and Forest Department (FD); hence they should obtain urgent actions to mitigate existing threats. Relevant government authorities should conduct education and awareness programs in surrounding villages.

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Fig. 20. Original and natural forest cover clearing for the tea plantation illegally (near Rakwana).

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Fig. 21. Illegal captive pet trade of *L. scutatus* in Japan (photo took from a web advertisement in the internet).

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