

## CRICKET FROG (AMPHIBIA: ANURA: DICROGLOSSIDAE): TWO REGIONS OF ASIA ARE CORRESPONDING TWO GROUPS

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**Abstract.** Cricket frogs are widely distributed throughout South and Southeast Asia. They are divided into two distinct clades based on phylogenetics and morphology: South Asian morph and Southeast Asian morph. Morphologically, they can also be classified according to their distribution pattern. Herein, South Asian Cricket frogs are grouped under *Zakerana*, a new genus.

**Key words:** Amphibia, Cricket frog, *Fejervarya*, *Zakerana* gen. nov.

Cricket frog is nominated as *Fejervarya* Bolkay, 1915. Presently, the genus is exhibiting 32 species distributed throughout South and Southeast Asia. After analyzing the phylogenetic data, Frost et al. (2006) assigned *Fejervarya* with *Hoplobatrachus* Peters, 1863, *Euphlyctis* Fitzinger, 1843, *Nannophrys* Günther, 1869 and *Sphaerotheca* Günther, 1859. Morphometric nature of the *Fejervarya* species are much problematic (Kotaki et al., 2010) and several cryptic species have been found from *Fejervarya* populations formerly recognized as single nominal species (Dubois, 1975; Toda et al., 1998; Veith et al., 2001; Sumida et al., 2007; Islam et al., 2008a, 2008b). About the half of *Fejervarya* species were described in the 19th century and early 20th century (Frost, 2011). Those specimens and literatures are difficult to get access to. Due to the presence of huge morphological variation, but lack of information, most of the South Asian taxonomist designated their specimens as *Fejervarya limnocharis* (Gravenhorst, 1829) complex. *F. limnocharis* is confined to Indonesia, Malaysia, Laos and Vietnam (Toda et al., 1998; Biju, 2001; Veith et al., 2001; Djong et al., 2007). To avoid the taxonomic caucous authors had to use only geographical or morphological congeners to compare their new species (Howlader, 2011; Kuramoto et al., 2007; Stuart, et al., 2006) and most of them could not present detailed comparison (Matsui, et al., 2007, Dutta, 1997). Studies of Kosuch et al. (2001; based on 572-bp sequences of the 16S rRNA gene); Frost et al. (2006; part of a cladogram, presented on page 136); Sumida et al. (2007; based on nucleotide sequences of a 422-bp segment of the

mitochondrial 16S rRNA gene); Kotaki et al. (2008); based on 638 bp of the mitochondrial 16S and 12S rRNA genes); Wiens et al. (2009; two mitochondrial, three nuclear); Kotaki et al. [2010; based on 6364 bp of the mitochondrial (*Cytb*, *12S*, and *16S*) and nuclear genes (*BDNF*, *CXCR4*, *NCX1*, *RAG-1*, *RAG-2*, *Rhod*, and *Tyr*)] also reflect *Fejervarya* as two distinct groups, viz. South Asian and Southeast Asian. However, none of the above mentioned authors presented any morphological comparison of the two groups. Herein, South Asian group is represented as separate genus from *Fejervarya*. Southeast Asian group (*Fejervarya limnocharis* group) is treated here as *Fejervarya*, because *F. limnocharis* is representing type species of *Fejervarya*. A brief diagnosis, distribution ranges and list of coined species under the proposed new genus are presented here.

**South Asian Cricket frog: *Zakerana* gen. nov.** (Type Species: *Rana limnocharis syhadrensis* Annandale, 1919).

**Etymology:** Zaker + Latin: rana [frog] reflects the contributions to wildlife conservation by Professor Kazi Zaker Husain [1933-2011], founder of Wildlife Biology in Bangladesh.

**Diagnosis:** *Zakerana* gen nov. may be characterized as a group of small-sized frogs having snout not much pointed or slightly rounded; relatively small tympanum; small rounded or slightly elongated, laterally compressed internal metatarsal tubercles; rudimentary webbing on feet; and small tibia.

The snout-vent length and rudimentary webbing on the feet *Zakerana* correspond to *Minervarya* Dubois, Ohler, and Biju, 2001, but absence of rictal gland and large number of tubercles in *Zakerana* separate them from *Minervarya*. Small body size, not much pointed or slightly rounded snout, relatively small tympanum, small internal metatarsal tubercles, rudimentary webbing on feet, and small tibia distinguish *Zakerana* from *Fejervarya* (Table 1).

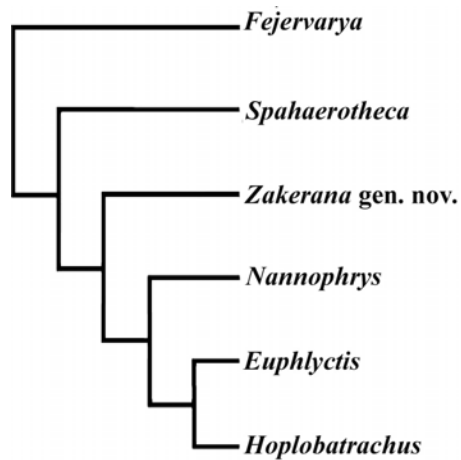


Figure 1. Cladistic relationship to distinguish the position of *Zakerana* gen. nov. with congeners (redrawn from Frost et al., 2006; Fig. 63. *Zakerana*, presented here instead of *Fejervarya syhadrensis* and *F. kirtisinghei*; other genera for their own species.)

**Cladistic relationships:** Based on phylogenetics, Frost et al. (2006) nested *Fejervarya* with *Hoplobatrachus*, *Euphlyctis*, *Nannophrys*, and *Sphaerotherca* (Figure 1). The presence of *Fejervaryan* line is a synapomorphic character among *Fejervarya*, *Zakerana* and *Minervarya*, I think. Hence, they are sister genera. However, *Zakerana* and *Minervarya* are hypothesized to have a common origin for their common habitats in South Asia and small body size with rudimentary webbing on feet. Molecular work will be presented on another paper to clarify the hypothesis.

**Species contents:** *Zakerana brevipalmata* (Peters, 1871) comb. nov.; *Zakerana caperata* (Kuramoto, Joshy, Kurabayashi, and Sumida, 2007) comb. nov.; *Zakerana granosa* (Kuramoto, Joshy, Kurabayashi, and Sumida, 2007) comb. nov.; *Zakerana greenii* (Boulenger, 1905) comb. nov.; *Zakerana keralensis* (Dubois, 1981) comb. nov.; *Zakerana kirtisinghei* (Manamendra-Arachchi and Gabadage, 1996) comb. nov.; *Zakerana kudremukhensis* (Kuramoto, Joshy, Kurabayashi, and Sumida, 2007) comb. nov.; *Zakerana mudduraja* (Kuramoto, Joshy, Kurabayashi, and Sumida, 2007) comb. nov.; *Zakerana murthii* (Pillai, 1979) comb. nov.; *Zakerana mysorensis* (Rao, 1922)

comb. nov.; *Zakerana nepalensis* (Dubois, 1975) comb. nov.; *Zakerana nilagirica* (Jerdon, 1854) comb. nov.; *Zakerana parambikulamana* (Rao, 1937) comb. nov.; *Zakerana pierrei* (Dubois, 1975) comb. nov.; *Zakerana rufescens* (Jerdon, 1854) comb. nov.; *Zakerana sauriceps* (Rao, 1937) comb. nov.; *Zakerana syhadrensis* (Annandale, 1919) comb. nov.; *Zakerana teraiensis* (Dubois, 1984) comb. nov.; and *Zakerana asmata* (Howlader, 2011) comb. nov.

**Distribution:** All species of *Zakerana* are reported from South Asian countries like Bangladesh, India, Nepal, Pakistan, and Sri Lanka (Frost, 2011).

**Remarks:** Formation of geographical barriers and climatic fluctuations are the main causes of speciation (Mayr, 1942; Hewitt, 2000). Uplift of mountain systems and the development of river systems might have been formulating barriers to gene flow between populations, resulting in diversification along these boundaries (Nielson and Wakeley, 2001; Brant and Ortí, 2003; Carstens et al., 2004; Funk et al., 2005; Steele et al., 2005; Howes et al., 2006; Kozak et al., 2006; Lemmon et al., 2007). Main land of South Asia is separated from Southeast Asia and East Asia by series of mountains (Himalayan Mountains, Arakan Mountains, Patkai Mountains) and Indian ocean (Figure 2) which might have contributed to allopatric and parapatric speciation. South Asian species are showing significant level of genetic and some morphological variations from Southeast Asian frogs (Toda et al., 1998; Biju, 2001; Veith et al., 2001; Djong et al., 2007; Kuramoto et al., 2007; Alam et al., 2008; Joshy et al., 2009; Kotaki et al., 2010). Recently, South Asian species are nested some new genus (like *Raorchestis*, *Minervarya* and *Duttaphrynus*) for their endemism (Dubois et al., 2001; Frost et al., 2006; Biju et al., 2010). *Zakerana* gen. nov. is presented here for the South Asian species groups that was belonging to *Fejervarya*. However, there is one exceptional species, *F. orissaensis* representing morphological character like Southeast Asian group (Dutta, 1997) and not coined on the new genus. Kurniawan et al. (2010) suggested that *Fejervarya cancrivora* is exhibiting three morphotypes: mangrove type (India, Bangladesh, Thailand, and Philippines), large type (Malaysia and Indonesia), and Pelabuhan ratu / Sulawesi type (Southeastern Indonesia). Herein, mangrove type (South Asian) is considered as *F. cancrivora* species complex instead of *F. cancrivora* for their localities, habitat ecology and smaller size than the type locality. According to Gravenhorst (1829) *Rana cancrivora* (*F. cancrivora*) is “larger” than *R. limnocharis* (*F. limnocharis*), and the name *R. cancrivora* has been

consistently applied to large individuals in the *R. limnocharis* complex occurring in Java and neighboring regions. South Asian mangrove type (*F. cancrivora* complex) should be concluded on several taxa.

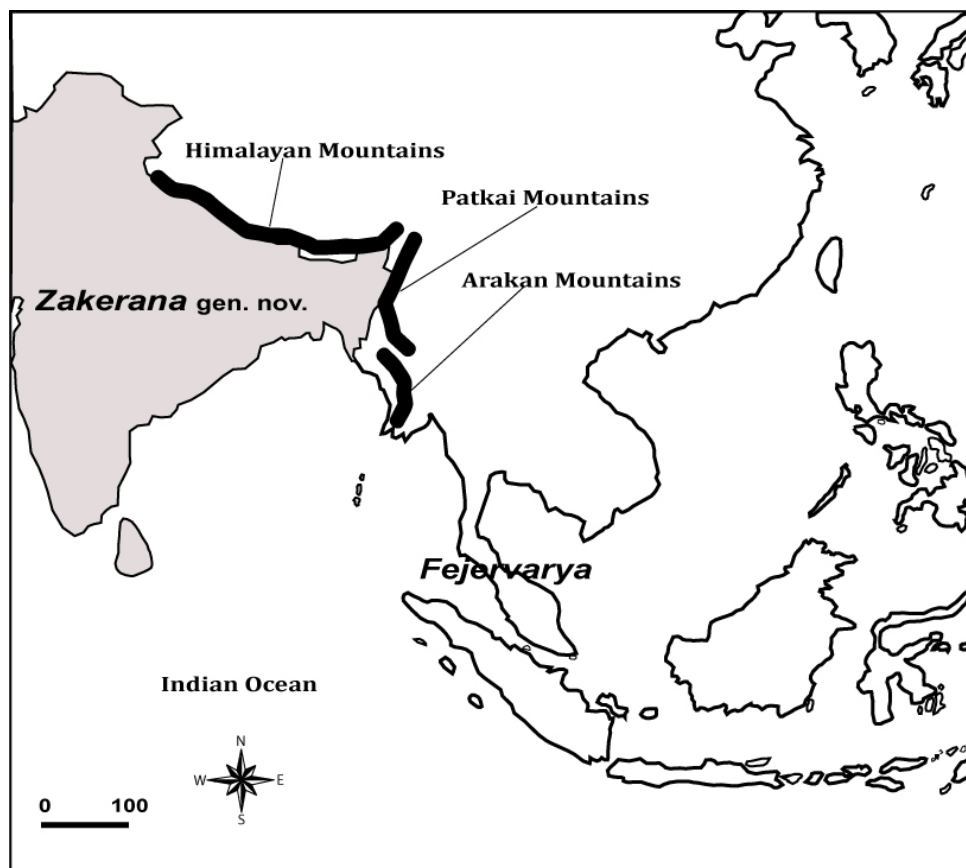


Figure 2. Distribution of *Zakerana* gen. nov. and *Fejervarya*.

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Table 1. Comparison of morphological characters of *Zakerana* gen. nov. with its congeners.

Characters	<i>Zakerana</i> gen. nov.	<i>Fejervarya</i> Bolkay, 1915	<i>Mnervarya</i> Dubois, Ohler and Biju, 2001	<i>Sphaerotheca</i> Günther, 1859	<i>Euphlyctis</i> Fitzinger, 1843	<i>Hoplobatrachus</i> Peters, 1863	<i>Nannophrys</i> Günther, 1869
SVL (Adult male)mm	22-36	38-80	17-21	30-55	40-95	75-130	24-37
SVL (Adult female)mm	23-45	45-90	20-23	35-60	45-130	65-140	26-46
Snout	Slightly pointed	Pointed	Slightly pointed	Slightly rounded	Slightly pointed	pointed	Rounded
Rictal gland	Absent	Absent	Present	Absent	Absent	Absent	---
Webbing on feet	Rudimentary	Small to medium	Rudimentary	small	Complete	Large	Free or basal trace
Internal metatarsal tubercle	Small, rounded or slightly elongated, laterally compressed	More wider, rounded	Rather long, cylindrical	Short, shovel-shaped	Pointed, cylindrical, digit-like	Rather long, cylindrical or shovel-shaped	Elongated
Dorsal skin	With several longitudinal folds arranged on regular form	Interrupted longitudinal folds	With several longitudinal folds	Smooth	Smooth with horny granules	More arranged longitudinal folds	Warty
Lateral line system in adult	Absent	Absent	Absent	Absent	Present	Absent	---
Fejervarya lines	Present	Present	Present	Absent	Absent	Absent	Absent
Femoral glands	Absent	Absent	Absent	Present	Absent	Absent	Data not found
Tympanum diameter	Small	Large	Small	medium	medium	Large	Large
Tibia length (relative to the SVL)	Approximately half of SVL	More or less equal to SVL or nearest value to SVL	Approximately half of SVL	---	Approximately half of SVL	---	Larger than SVL
References for characters	Boulenger, 1890; Rao, 1922, 1937; Pillai, 1979; Dutta and Manamendra-Archchi, 1996; Dutta, 1997; Chanda, 2002; Stuart et al., 2006; Borthakur et al., 2007; Kuramoto et al., 2007; Matsui et al., 2007; Rasel et al., 2007	Boulenger, 1890; Rao, 1922, 1937; Pillai, 1979; Dutta and Manamendra-Archchi, 1996; Dutta, 1997; Chanda, 2002; Stuart et al., 2006; Borthakur et al., 2007; Kuramoto et al., 2007; Matsui et al., 2007	Dubois et al. 2001; Ohler et al., 2009.	Boulenger, 1920; Kirtisinghe, 1957; Dutta and Manamendra-Archchi, 1996.	Boulenger, 1920; Dutta and Manamendra-Archchi, 1996; Khan, 1997; Joshy et al., 2009.	Boulenger, 1920; Fie et al., 1991; Fie, 1999; Chanda, 2002.	Clarke, 1983; Fernando et al., 2007

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15. NLC, National Library of China, Western Language Publications Acquisitions Section, Beijing, China
16. ZSI, Zoological Survey of India, New Alipore, Kolkata, India
17. IUCN Red List Unit, Cambridge, UK
18. OUMNH, Oxford University Museum of Natural History, Parks Road, Oxford, UK
19. NLSA, National Library of South Africa, Cape Town, South Africa

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