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Neotype designation for *Calotes versicolor* Daudin, 1802 (Sauria: Agamidae) with notes on its systematics

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Abstract

Calotes versicolor Daudin, 1802 is one of the most widespread agamid lizard species which was described without a locality. The type specimen of the species has long been considered lost; however most workers considered Pondicherry as the type locality for the species. Studies by Zug *et al.* 2006 confirmed that *C. versicolor* is a complex of multiple species which necessitates fixing type locality and specimen for the species in order to resolve the systematics of the species complex. An adult male from Pondicherry was collected and is here designated as the neotype. A re-description of the species is provided along with notes on systematics of the species.

Key words: *Calotes versicolor* group, re-description, taxonomy, Squamata, species complex, *nomen nudum*, *nomen dubium*

Introduction

Calotes Cuvier, 1817 is among the most speciose draconine agamid genera, containing at least 28 species distributed in South and Southeast Asia (Uetz & Hosek 2016). Majority of the species are relatively restricted to small geographic regions of the Western Ghats, Sri Lanka, Northeast India and Indo-Burma (Hallermann 2000), with the exception of *Calotes versicolor* Daudin, 1802 which has a larger range compared to its congeners (Uetz & Hosek 2016) and has possibly been introduced in some parts of the world. This species is among the most widespread non-gekkonid lizards (Matyot 2004), and also among the most taxonomically neglected. The species was first described as *L'Agama arlequin, a deux raies*, which translates to Harlequin Agama with two stripes, by Daudin (1802), based on two specimens from *Muséum national d'Histoirenaturelle*, Paris (MNHN), however he was not aware of the origin of these specimens, and thus described the species without type locality. Daudin (1802), nonetheless, mentioned that the species was present as an illustration in Seba's book (*fide* Amarasinghe *et al.* 2009), which Seba identified as *lezard trejuguacu du Bresil*. This illustration, however cannot be the type of the species as this is an illustration of a Brazilian species, probably the iguanid species *Plica umbra* Linnaeus, 1758 (Amarasinghe *et al.* 2009). Kuhl (1820) was the first author to restrict Pondicherry as the type locality of *Calotes versicolor*, and Leschenault, a French Botanist and Ornithologist, as the collector of the specimens examined by Daudin, while Kuhl himself described *Agama tiedemanni* from the same locality. Duméril & Bibron (1837) examined numerous specimens of *Calotes versicolor* from Bengal and Pondicherry, which they called the homeland (*Patrie*), which here can be interpreted as the type locality, at MNHN, and they credited Leschenault among others as the collector of the examined specimens. Although some doubts exist about the collector of the species and type locality (see Amarasinghe *et al.* 2009, and references therein), numerous studies have considered Pondicherry as the type locality (Kuhl 1820; Zug *et al.* 2006) and Leschenault the collector (Kuhl 1820). Smith (1935) also noted that following Kuhl (1820), Pondicherry should be accepted as the type locality of the species.
As of today, MNHN hosts only three specimens from Pondicherry, of which only one is collected by Leschenault,

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which most probably is the syntype of Kuhl's *Calotes tiedemanni* (Amarasinghe *et al.* 2009), the second deposited by Maindros in 1881 and third being deposited almost a century after description of the species, and thus these cannot be the type specimens. Duméril & Bibron (1837), while commenting about the illustration by Seba mentioned that the illustration was of *Calotes calotes* (=*ophiomachus*), and thus cannot be that of the type material of the species. Also, the two specimens deposited by Seba cannot be the type material, considering Daudin's description, and most likely Daudin's specimens were adult females. The specimens Daudin referred to are either lost, misplaced, stolen or not deposited at all at MNHN, and the only available material from Daudin's description of the species is the illustration (Daudin 1802, Fig. 1).

Since the description of the species, numerous naturalists described new species from *C. versicolor* group, (Kuhl 1820; Harlan 1825; Hardwicke & Gray 1827; Gray 1846; Blyth 1853), and another by Jacquemont in 1844 (fide Smith 1935) only to be synonymized by Duméril & Bibron (1837), Boulenger (1885) and later by Smith (1935).

Recent molecular studies in populations across the geographic range of the species indicate that *Calotes* "*versicolor*" is actually a heterogeneous group and contains several taxa embedded within it (Zug *et al.* 2006; Huang *et al.* 2013). Studies in the recent past integrating molecular data with classical taxonomy have led to discovery of new species, or shed light on their systematics (Lajmi *et al.* 2016, Macey *et al.* 2000a, 2000b, Vijaykumar *et al.* 2014). However the absence of type material or knowledge on the origin of types hinders comparison; making it impossible to carry out studies pertaining to taxonomy of the group or species complex.

To resolve this situation, fresh material was collected from Pondicherry which may be safely be accepted as the type locality following past workers, enabling us to designate a neotype and re-describe the species. A brief discussion on putative synonyms of *C. versicolor* is also provided.

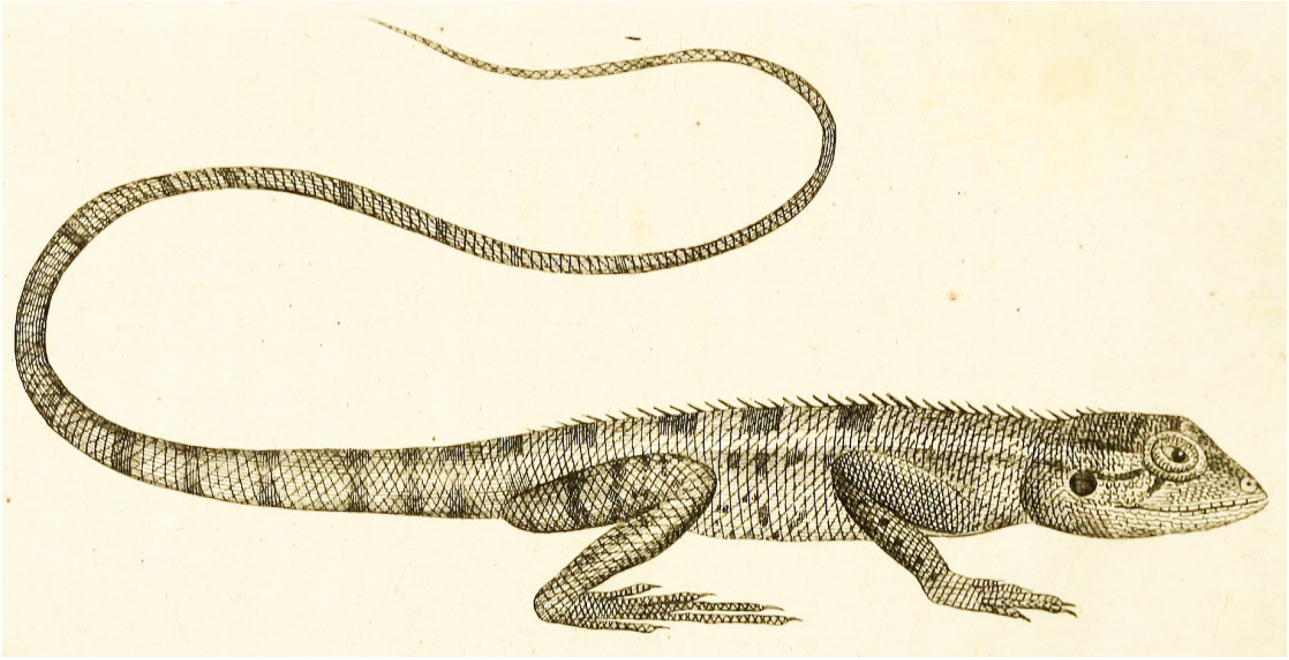

FIGURE 1. Illustration of the type of *Agama versicolor* plate XLIV of Daudin 1802.

Materials and methods

The specimen was collected and fixed in 10% formalin solution over 48 hours, which was washed in water and later transferred to 70% ethanol solution for long-term preservation. Muscle tissue from thigh was collected through a longitudinal incision and is stored in molecular grade ethanol for molecular work in near future.

Mensural and meristic measurements were taken following Zug *et al.* (2006). Measurements were taken using Mitutoyo™ digital calipers (to the nearest 0.1mm). Following characters were recorded and used in the description of the neotype: Eye-ear length (EyeEar), Head height (HeadH), Head length (HeadL), Head width (HeadW), Interorbital width (Interorb), Jaw width (JawW), Naris-eye length (NarEye), Snout-eye length (SnEye), Snout

width (SnW), 4th finger (4FingLng), 4th toe (4ToeLng), Crus length (CrusL), Forefoot length (ForefL), Lower arm length (LoArmL), Pectoral width (PectW), Pelvic width (PelvW), Snout-vent length (SVL), Snout-forelimb length (SnForeL), Tail height (TailH), Tail length (TailL), Tail width (TailW), Trunk length (TrunkL), Upper arm length (UpArmL), Upper leg length (UpLegL). Following meristic data was taken: Canthus rostralis (CanthR), dorsal eyelid scales (Eyelid), dorsal head scales (HeadSLn), head scales (HeadSTr), infralabials (Inflab), snout scales (SnS), supralabials (Suplab), temporal spines (TempSp), 4th finger lamellae (4FingLm), 4th toe lamellae (4ToeLm), dorsal scales or spines (Dorsal), midbody scale rows (Midbody). For definitions of these characters see Zug *et al.* (2006). Images of the type were clicked with a Canon™ 70D mounted with Canon™ 100mm macro. Specimen was examined with a Leica™ S8APO stereo binocular microscope.

Institution acronyms: BNHS—Bombay Natural History Society, Mumbai; NCBS—National Centre for Biological Sciences, Bangalore; MNHN—*Muséum national d'Histoirenaturelle*, Paris. Data for specimens housed in MNHN was derived from 'https://www.mnhn.fr/fr'.

Systematics

Calotes versicolor Daudin, 1802

(Figs. 2–5)

Agama versicolor Daudin 1802: 395
Agama tiedemanni Kuhl 1820
Agama vultuosa Harlan 1825: 296
Agama indica Gray 1827: 217
Calotes versicolor Duméril & Bibron 1837: 405
Calotes cristatus Jaquemont 1844
Calotes viridis Gray 1846: 429
Calotes gigas Blyth 1853: 648 (*nomen dubium*)
Calotes versicolor Boulenger 1885: 321
Calotes versicolor De Rooij 1915: 124
Calotes versicolor major Annandale 1921 (*nomen nudum*)
Calotes versicolor Smith 1935: 189
Calotes versicolor Taylor 1963: 891
Calotes versicolor Manthey & Grossmann 1997: 163
Calotes versicolor Cox *et al.* 1998: 96
Calotes versicolor Manthey & Schuster 1999: 35
Calotes versicolor versicolor Manthey 2008: 86
Calotes cf. *versicolor* Mahony *et al.* 2009
Calotes versicolor farooqi Auffenberg & Rehmann 1995
Calotes versicolor nigrigularis Auffenberg & Rehmann 1993
Calotes versicolor farooqi Auffenberg &Rehmann 1995
Calotes versicolor nigrigularis Sang *et al.* 2009: 202
Calotes versicolor farooqi Sang *et al.* 2009: 202
Calotes versicolor farooqi Masroor 2011

Neotype (here designated). NCBS AT102, male from Pondicherry University Campus, Kalapet, Pondicherry, India (12.029097° N, 79.850343° E, elevation 34m). Collected by Anurag Mishra and Zeeshan A. Mirza on 20 March 2016.

Type locality (by virtue of neotype designation). Pondicherry, India

Etymology. The specific epithet is an adjective referring to variable (*versi*) colour (*color*) of the species in life.

Description of neotype male NCBS AT102. The neotype is an adult male measuring 110.1mm SVL in a good condition with small longitudinal incisions on each hind thigh. The tail is entire and the specimen has no evident scar or damage. 38.7 mm SnForel, 50.8 mm TrunkL, 310 mm TailL, 17.8 mm TailH, 12.11 mm TailW, 20.9 mm PectW, 12.5PelvW, 23.3 mm UpArmL, 21.5 mm LoArmL, 12.6 mm 4FingLng, 26 mm UpLegL, 28.1 mm CrusL and 20.3 mm 4ToeLng. Head pentagonal (dorsal outline) covered with heterogeneous, smooth scales juxtaposed in the anterior half to slightly overlapping in the posterior half; 25.8 mm HeadL, 25.6 mm HeadW, 28.3 mm JawW, 18.8 mm HeadH, 11.4 mm SnEye, 21.8 mm NarEye, 8.05 mm EyeEar, 7.5 mm SnW, and 13.9 mm InterOrb.

Colouration in life (Fig. 2): Background colour yellowish, especially the head which is almost pale yellow, upper parts of trunk and tail with bright orange tinge, underparts light yellowish. A series of lateral dorsal scales on the trunk with a dark basal spot forming broken bands across the trunk at fairly regular intervals. Limbs in a shade of brown with randomly placed dark brown to black spots.

FIGURE 2. *Calotes versicolor* neotype male NCBS AT102 in life.

Colour in preservative: Coloration faded in preservative. The orange dorsal coloration is reduced to shade of pink, largely restricted to the mid-dorsal crest and three rows bordering these. Head and tail much paler. Two black inter-parietal spots present. Chin whitish with remains of red coloration, throat scales in shade of red, belly scales nearly pinkish with a tinge of brown; underside of tail yellowish brown.

Head distinct from neck (Fig. 3A), as long as wide (HeadW/HeadL 0.99), makes up to a large part of the SVL (HeadL/SVL 0.23); snout to eye broadly acute and triangular, snout-tip blunt (Fig. 4A); edges of head not parallel, especially posterior to orbital region with a large outward bulge of jaw muscle (Fig. 2C). Sides of head flat, dropping from the sharp ridge from the supraciliary along the canthus rostralis up to the edge of supralabials (Fig. 4B). Posterior portion of the head roundish with two large sub-conical processes that bear two large temporal spines on each; posterior part of head rotund, formed of muscular bulge of jaw muscles. Large posteriorly oriented scales form serrated edge of the posterior border of the head. Dorsal head scales heterogeneous, those posterior to rostral are small in size, juxtaposed (Fig. 4A); these small scales continue to the interparietal in a longitudinal band composed of two to three scale rows, this band of small scales is edged by large scales on both sides of the supraocular area. Posterior to the interparietal, all scales merge into the dorsal trunk scales. Rostral as deep and wide as the adjoining supralabial, 7 SnS; 8/8 elongate, with their ends overlapping, form a sharply folded ridge along the CanthR. Large scales in the supraocular area do not form distinct supraocular plates; 17 HeadSL and 13 HeadSTr. Interparietal, large, sub-pentagonal, with a prominent parietal eye. A fairly large, oval shaped nasal scale perforated by a large naris, nasal scale touching rostral and separated from the labial scales by two rows of scales; loreal and preocular area with small scales, those above supralabials arranged in two parallel longitudinal rows extending to posterior marge of orbit; 11/11 Suplab, eye covered with small, non-granular scales and opening bordered by two rows of eyelid scales, outermost row of ridged scales that are subequal in their length and width and an inner row of smooth flat, wide scales 13/13 Eyelid; postocular and temporal scales nearly of same size as dorsal trunk scales, postocular scales smooth, temporal scales keeled; tympanum large, naked, 3.24 mm in diameter; cluster of spines in supratympanic area, two of these are large, anterior tympanic spine larger, dorsally directed positioned just above the tympanum, posterior spine dorsolaterally directed positioned posterior to the tympanum, tympanic spines separated by four scales; scales 12/12 rectangular Inflab scales along mouth margin; bordered below by 3–4 rows of smooth scales, first row among these scales is the smallest; medially the chin scales triangular, anterior scales smooth and those in the posterior region feebly keeled; single median subtriangular mental scale between left and right Inflab (Fig. 4C).

Trunk elongate (Trunk/SVL 0.46, Fig. 5A), scalation strongly keeled dorsally and laterally; mid-dorsal crest of elongate scales, separated from interparietal by two large and one small scale, dorsal spine scales large, length of dorsal spine scales nearly equal up to vent where the size decreases and eventually flatten out on the tail to merge with adjacent dorsal scales of tail; 36 Dorsal, 42 Midbody (Fig. 5A); all trunk scales keeled, increasing in size from neck to trunk; all scales oriented backward and diagonally upwards; scales on dorsum and venter sub-equal; preaxillary scales slightly smaller than dorsal trunk scales, feebly keeled.

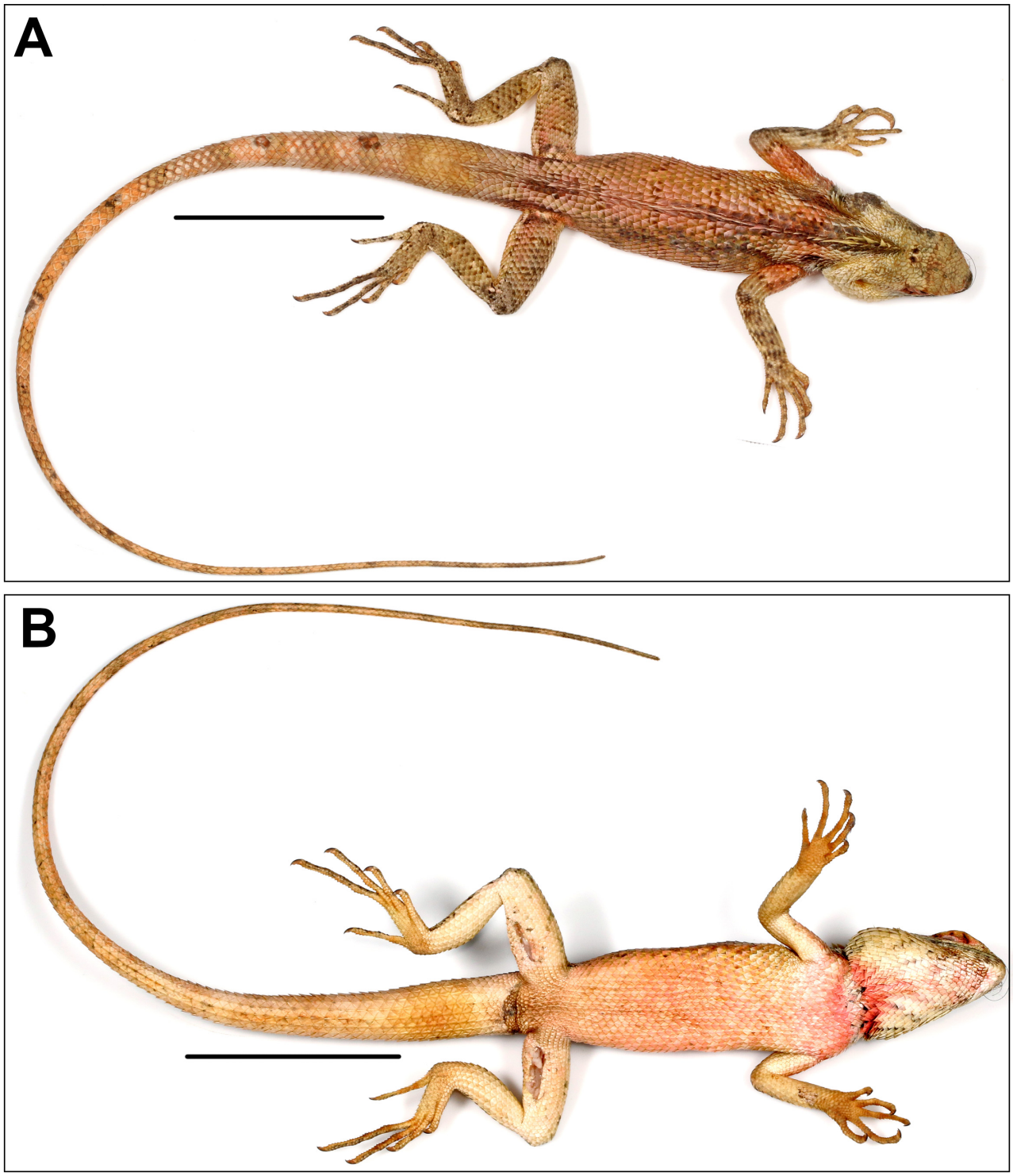

FIGURE 3. *Calotes versicolor* neotype male NCBS AT102, (A) dorsal, (B) ventral. Scale bar 50 mm.

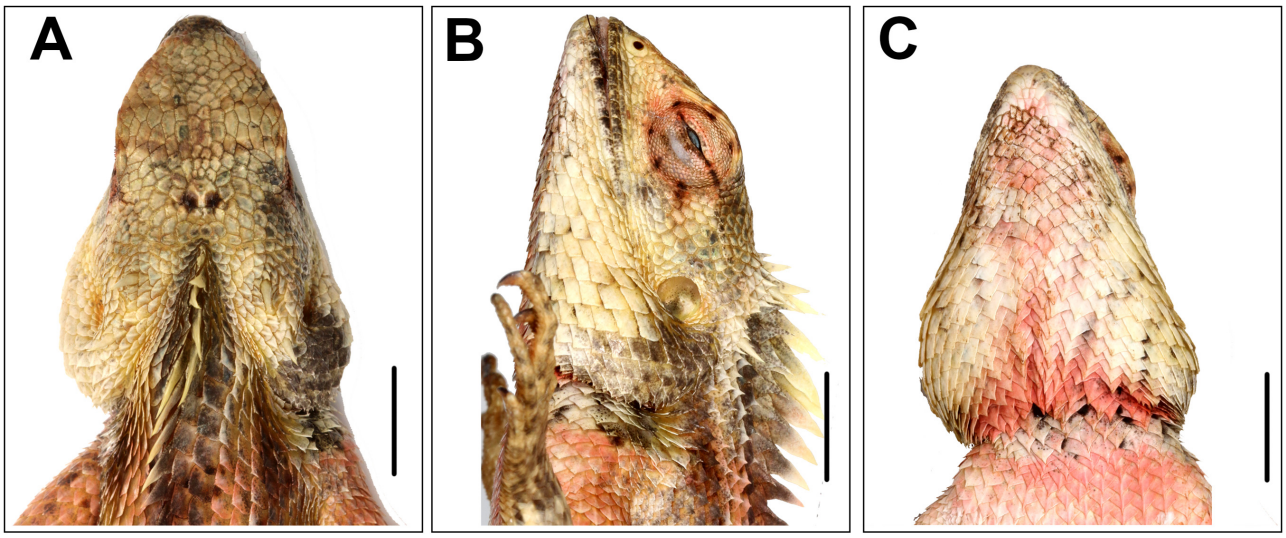

FIGURE 4. *Calotes versicolor* neotype male NCBS AT102 head, (A) dorsal, (B) lateral, (C) ventral. Scale bar 10 mm.

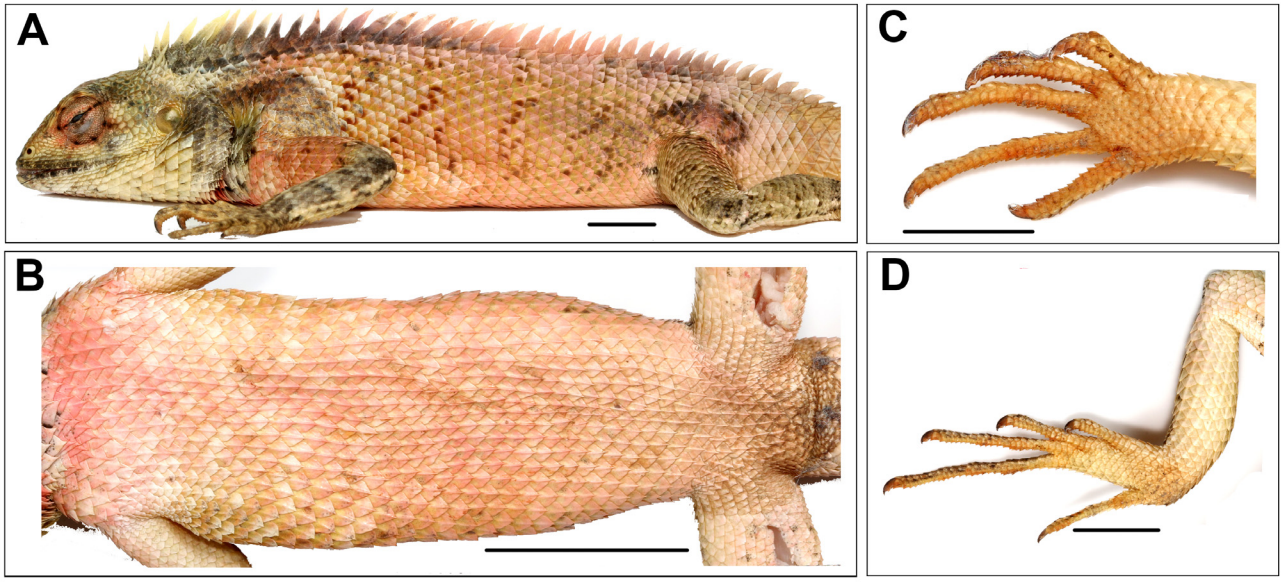

FIGURE 5. *Calotes versicolor* neotype male NCBS AT102 head, (A) lateral view of body, (B) ventral view of trunk, (C) right manus ventral view, (D) right pes ventral view. Scale bar 10 mm.

Limbs with modest to large scales, scales on dorsal aspect of limbs strongly keeled, those on the underside feebly keeled; scale on palm and heel smaller than adjacent scales; hind leg considerably longer than forelimb (CrusL/SVL 0.26, LoArmL/SVL 0.20) lamellae strongly bicarinate; 10, 15, 21, 21, 14 on manus (Fig. 5C) and 12, 17, 23, 28, 16 on pes (Fig. 5D); relative length of digits IV (12.1) > III (11.8) > II (8.6) > V (7.1) > I (7) right manus, IV (19.9) > III (16.8) > II (13.7) > V (13.4) > I (7.8).

Tail long, about 2.8 times SVL (Fig. 3A–B), oval in cross section near vent; 17–18 scale rows round the tail at base which progressively drop in number; eight dorsal spines extend on tail post vent. Scales similar to trunk scales.

Discussion and conclusion

Zug *et al.* (2006) presented the first ever comprehensive analysis of *C.* "*versicolor*" of a region which supports the fact that *C. versicolor* is a group of species presently clubbed under a single nomen. Despite their efforts, much

work remains in resolving systematics of the species; largely due its wide distribution which makes range intensive sampling logistically difficult. Furthermore, lack of type specimen of the species as well as its synonyms make it difficult to undertake a systematic review of this group.

A close scrutiny of synonyms of *C. versicolor* revealed two nomen which require to be assessed with regards to their usage and availability considering provisions under the ICZN (1999). *Calotes gigas* was described by Blyth (1853) based on a specimen without a locality and in the description Blyth mentions that his *C. gigas* might be *C. ophiomachus* which is a junior synonym of *Calotes calotes* Linnaeus, 1758. Given that the type specimen of *C. gigas* is untraceable (Das *et al.* 1998, Smith 1935) and the description is too nebulous, we propose to consider *Calotes gigas* Blyth, 1853 a *nomen dubium* as per the provisions in ICZN (1999). Furthermore, Annandale (1921) credits the authorship of *Calotes versicolor major* to Blyth; however, Blyth never described this taxon and likely *Calotes versicolor major* Blyth was a lapsus for *Calotes gigas* Blyth, 1853 (*fide* Das *et al.* 1998). *Calotes versicolor major* as a nomen does not adhere to Article 11 & 12 of ICZN (1999), hence we consider *Calotes versicolor major* a *nomen nudum*. The following names are available considering 'Principle of Priority' (ICZN, 1999) if these are shown to be valid (Fig. 6): *Calotes viridis* from Madras (now Chennai, Tamil Nadu), *Calotes vultuosa* (=*Agama vultuosa*, Kolkata, West Bengal), *Calotes farooqi* (Manshera, Pakistan).

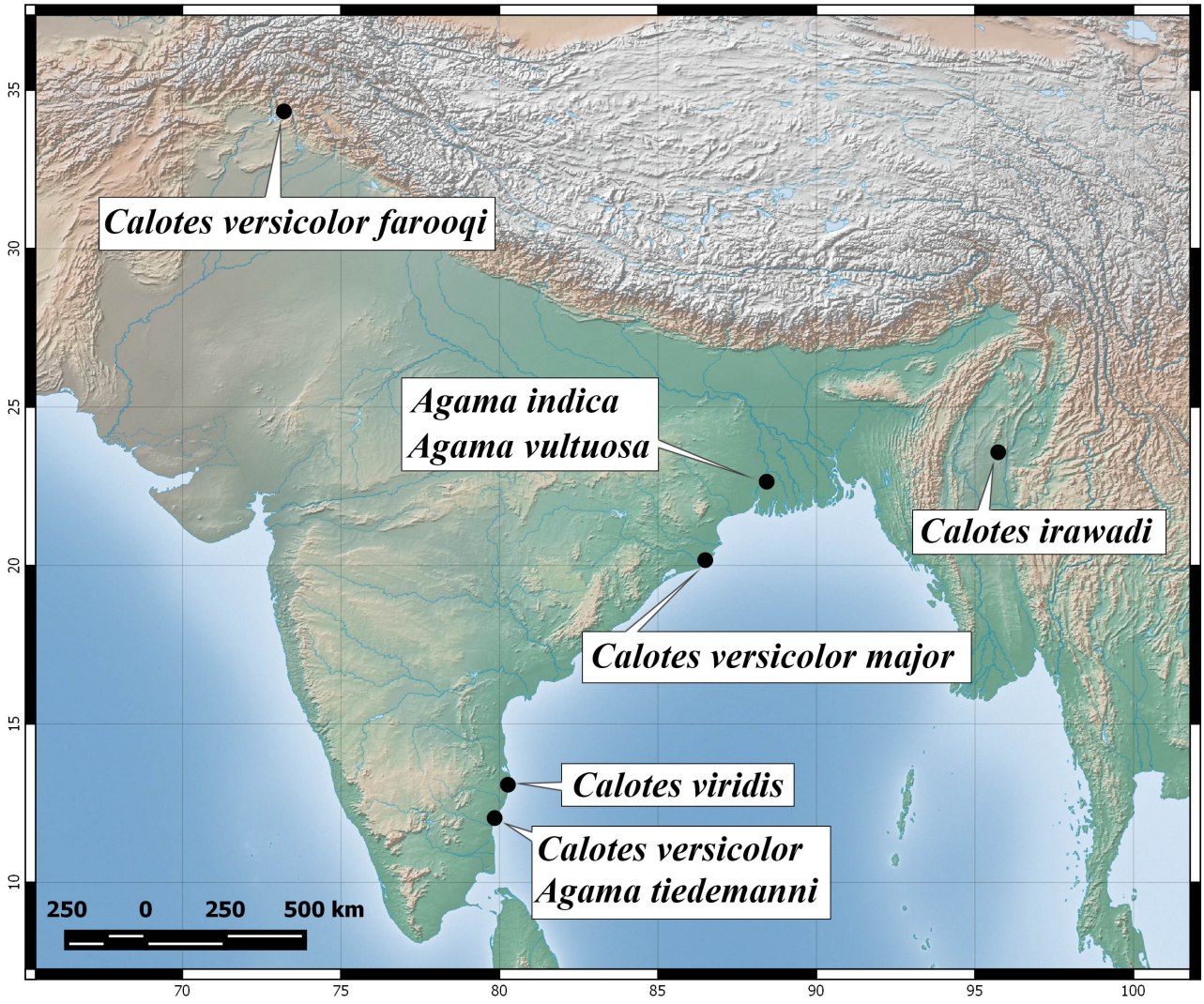

FIGURE 6. Map showing type localities for members of *C. versicolor* group.

Designation of neotype for *C. versicolor* is in accordance with Article 75.3 of the International Code of Zoological Nomenclature, ICZN (1999) and is based on a specimen collected from a locality which has also previously been considered as the type locality for the species. The present designation is not only important from the point of restricting the type locality but will enable subsequent workers to work on one of the most widespread

agamid lizards, which however remains unattended from taxonomic point of view, evident from the long list of synonyms, most of which may eventually turn out to be valid species. A detailed investigation of *C. versicolor* across India is ongoing and the present work is the first step in resolving *C*. "*versicolor*". An integrated approach combining morphological and molecular data is imperative to resolve this complex group, using geographically intensive sampling strategy, especially from type localities of putative synonyms of *C. versicolor.*

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