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Correspondence

Non-reproductive seasonal colour change in a population of *Calotes "versicolor"* from Myanmar (Squamata: Agamidae)

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The bright red head of breeding male *Calotes "versicolor"* is a well-known aspect of their biology, and unfortunately, this colouration has led to a horrific vernacular name, common bloodsucker. A previously unobserved colouration feature is a seasonal shift of background colour in adult females and males, at least for the population of *C. "versicolor"* in the Yangon region of Myanmar (The use of quotes denotes the absence of a specific epithet for a population. *C. versicolor* is a group of species, most of which are presently undescribed [Zug et al. 2006]. The population of coastal southwestern India is the true *C. versicolor*.).

Early in our survey of the Burmese herpetofauna, we observed greenish garden lizards in the Yangon-Pegu corridor of southern mainland Myanmar. Because our surveys concentrated on areas previously unsurveyed, this observation did not focus our attention to the possibility of the green colouration as a monsoonal or seasonal phenomenon. In July 2007 (early-mid monsoon), we obtained a small sample of *C. "versicolor"* from the Hlawga Wildlife Park, a protected forest reserve about 20 km NNE of Yangon. In February 2009 (mid dry season), we returned to Hlawga and obtained another sample. These two samples confirm a distinct seasonal shift in overall colouration (Fig. 1) from light brown in the dry season to green during the monsoon.

Green is not an exceptional background colour for agamid lizards. It occurs widely in *Calotes* and other agamid genera (Table 1). *Bronchocela cristatella* is known as the green-crested or tree lizard owing to regular use of green as a background colour (Auliya 2006); it can alter this green to light olive to brown. Among *Calotes* spp., a green colouration dominates the overall appearance of *C. calotes* and *C. emma*. *Physignathus cocincinus* similarly is predominantly green in appearance. The tendency among Asian forest-dwelling agamids is to possess a green background, although the background may be obscured by darker markings, and some groups, such as *Draco*, tend toward dark olive or lichenous gray.

What has not been observed is a shift within a population of lizards from one background colour to another in association with the wet-dry seasonal cycle. We assume that the colour shift observed in the Hlawga lizards is crypsis. Lowland south-central and central Myanmar has a strong monsoonal cycle. The rains normally begin in mid-May, are heaviest from June through early August, and continue regularly through September. Rain is uncommon from December to April. The parched landscape becomes increasingly brown and many trees shed their leaves, partially or entirely. In this landscape, a green lizard would be a beacon for predators, particularly avian ones. Diurnally active brown lizards are much less conspicuous. The reverse situation would occur during the wet season for an arboreal brown lizard. Our observations are insufficient to document the timing of the colour shifts and sequence of colour change. We hypothesize that the shift from green to brown is gradual, occurring from November through the *Calotes "versicolor"* inactivity period (cool season, December–January) with full attainment of brown by earliest February and renewed activity. The shift from brown to green is likely more rapid and might be stimulated by the occurrence of daily rain with the onset of the monsoon. The greening of the landscape is rapid with the leaving of trees, shrubs and grasses, and sprouting of annuals; about two weeks from our casual observation. We postulate a similar time interval for the shift from brown to green.

We have not observed this colour shift in the two species (*C. htunwini*, *C. irawadi*) of the *C. versicolor* group in central and north-central Myanmar. Both of these species have been captured and photographed by us and our survey team during the mid-monsoon as well as during pre- and post-monsoonal surveys, thus we are confident that seasonal colour shift is not one of their adaptations. Elsewhere in Myanmar, our observations cannot verify the presence or absence of the shift. Kästle (2002) noted that the "head turns greenish and is dotted with red" for breeding males in some Nepali populations. He also re-

Fig. 1. Portraits of Hlawga *Calotes "versicolor"*: (left) Adult female, July 2007 [CAS/jbs 19945]; (right) Adult male, February 2009.

ported that old males in some populations are nearly uniform with a "tinge." The greening of these males was not reported as a seasonal phenomenon; additionally, it is not clear whether this latter comment is Kästle's observations on Nepali males or a repeat of Smith' (1935: 190) statement on older males.

Another aspect of colouration among *Calotes* and *C. versicolor* group members is a rapid darkening or lightening of the ground colour. For the Burmese "*versicolor*" species, such a colour shift is slight in comparison to the diurnal-nocturnal shift or "emotional" shift observed in Burmese *Draco*, e.g., *D.* "*maculatus*". In contrast, we have noted moderately rapid (<15 minute) colour shifts in Burmese *Calotes emma* and *C. mystaceus*. Other agamid taxa certainly display lightening or darkening shifts and/or brightening-fading of colour patterns; however, the rapidity has been difficult to document as these data are absent or ambiguous in the herpetological literature (see the sparsity of <1 h colour shifts in Table 1).

An aspect of colouration shared among the south-central, central, and north-central Myanmar members of the *Calotes versicolor* group is the absence of the bright red head, neck, and anterior trunk of breeding (reproductive active) males of the Indian and Southeast Asian populations. We have not observed bright red forequarters in adult males of the Hlawga *C. "versicolor"* (Table 2). *C. irawadi* males similarly lack red forequarters. *C. htunwini* has a pink to red flush on the chest, but this flush was not visible to us during their daily activity. The brief summary of forequarter breeding colouration in Table 2 indicates that Burmese *C.*

Table 1. A selection of agamid lizard taxa with a predominantly green background or ground colour. Most of the following taxa also have various shaped markings of light and dark colours on the green background, and these markings can result in an overall colouration that suppresses the impression of a green lizard. [1)]The source identifies only the presence of a green ground colour, not rapidity of colour shift.

Taxon	<1 hr colour phase shift	Data Source[1]
Acanthosaura lepidogaster	.	Ziegler 2002
Aphaniotis fusca	.	Manthey & Schuster 1996
Bronchocela cristatella	+	Manthey & Schuster 1996
Calotes calotes	.	Manthey 2008
Calotes emma	+	Ziegler 2002
Calotes grandisquamis	.	Manthey & Schuster 1996
Calotes jerdoni	.	Manthey & Schuster 1996
Calotes liocephalus	.	Manthey 2008
Calotes nigrilabirs	.	Manthey 2008
Ceratophora stoddardi	.	Manthey & Schuster 1996
Dendragama boulengeri	.	Manthey 2008
Gonocephalus dorae	.	Manthey & Schuster 1996
Gonocephalus borneensis	.	Manthey & Schuster 1996
Gonocephalus grandis	.	Manthey & Schuster 1996
Harpesaurus beccari	.	Manthey & Schuster 1996
Japalura major	.	Manthey & Schuster 1996
Japalura polygonata	.	Manthey & Schuster 1996
Physignathus cocincinus	.	Ziegler 2002
Salea horsfieldi	.	Manthey & Schuster 1996
Salea kukhienensis	.	Manthey & Schuster 1996

Table 2. Distribution of red colour in reproductively active males of the *Calotes versicolor* species group. Symbols: + integument light to dark red or orange; - not red or orange; for simplicity of coding, we ignore the black neck-throat patch. [1)] Auffenberg & Rehman (1993); [2)] Manthey (2008); [3)] Sharma (2001); [4)] G. Zug, field notes and photographs 1985; [5)] Myanmar Herpetological Survey, team observations 1999-2009.

Locality	Head		Neck		Trunk				
	Top & Side	Chin	Dorsal & Side	Throat	Shoulder	AntTrunk	MidTrunk	Chest	Stomach
Pakistan									
country–wide[1]	+	+	+	+	+	+	–	+	–
India									
Assam[2]	+	+	+	+	+	+	±	+	–
Rajasthan[3]	+	+	+	+	+	+	–	+	–
Nepal									
Chitwan[4]	+	+	+	+	+	+	–	+	–
Gandaki[2]	+	+	+	+	+	+	–	+	–
Myanmar									
Chatthin[5]	–	+	–	+	–	–	–	±	–
Hlawga[5]	–	–	–	–	–	–	–	–	–
Thailand									
Chiang Mai[2]	+	+	+	+	+	+	–	+	–
Laos									
Champasak[2]	+	+	+	+	+	+	–	+	–

"*versicolor*"are the only *C. versicolor* group members to lack red forequarters. The red colour reported (Table 2) for *C. htunwini* is in fact only a flush of red or pink and is apparent when the male lizard is in hand. Is this lightness and absence in other Burmese populations a failure of our observations? That explanation is a possibility, although the red

forequarter is not a quick change. Here again the herpetological literature is weak. We have been unable to document the time of its onset or disappearance in adult males. Aside from Auffenberg & Rehman (1993) and Kästle (2002), authors typically have limited comments or descriptions of colouration (i.e., colour and pattern). Our extraction of regionalization of male breeding colouration derives largely from images. For such a broadly distributed taxon and usually a moderately abundant and visible one, the seasonality of breeding and other colours is weakly documented in local populations and thwarts attempts to examine colouration differences in a geographic setting.

The shape and size of the black throat/gular patch in mature *C. versicolor* group males has attracted more attention, particularly its variation among populations. Auffenberg & Rehman (1993) reported the absence of the dark collar in all adult females and males throughout most of Pakistan; however, in northern Pakistan, males develop a large black gular mark during the breeding season. The mark is U-shaped with the transverse part lying at the base of the neck and the major portion laterally; the lateral portion extends anteriorly along the sides of the throat and jaw nearly to the chin and laterally upward on the neck to the level of the ear opening, but not onto the head or jowls, and posteriorly onto shoulder and base of forearm. Auffenberg & Rehman furthermore noted that both the gular mark and red forequarters may disappear upon death. Breeding males of the more widespread Pakistani *versicolor* morph intensify the black chin and throat stripes. Sharma (2001) showed a striking difference in the size of the breeding male gular mark in the populations at the southern and northern ends of the Aravalli mountain range in western India. To the north, in Nepal, Kästle (2002) identified and illustrated two gular mark patterns. None of the preceding six patterns match one another, and other gular patterns are evident in Manthey's (2008) illustrations of breeding males of the *C. versicolor* group from throughout the range of this species group. The diversity of the gular marks and the head-bobbing behavior of adult males suggest a visual signaling function, and likely these patterns are species-specific.

The preceding observations on colouration differences highlight the need to be more attentive to pattern difference in *Calotes* and especially to documenting these patterns ontogenetically, seasonally, and gender-specifically.

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