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CNEMASPIS GORDONGEKKOI, A NEW GECKO FROM LOMBOK, INDONESIA, AND THE BIOGEOGRAPHY OF ORIENTAL SPECIES OF *CNEMASPIS* (SQUAMATA: SAURIA: GEKKONIDAE)

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(with one plate and two text-figures)

ABSTRACT: A new species of *Cnemaspis* is described from the Indonesian island of Lombok, in the Lesser Sundas. The new species, *C. gordongekkoi*, is compared with its congeners from the south-east Asian archipelago. *Cnemaspis* shows a distinctly disjunct distribution in south and south-east Asia, known species forming a western component (south-western India and Sri Lanka), a central component (from southern Malay peninsula, the Andaman and Nicobar Islands, and the Greater Sundas) and an eastern component (Lombok and Timor).

The absence of *Cnemaspis* species in regions between the western and central components is attributed to marked seasonal climate including cold winters and more xeric conditions. However, the Plio-Pleistocene sea-level rises that fragmented the once continuous distribution, in addition to the progressive desiccation of the Lesser Sundas, may have been responsible for causing the present disjunction for approximately 800 km between Lombok and Timor. The absence of these geckos on the islands is attributed to anthropogenic changes on the landscape, particularly on Bali and Java, which have lost much of their natural vegetation. However, the apparent absence of members of the genus *Cnemaspis* on Sumatra is curious and is suspected to be the result of poor sampling of the island's herpetofauna rather than biogeographic phenomena.

KEY WORDS: *Cnemaspis gordongekkoi*, Gekkonidae, biogeography, Lombok, Indonesia.

INTRODUCTION

The Indonesian archipelago, composed of 13,677 small and large islands, is one of the richest zones on earth in terms of biodiversity Approximately 1,000 species of amphibians and reptiles are expected to occur on these islands (Collins, *et al.*, 1991). The last monograph on the reptile fauna, now in need of a revision, is the series by De Rooij (1915; 1917), show the great inadequacy of studies on this fauna.

The genus *Cnemaspis* contains 35 species (Kluge, 1991), the members of which are distinguished from other gekkonids in possessing a suite of characteristics, including rounded pupils, non-dilated, clawed digits, a distinct eyelid-like structure around the eyes and diurnal habits. Two examples of a gecko collected during a field trip to Lombok Island, Nusa Tenggara (Lesser Sunda) District, Republic of Indonesia, proved to be hitherto undescribed after comparisons with previously-described south-east Asian species of the genus (at the AMNH, BMNH, MNHN and ZRC) and the literature (e.g., De Rooij, 1915; Smith, 1925; Dring, 1979). The type series was hand-collected, photographed alive, fixed in four percent formalin and preserved in 70% ethanol, all measurements and descriptions taken of the preserved material eight to 10 months after preservation. These are here being described as a new species. Institutional abbreviations follow Leviton *et al.* (1985); geographical coordinates for the islands in the Lesser Sundas are from Anon. (1968).

Cnemaspis gordongekkoi **sp. nov. Plate 1, Fig. 1.**

Holotype.- ZRC 2.3380, collected by Indraneil Das on August 8, 1992, from the vicinity of Sendanggila Falls, *circa* 0.5 km south of Senaru village, Lombok, Nusa Tenggara District, Republic of Indonesia (8° 45'S, 116° 30'E). Gravid female. The type locality is indicated in Fig. 2.

Paratype.- ZRC 2.3381, same data as holotype. Adult male.

Diagnosis.- A large species of *Cnemaspis* (SVL to 73 mm), separable from other members of the genus by the following characteristics: absence of femoral and preanal pores, snout obtusely pointed; nostril antero-laterally directed; dorsum with large scattered tubercles from the nape backwards; ventral scales smooth and overlapping; fourth and fifth toes unequal; 22-23 scales under fourth toe; and large body size.

Description of Holotype.- Nostril antero-laterally oriented (Fig. 1.1); rostral wider than deep (rostral length/rostral depth ratio 2.62), deeply notched anteriorly by a deep groove; supranasals bordering nostrils, separated by a single scale; supralabials to below pupil nine; infralabials 10; four scales follow supralabials from below the level of the pupils to the posterior corner of the mouth; first supralabial contacting the eye; mental subtriangular (Fig. 1.2); first postmental longer than mental, shorter than the second postmental; second postmental pair separated by the first postmental pair; ear opening wider than high, as high as the first supralabial; interorbital scale rows at the midpoint of the orbit 20; canthal ridge extending backwards above the eyes; nasals and rostral contacting the nostrils (Fig. 1.2); head oviform; distinct from neck; forehead concave; snout short (head length/snout-vent length ratio 0.20), obtusely pointed; scattered warts on head and upper eyelids; small scales on snout; pupil rounded, eye with "extra-brillar fringes" (Underwood, 1954); tongue elongate, with a rounded tip, lacking a cleft.

Scutellation (of holotype, followed by paratype in parentheses): supralabials 9 (9); infralabials 10 (10); interorbital scale rows 20 (20); midbody scale rows at belly to lowest row of tubercles 30 (30); lamellae under fourth toe 22 (23).

Habitus depressed; dorsum with scattered large, rounded, non-spinose tubercles, commencing from the nape; the largest tubercles on the dorsum at midbody measuring 0.9 mm; throat and ventral scales smooth, overlapping; lateral body fold absent; mid-body scale rows across belly to below lateral row of tubercle 30; anal single; scales on palms and soles oval or elongate; femoral and preanal pores absent; tubercles on the throat, temporal region and on the sides of the vent absent.

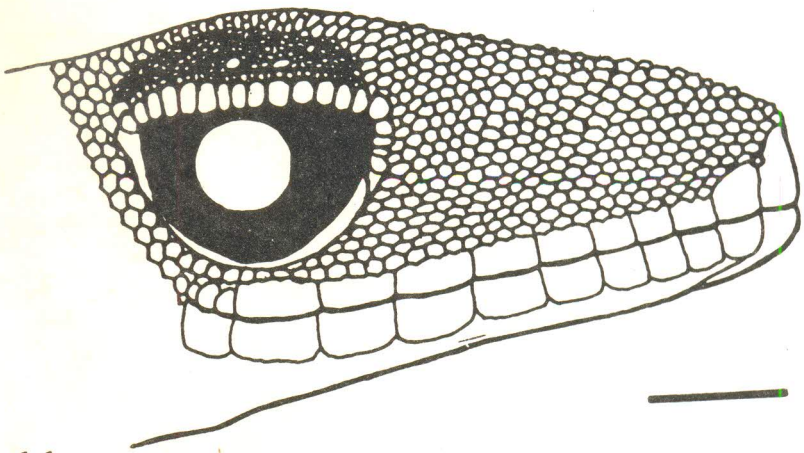
Digits slender, elongate, all clawed; subdigital scansors entire, unnotched; width of basal subdigitals less than twice adjacent scales; interdigital webs absent; fingers IV and V unequal; distal subdigital formulae: 4>3>2>5>1 (finger); 4>3>5>2>1 (toe); subdigital scansors (right limbs), 15 on finger I, 19 each on fingers II and III, 21 on finger IV, 17 on finger V; 14 on toe I, 17 on toes II, 20 on toe III, 22 on toe IV, 20 on toe V.

Tail (original, unregenerated tail) long (tail length/snout-vent length ratio 1.20), slightly flattened (tail depth/tail width ratio 0.56), not kinked at base; tubercles on the tail arranged in rows, best marked close to the tail base; subcaudal scales smooth, hexagonal, non-overlapping and not enlarged.

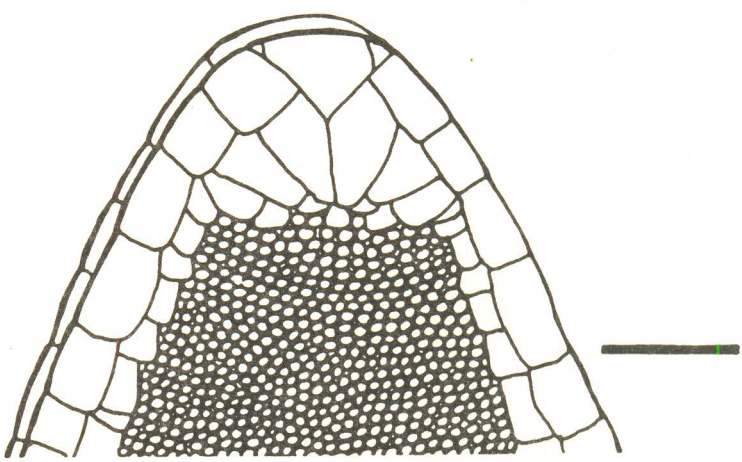
Colour in life (from Fujichrome 100 ASA slide transparencies; nomenclature after Smith, 1974; 1981): dorsum drab gray, variegated with brownish-olive and pale horn paravertebral blotches; eyelid-like structure around the eyes sulfur yellow; ventrum cream, each scale with numerous small black spots; upper surface of tail with 14 drab and olive-brown alternating bands; lower surface of tail cream (see Plate 1).

Holotype of *Cnemaspis gordongekkoi* sp. nov. (ZRC 2.3380), showing the animal in life with the tail curled over its back.
Photo: Indraneil Das. Lombok, Indonesia.

Malayan softshell turtle (*Dogania subplana*). Thailand. Photo: Indraneil Das.



1.1.



1.2.

FIGURE 1: The snout in profile (1.1) and anterior aspect of throat (1.2) of the holotype of *Cnemaspis gordongekkoi* sp. nov. (ZRC 2.3380). Markers represent 3 mm.

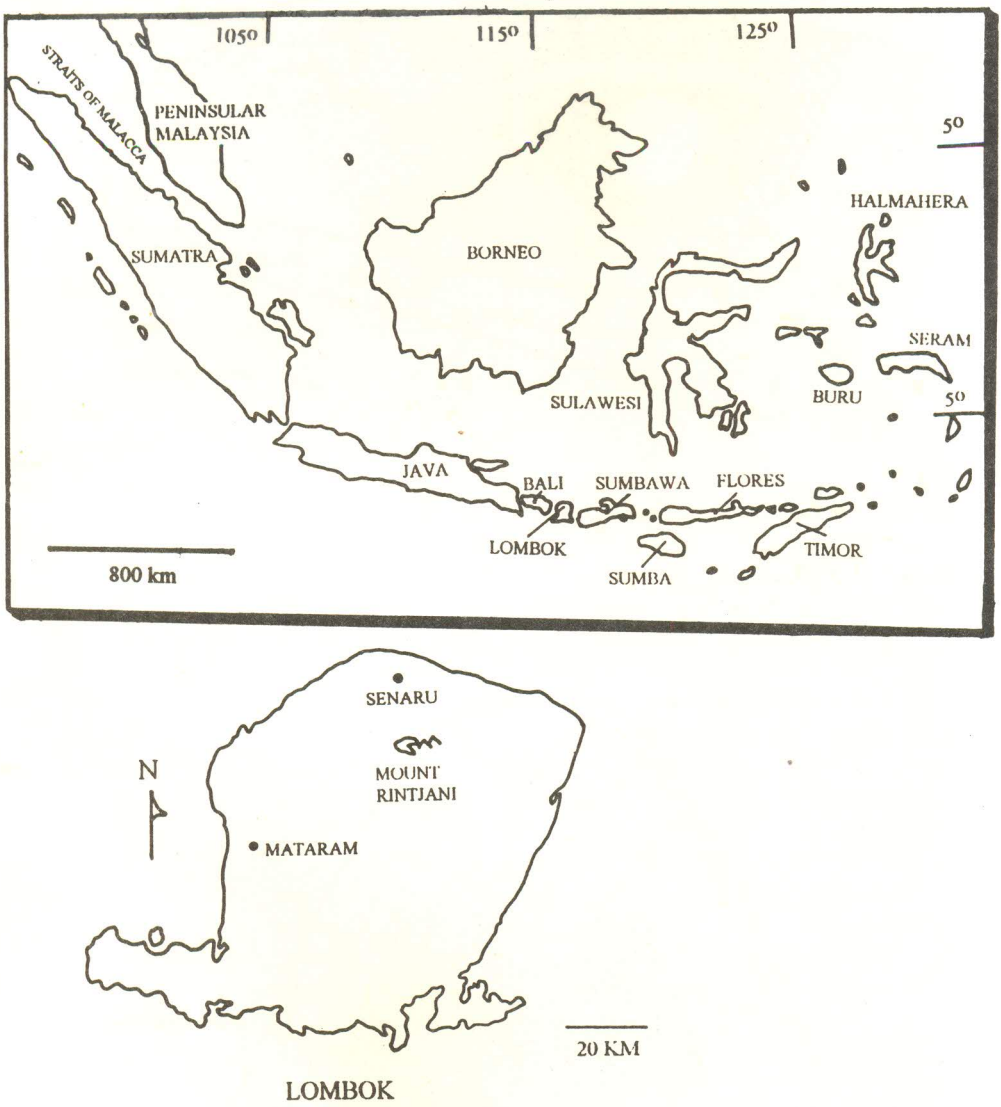


FIGURE 2: The Indonesian archipelago (excluding Irian Jaya) showing the island of Lombok (enlarged below) and the type locality of *Cnemaspis gordongekkoi* sp. nov.

Etymology.- In appreciation of the film "Wall Street" (Stone, 1987).

Measurements.- (In mm; holotype followed by paratype in parentheses): snout-vent length 73.0 (70.6); total body length 161.0 (149.6); tail length 88.0 (99.0); tail width 8.6 (7.9); tail depth 4.9 (4.9); axilla to groin distance 28.7 (33.9); head width at jaws 12.8 (12.3); head length 14.6 (13.2); head depth 5.2 (6.7); eye diameter 5.0 (5.0); eye to ear distance 6.3 (7.1); ear length 1.7 (1.4); interorbital distance 6.0 (6.2); snout-tip to eye distance 8.5 (8.2); snout-tip to nostril distance 0.8 (1.9); snout to axilla distance 27.9 (27.2); forelimb length 26.0 (24.8); hindlimb length 34.0 (31.0); tibia length 14.2 (15.0); distance between knees with femora perpendicular to body 32.0 (33.1).

COMPARISONS

In the key to the Sundaic species of *Cnemaspis* provided by De Rooij (1915), the new species falls out close to *C. timoriensis* (Duméril and Bibron, 1836) in possessing the following suite of characters: short, pointed snout; absence of femoral and preanal pores; head covered with small granules and a series of brown spots along each side of the vertebral line. The Lombok material can be easily separated from the aforementioned species in showing the following characteristics: rostral much broader than deep (versus slightly broader than deep); nine and 10 supralabials and infralabials, respectively (versus five and three supralabials and infralabials, respectively); dorsum with large, scattered tubercles (versus dorsum with small equal scales); 22-23 (versus 12) distal scales under the fourth toe; ventral scales smooth (versus imbricate) and a much larger body size: snout-vent length to 73 mm (as opposed to 35 mm in *C. timoriensis*).

The most recent identification key to the south-east Asian species of *Cnemaspis* has been given by Dring (1979), which includes species from the Malay peninsula and the Greater Sundas, but excludes the only species then known from the Lesser Sundas, *C. timoriensis* (Duméril and Bibron, 1836). In lacking femoral pores and proximal subdigital scales not larger than distal subdigital scale, it is easily differentiated from *Cnemaspis kandiana* (Kelaart, 1852), a widespread species from south-western India, Sri Lanka, the Andaman and Nicobar Islands of India and Sumatra, Sipora and Enggano, all belonging to Indonesia. These characteristics unite *C. gordongekkoi* sp. nov. to the rest of its congeneric south-east Asian species. Its smooth ventral abdominal scales differentiates the new species from *C. nigridius* (Smith, 1925), from north-western Borneo, which is further differentiated in being larger- to 85 mm- and possessing preanal pores. The new species is also easily separable from *C. kendalli* (Gray, 1845), from southern peninsular Malaysia and the nearby Pulau Tioman, Singapore, the Indonesian islands of Anamba and Natuna, and Sarawak, Malaysian Borneo, which possesses a rounded and depressed snout, unlike the short, narrow snout in *C. gordongekkoi* sp. nov. and is smaller- to 58 mm in maximum head-body length. The Lombok material also differs from the newly-described *C. argus* Dring (1979), from northern Trengganu, peninsular Malaysia, which has preanal pores (lacking in the new species), besides a smaller body size- to about 64 mm.

Cnemaspis gordongekkoi is morphologically separable from *C. boulengerii* Strauch, 1887, from Con Son, Con Dao (= Pulo Condore) and Hon Bai Can, all offshore islands in the South China Sea belonging to Vietnam, which has fewer distal subdigitals, a series of shield-like subtibial scales almost as wide as the tibia, subcaudals almost as wide as the tail and smaller maximum body size- to 66 mm. The new species is also separable from *C. affinis* (Stoliczka, 1870), from peninsular Thailand and peninsular Malaysia, which shows preanal pores and a substantially smaller maximum body size- 46.7 mm. The new species can be easily differentiated from *C. kumpoli* Taylor (1963) from Trang Province, Thailand, which has preanal pores and a smaller body size- 51 mm and *C. flavolineata* Nicholls (1949) from northern peninsular Malaysia, which also shows preanal pores, in addition to having smooth ventrals and attains a smaller size- 27.7 mm.

The new species can be recognised from both the southern population (northern Malay peninsula) of *C. siamensis* (Smith, 1925) which has one tubercle at each side of the vent, preanal pores and a snout-vent length of up to 39.7 mm; distinguished from the new Indonesian species in having preanal pores, deep and rounded mentals, ventrals heavily pigmented and smaller body size- to 46.7 mm.

TABLE 1: External characteristics of the south-east Asian species of *Cnemaspis*. Abbreviations: SVL, maximum recorded snout-vent length; ST4, distal scales under fourth toe; VS, ventral scales; FP, femoral pores; PP, preanal pores. Measurements in mm. + = presence; - = absence. "n.p." and "s.p". in the case of *C. siamensis* refer to the northern and southern populations, respectively. Further details of *Cnemaspis* species A and B can be found in Dring (1979).

Species	SVL	ST4	VS	FP	PP
Cnemaspis affinis	46.7	17-20	keeled	-	+
Cnemaspis argus	64.0	22-24	keeled	-	+
Cnemaspis boulengerii	66.0	16-18	smooth	-	-
Cnemaspis flavolineata	27.7	28	keeled	-	+
Cnemaspis gordongekkoi	73.0	22-23	smooth	-	-
Cnemaspis kandiana	35.0	11-12	smooth	+	+
Cnemaspis kendalli	58.0	18-23	keeled	-	-
Cnemaspis kumpoli	51.0	21-24	smooth	-	+
Cnemaspis nigridius	85.0	17-24	keeled	-	- or +
Cnemaspis siamensis (n.p.)	38.0	15-21	keeled	-	-
Cnemaspis siamensis (s.p.)	39.7	17-22	keeled	-	+
Cnemaspis timoriensis	35.0	12	keeled	-	-
Cnemaspis sp. A	42.0	17-19	smooth	-	+
Cnemaspis sp. B	46.7	20	keeled	-	+

and the northern population (north of the Isthmus of Kra) of the same species which typically shows two tubercles on each side of the vent, a median dark line on the throat and a smaller body size- to 38 mm.

At least two undescribed species of *Cnemaspis* remain in the region. Dring's (1979) "Species A", from northern Borneo, previously assigned to *C. siamensis* by Smith (1925), can be separated from *C. gordongekkoi* sp. nov. in having the fourth and fifth fingers subequal, presence of preanal pores and a smaller body size- to 42 mm. Dring's (1979) "Species B", known from a single specimen (FMNH 148588; not personally verified), from Labang Camp, Bintulu District, Sarawak, East Malaysia, can be

Table 1 summarises some of the diagnostic features of the south-east Asian species of *Cnemaspis*, which complements the key to the genus *Cnemaspis* for the south-east Asian species in Dring (1979). Included in the table is *C. flavolineata* Nicholls (1949), that Dring (1979) suspected to be conspecific with *C. affinis*, but considered valid by Kluge (1991).

ECOLOGICAL AND BIOGEOGRAPHIC NOTES

The two geckos were taken from unplastered brick-walls of an abandoned house between 1800-1815 hours. The collection locality is in the vicinity of the scenic Sendanggila Falls, in an area of disturbed evergreen forests. In captivity, the geckos had the curious habit of curling their

tails over the backs (Plate 1), similar to the behaviour noted in *Cnemaspis kendalli* by Lim and Lim (1992). The holotype contains a single undeveloped (uncalcified) egg in each oviduct, measuring 46 mm (left) and 56 mm (right), respectively.

Four species of gekkonid lizards (nomenclature after Kluge, 1991) have been recorded from Lombok by De Rooij (1915). These are *Cosymbotus platyurus* (Schneider, 1792) (as *Hemidactylus platyurus*), *Gekko gecko* (Linnaeus, 1768) (as *Gekko verticillatus*), *Gonydactylus marmoratus* (Gray, 1831) (as *Gymnodactylus marmoratus*) and *Hemidactylus frenatus* Duméril and Bibron, 1836. *Cnemaspis gordongekkoi* sp. nov. is therefore the first record of a *Cnemaspis* from the island of Lombok.

Among its south-east Asian congeners, *Cnemaspis timoriensis*, which appears closest morphologically to *C. gordongekkoi* sp. nov. (see "Comparisons") is also not surprisingly the nearest geographically. The distribution of members of the genus is highly disjunct, being focussed in the southern part of the Malay peninsula and the Greater Sundas (in the east) and southern India and Sri Lanka (to the west), south of 20° latitude. Several other taxa of amphibians and reptiles show similar disjunct distribution, including *Ansonia* (*fide* Inger, 1960) and *Dasia* (Inger and Brown, 1980), their absence in the intervening regions apparently due to the absence of wet evergreen forests in central and eastern peninsular India and marked seasonal climate, especially cold winters in north-eastern India, Myanmar and northern Thailand.

The distribution of species of *Cnemaspis* in the east (the Lesser Sundas) appears curious, the two species separated by straits and islands for a distance of *circa* 800 km. The apparent absence of *Cnemaspis* species on the intervening islands, including Sumbawa (8° 40'S, 118° 00'E), Sumba (10° 00'S, 120° 00'E) and Flores (8° 30'E, 121° 00'E), the islands belonging to the Maluku (formerly Moluccas) group or on the larger islands of Java and Bali cannot be attributed to inadequate study (see Brongersma, 1945; Edgar and Lilley, 1993; Kopstein, 1926; Mertens, 1928, 1957a; 1957b; Auffenberg, 1980). The south-east Asian archipelago is composed of a series of large allochthonous terranes that broke away from the northern margin of Australia during the Late Permian (Audley-Charles, 1988) or even the Early Cretaceous (Metcalfe, 1988), rafting northwards to collide with the Asian mainland. The Lesser Sundas, including Lombok, are composed of small islands that are primarily volcanic in origin (Audley-Charles, 1987; van Bemmelen, 1949). The islands in the outer arc, Sumba and Timor (8° 50'S, 126° 00'E), are primarily composed of sandstone, mudstone with igneous intrusions overlaid by limestone (Whitten and Whitten, 1992). There is little doubt that the islands of the Sunda Shelf are landbridge islands that were joined during the Quaternary glacial maxima (Morley and Flenley, 1987). Periodic inundations, during sea-level rises that marked the Plio-Pleistocene interglacial periods in the Lesser Sundan region may have caused the extinction of *Cnemaspis* by the fragmentation of once widespread continental populations that subsequently led to local extinctions on some of the islands.

Lawlor (1986) showed that the distribution of non-volant mammals are a historic consequence of extinction of relict populations on landbridge islands, where the range of formerly contiguous populations may have been fragmented by sea-level rise. However, the progressive aridity of the Lesser Sundas must have had serious effects on the biota of the islands, presumably adversely affecting species linked to mesic habitats, although disjunct, possibly relictual, distribution of the Sundaic xeric biota has also been reported (Auffenberg, 1980). A factor that may have contributed to the present disjunction in the distribution of the *Cnemaspis* geckos on these islands is the loss of moist evergreen forests as an effect of desiccation of the region.

The climate of contiguous land mass of the Sundas during the glacial maxima of the Pleistocene was essentially continental, i.e., relatively more seasonal, with semi-evergreen forests and other drier ecosystems in undisturbed areas to-

day covered with evergreen forests (Morley and Flenley, 1987). A continuous strip of savanna is thought to have existed from India to the Lesser Sundas over areas in the Indo-Malayan region that are covered by evergreen forests (Van Steenis, 1935; 1938). The seasonal climate is at present well-marked in the southern parts, especially on the Lesser Sundas, and xeric refugia may have persisted here from the Pleistocene, and even expanded in recent times. This change may have been promoted through anthropogenic change, and is supported by the disjunct, possibly relictual, distribution of the area's xeric herpetofauna as reported by Auffenberg (1980), that have close affinities with the mainland fauna.

The Lesser Sundas are the driest part of Indonesia due to the dry South Monsoons experienced during the middle parts of the year (Whitmore, 1984). With an average annual rainfall of 1,349 mm and a history of extensive deforestation and forest burning, whatever little moist evergreen forests that survive today are on mountains or in steep valleys, the typical vegetation in the archipelago being tree-less grassy hills (Bruce, 1986).

Excessive deforestation on Bali and Java (summarised by Hurst, 1990) may be a tenable reason for the absence of these largely rainforest species on the two islands, but fail to explain why no *Cnemaspis* species have been recorded from the large (473,607 sq km), relatively undisturbed and still forested island of Sumatra. Intensive field work on Sumatra, I predict, would prove the occurrence of perhaps hitherto undescribed species of *Cnemaspis* on this great island. Sumatra is separated from peninsular Malaysia, where five species belonging to the genus are known to occur, by a relatively shallow channel (the Straits of Malacca) 65 km in width.

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