



EDITORIAL

Asian Agamid lizards (Agamidae, Acrodonta, Sauria, Reptilia): Phylogenetic and taxonomic diversity

The Southeast Asian-Indonesian and Australian-New Guinean tectonic plates have both been hypothesized to be centers of origin of agamid lizards (Moody, 1980). The Asian continent housed a number of hotspots of plant and animal diversity and endemism, important for the conservation of biodiversity on a global scale. There are many threatened areas in tropical Asia in terms of destruction of tropical rain forest as an environment with a unique biota and herpetofauna in particular. New intensive studies of the Asian fauna as well as new opportunities offered by molecular methods make it clear that taxonomic diversity is underestimated, especially in South and Southeast Asia. The aim of this paper is to show the taxonomic diversity of different evolutionary lineages and the distribution of agamids by sub region in Asia.

We compare several Asian territories well studied in diversity of agamids: China (Ananjeva & Wang, 2008; Zhao & Adler, 1993; Zhao *et al.*, 1999); North Eurasia, i.e. former Soviet Union plus Mongolia (Ananjeva *et al.*, 2006); Iran (Anderson, 1999); South Asia (Das, 1996; Das & de Silva, 2005) and different regions of South-East Asia: Vietnam (Ananjeva *et al.*, 2007); Thailand (Taylor, 1963 with additions); Myanmar (Zug *et al.*, 2003); and the Sunda Archipelago (Manthey & Grossmann, 1997).

The study of mitochondrial DNA (Ananjeva, 2004; Macey *et al.*, 2000) has allowed the construction of a phylogenetic tree of acrodontan squamates and their main evolutionary lineages, which are associated with the fragmentation of Gondwana into separate tectonic plates. Such interpretations are based on the integration of morphological (Moody, 1980) and molecular data (Macey *et al.*, 2000). Six groups of agamids correspond to 6 subfamilies: (1) Uromastycinae Theobald, 1868 with the genera *Uromastyx* and *Saara*; (2) Leiolepidinae Fitzinger, 1843 with the genus *Leiolepis*; (3) Amphibolurinae Wagler, 1830 with all Australian and New Guinean species; (4) Hydrosaurinae Kaup, 1828 with the genus *Hydrosaurus*; (5) South- and Southeast Asian Draconinae Fitzinger, 1826 with numerous Indian and Southeastern genera (mostly arboreal or semi-arboreal) and (6) Afro-West-Asian Agaminae Spix, 1825.

The Asian agamid fauna has a complicated origin. For example the highest phylogenetic variety in Asia with taxa belonging to 4 subfamilies Leiolepidinae, Amphibolurinae, Agaminae and Draconinae has been recorded in China (Ananjeva & Wang, 2008); the fauna of agamid in South Asia is represented by 3 subfamilies: Agaminae, Draconinae and Uromastycinae (Das, 1996) as is that of Southeast Asia: Leiolepidinae, Amphibolurinae and Draconinae (Ananjeva *et al.*, 2007) and Iran: Agaminae, Draconinae, Uromastycinae (Anderson, 1999). The Sunda region is presented by 2 subfamilies: Draconinae, Leiolepidinae (Manthey & Grossmann, 1997) and North Eurasian agamids are members of only the subfamily Agaminae (Ananjeva *et al.*, 2006).

The subfamily Amphibolurinae is presented in Asia by the genus *Physignathus* which is the sister group to Australo-New Guinean agamids. At present the genus *Physignathus* includes 2 species: *P. cocincinus* and *P. lessueurii*. *P. cocincinus* inhabits the Southeast Asian region and part of China. Some authors provide evidence for a polyphyletic origin of this genus (Macey *et al.*, 2000; Moody 1993; Schulte *et al.*, 2003) which represents additional support for the ancient fragmentation of lizard taxa from both sides of Wallace's line (Schulte *et al.*, 2003); another point of view suggests a much more recent divergence between SE Asian and Australian agamids (around 30 MYA) (Hugall & Lee, 2004; Hugall *et al.*, 2008). Agamids of this subfamily have femoral pores and lens-like skin receptors (Ananjeva, 2004).

The monotypic subfamily Leiolepidinae is known from Southeast Asia and part of China and Sulawesi in Sunda region. Study of mt-DNA (Macey *et al.*, 2000) and morphological characters of the integument (Ananjeva *et al.*, 2001) support the monophyly of this lineage, previously combined with *Uromastyx* into a

subfamily (family) Uromastycinae (-dae) Theobald, 1868 (Moody, 1980). These lizards have femoral pores and lens-like receptors without hairs (Ananjeva, 2004; Ananjeva *et al.*, 2001). Among 8 species there are bisexual (*L. belliana*, *L. guttata*, *L. reevesii*, *L. peguensis*) and parthenogenetic: (*L. triploida*, *L. guentherpetersi*, *L. boehmei*, *L. ngovantrii*) (Darevsky & Kupriyanova, 1993; Grismer & Grismer, 2010) examples.

The lizards of the subfamily Uromastycinae with 18 species are distributed in western Asia and Africa. One of the species, belonging to genus *Saara*, is the widespread *S. hardwickii* Gray, 1827 which inhabits Pakistan, northwestern India (Rajasthan, Gujarat) and Afghanistan (area bordering Pakistan). Another species, *S. asmussi* (Strauch, 1863) also penetrates South Asia in Pakistan (Baluchistan).

The subfamily Draconinae contains the maximum diversity of genera and species in South and Southeast Asia (Ananjeva, 2004; Macey *et al.*, 2000; Moody, 1980). This subfamily is the most diverse group with a high percent of endemic genera of arboreal and semiarboreal agamids (Moody, 1980). Among them there are monotypic genera or those represented by 1–3 species (*Aphaniotis*, *Cophotis*, *Ptyctolaemus*), as well as genera with high species diversity (*Draco*, *Gonocephalus*, *Japalura*). Draconine agamids exhibit very high degrees of diversification at the generic level (23 genera in South Asia and 24 genera in Southeast Asia). Phylogenetic studies conducted in recent decades have improved our knowledge about the composition and phylogeny of the subfamily. Some problems still exist relating to newly described or re-studied species in certain genera (Ananjeva & Stuart, 2001; Macey *et al.*, 2000; Maduwage *et al.*, 2008; Manthey & Grossmann, 1997; Schulte *et al.*, 2002, 2004).

In the course of taxonomic revisions of the genera *Acanthosaura* (Ananjeva *et al.*, 2008; Kalyabina-Hauf *et al.*, 2004; Orlov *et al.*, 2006; Wood *et al.*, 2009, 2010), *Bronchocela* (Hallermann, 2004, 2005), *Calotes* (Bahir & Maduwage, 2005; Hallermann, 2000; Ota & Hikida, 1991, 1996; Vindum *et al.*, 2003; Zug *et al.*, 2006); *Draco* (Inger, 1983; McGuire & Heand, 2001; Musters, 1983), *Gonocephalus* (Diong *et al.*, 2000; Honda *et al.*, 2002; Manthey & Grossmann, 1997), *Japalura* (Ota, 1989a,b; 1991, 2000a,b; Ota & Hikida, 1989; Ota *et al.*, 1998), *Pseudocalotes* (Hallermann & Böhme, 2000; Hallermann & McGuire, 2001; Hallermann *et al.*, 2010), *Otocryptis* (Bahir & Silva, 2005), *Cophotis* (Samarawickrama *et al.*, 2006) and *Ptyctolaemus* (Ananjeva & Stuart, 2001; Manthey & Nabhitabhata, 1991; Schulte *et al.*, 2004) descriptions of a number of new species and even genera have been made. Moody (1980) revised the family Agamidae and divided the genus *Agama* into the following six genera: *Agama*, *Stellio*, *Trapelus*, *Pseudotrapelus*, *Brachysaura* and *Xenagama*.

The subfamily Agaminae comprises about 115 species living mainly in Africa and Palearctic Asia. In comparison with agamids of the subfamily Draconinae it is characterized by relatively low generic diversity (number of species in parentheses) – 9 genera in total: *Acanthocercus* Fitzinger, 1843 (about 10), *Agama* Daudin, 1802 (about 30), *Brachysaura* Blyth, 1856 (1), *Bufoniceps* Arnold, 1992 (1), *Phrynocephalus* Kaup, 1835 (40), *Pseudotrapelus* Fitzinger, 1843 (1), *Laudakia* Gray, 1845 (16), *Trapelus* Cuvier, 1817 (12), *Xenagama* Boulenger, 1895 (2). Problems of phylogenetic relations within Agaminae and position of monotypic genera are of increasing interest: DNA study revealed cryptic phylogenetic diversity (in particular non-monophyly of genus *Laudakia*) (Macey *et al.*, 2000, 2006).

It has been recorded (Moody, 1980) that only 5 agamid genera (*Draco*, *Japalura*, *Laudakia*, *Calotes* and *Uromastyx*) cross the boundaries of the six regions of endemism (i.e. Sub-Saharan Africa, Eurasia, India, Orient and Sunda, Wallacea and Australia and Melanesia). This can be seen when we analyze agamid lists of China, South- Southeast Asia and other Asian regions. Comparison of the lists of specified Vietnamese agamids with those of several regions of South-East Asia (Myanmar, Thailand, Sunda region, China (Ananjeva & Wang, 2008; Ananjeva *et al.*, 2007; Manthey & Grossmann, 1997; Zhao & Adler, 1993; Zhao *et al.*, 1999; Zug *et al.*, 2003) shows species diversity increasing from 24 (Vietnam) to 29 in Myanmar and Thailand and 48 in China. The South Asia and Sunda regions have much higher species diversity (67 and 60 sp., respectively).

The methodology of phylogenetic systematics (Moody, 1980) as well as approaches and methods of molecular analysis (Ananjeva, 2004; Honda *et al.*, 2000; Macey *et al.*, 2000) have made a great contribution

to the understanding of generic assignment of problematic species. However the problem of interpretation and phylogenetic evaluation of morphological characters remains and has a practical aspect with respect to the construction and use of identification keys.

The problem of the evaluation of the endemism of Asian agamids is of special importance in the context of conservation. Physiographically the South Asian region includes several parts: the northern islands of the Bay of Bengal Islands, the southern islands, different parts of India, plain and mountain regions of Pakistan and the continental island of Sri Lanka (Das, 1997). This region supports 23 endemic genera (many of them are monotypic) belonging to 3 subfamilies. It has the second agamid greatest diversity region after Southeast Asia (Moody, 1980). Within this region the Sri Lankan agamid fauna with its high level of endemism is of special interest: it supports 18 species (Das & de Silva, 2005) representing 6 genera of one subfamily Draconinae; 15 of them are endemic to the island.

Among the 24 species in Vietnam, 12 species (50%) are endemics. The distribution of 10 of the 12 endemics is delimited by the southern part of the Annamite Mountains. This is additional evidence for the designation of an Annam sub region with tropical mountain forests. Inger (1999) wrote that this region is one of the centres of active cryptic speciation in Asia for anurans. Only one endemic species, *L. guentherpetersi*, is described from Central Vietnam, one more from the Tonkin region (North Vietnam) - *Japalura chapaensis*. The other 10 species are known only from the Central Highland within Vietnam and adjacent regions of Laos and Cambodia (3 species *Acanthosaura*, 3 species *Bronchocela*, 1 species *Draco*, 1 species *Leiolepis*, 1 species *Pseudocalotes* and 1 species *Pseudocophotis*). In general the agamid fauna in Indochina is characterized by a high level of endemism and cryptic diversity. The data on cryptic diversity in genera such as *Acanthosaura* and *Bronchocela* confirm ideas about the diversification of the fauna of tropical forests (Moritz *et al.*, 2000), which is illustrated by numerous examples from tropical faunas of Central Africa, Australia and South America.

The agamid fauna of China includes 48 species of 4 subfamilies and 13 genera. The level of endemism is relatively high (19 species, i.e. 44%). Endemic species are referred to 4 genera: among them majority of species of genus *Japalura* (10 among 14) and species of the Tibetan clade of the genus *Phrynocephalus* (7 of 11 species) (Ananjeva & Wang, 2008).

These data and any attempts to summarize and analyze the modern data on biodiversity, level of endemism and allocations of the highest priority territories are of great value for conservation strategies.

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