

A five-way division of the agamid genus *Laudakia* Gray, 1845 (Squamata: Sauria: Agamidae).

Raymond T. Hoser

488 Park Road, Park Orchards, Victoria, 3134, Australia.

Phone: +61 3 9812 3322 Fax: 9812 3355 E-mail: viper007@live.com.au

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ABSTRACT

The Agamid genus *Laudakia* Gray, 1845 has had a checkered history in terms of nomenclature. However in recent years a number of molecular studies have confirmed the relationships between species within the genus *Laudakia sensu lato* and closely related genera.

As currently recognized the genus *Laudakia sensu lato* consists of five distinct species groups.

All are sufficiently divergent in terms of morphology, habits and divergence as ascertained from molecular studies to be accorded full genus status.

One of these groups is already commonly referred to as the genus *Phrynocephalus* Kaup, 1825 (26 species). In terms of the rest, the names *Laudakia* and *Plocoderma* Blyth, 1854 are available for two other groups.

The other two unnamed groups are formally named according to the Zoological Code within this paper. These are *Adelynkimberleyea* gen. nov. for the *caucasia* group and *Jackyindigoea* gen. nov. for the taxon *sacra*.

Within *Adelynkimberleyea* gen. nov. the morphologically and ecologically divergent taxon *lehmanni* is placed in the newly named subgenus *Agamatajikistanensis* subgen. nov..

Keywords: Taxonomic revision; new genera; new subgenus; *Laudakia*; *Phrynocephalus*; *Plocoderma*; *Adelynkimberleyea*; *Jackyindigoea*; *Agamatajikistanensis*.

INTRODUCTION

Lizards of the mainly south-west Asian genus *Laudakia* Gray, 1845 fit the profile of typical agamids in most respects.

They are dwellers of dry habitats and are stout spinose lizards with a round pupil. The body is slightly flattened with a broad head. The scales are distinctly tubercular and the ears in particular display the protective spines typical of many desert dwelling lizards. The tail is covered in whorls of spiny scales. Most species typically reach about 30cms in length of which the tail is about half.

The body tends to be some shade of grey, orange, yellow or even blackish in colour and the back may be marked in diamond or other shaped blotches or lateral stripes or bands which range from a various paler or darker colouration.

There are frequently similar coloured blotches on the flanks which sometimes join with the back markings to appear as complete bars. Females are typically more drab in colouration and with smaller heads and there is considerable variation in

colour, not just between species, but also within given species depending on locality.

In line with other "dragons" these lizards interact with one another doing so-called press-ups, raising and lowering the whole forepart of the body, head-bobbing, arm waving and the like.

The lizards subject of this paper, have been referred to the genus *Laudakia* Gray, 1845 in recent years, but have had a checkered past taxonomically.

Henle (1995) gives a detailed account of the taxonomy of the group to that date.

While these lizards were in the first instance referred to the catch-all genus *Agama* by Boulenger (1885), this changed when Moody (1980), split the genus *Agama (sensu lato)* into six genera. In doing so he overlooked Stejneger's (1936) designation of *Stellio saxatilis* of Laurenti, 1768 which is based on a figure in Seba (1734) as the type species.

This species is however unidentifiable.

Moody (1980) erroneously reused *Stellio* for the so-called *Stellio-group* of agamid lizards (currently referred to *Laudakia* Gray, 1845). Many authors followed Moody (1980) until some authors pointed out that *Stellio* was unavailable. They didn't fully discuss the implications for agamid nomenclature until 1995 when Henle proposed a restructure of the group using available existing nomenclature. To that end, Henle (1995) suggested to restrict *Laudakia* to *L. tuberculata* and to use *Ploceoderma* for the so-called *stellio-group* which was ultimately interpreted by most herpetologists to include about 20 species.

Two other groups of phenotypically similar agamids the Asian genus *Phrynocephalus* Kaup, 1825, includes about in excess of 20 species (about 26 recognized in 2012) and the middle-eastern genus *Acanthocercus* Fitzinger, 1843 includes 8 described species, (all but one described in the 1800's) were also dealt with by Henle (1995), who resurrected both genera and placed the component species within.

Acceptance of Henle's position in terms of genera *Phrynocephalus* and *Acanthocercus* by other herpetologists continues to 2012.

However in terms of the remaining species, most authors have subsumed *Ploceoderma* within *Laudakia*, which had date priority (e.g. Almog et. al. 2005). Hence *Laudakia* as currently recognized contains about 22 described species.

In the period since 1995 there have however been numerous phylogenetic studies into species within *Laudakia* (*sensu lato*, as in including *Ploceoderma*), including studies that have included what has now emerged as the four distinct phylogenetic groups.

Important and relevant phylogenetic studies include, Macey et. al. (1998, 2000a, 2000b, 2004, 2006), Moody (1980), Rastegar-Pouyani and Nilson (2002) and others.

Macey and others have also cited numerous important studies on similar and related genera as well as geological studies to infer divergence times of the relevant species groups within *Laudakia* (*sensu lato*, as in including *Ploceoderma*).

The final result of these studies in terms of the taxonomic placements used in this paper is perhaps best seen in Macey et. al. (2006), Fig. 2., page 884, which sees five main phylogenetic groups (including *Phrynocephalus* and excluding *Acanthocercus*) for *Laudakia sensu lato*.

As mentioned by Henle (1995), there is the available name *Ploceoderma* for the species taxon *stellio*. However for the so-called *caucasia-group* and the species *sacra*, there are no available genus names.

To resolve the situation, there are only two alternatives. One is to maintain all within *Laudakia*, but that would necessitate the merging of the widely used *Phrynocephalus* back into *Laudakia*. This is not tenable or consistent with the allocation of agamids within other genera based on similar divergences.

The second and eminently sensible alternative is to maintain *Phrynocephalus* as separate from *Laudakia* and to similarly subdivide the other four groups into genera, using the available names for two and assigning names to the other two.

This is done below.

The other two unnamed groups are formally named according to the Zoological Code (Ride et. al. 1999) within this paper. These are *Adelynkimberleyea* gen. nov. for the *caucasia* group and *Jackyindigoea* gen. nov. for the species taxon *sacra*.

Important studies relevant to species within the four genera *Laudakia* Gray, 1845, *Ploceoderma* Blyth, 1854, *Adelynkimberleyea* gen. nov. and *Jackyindigoea* gen. nov. include, Abo-Taira et. al. (1996), Aghili et. al. (2010), Almog et. al. (2005), Al-Quran (2009), Ananjeva and Atajev (1984), Ananjeva and Kalyabina-Hauf (2006), Ananjeva and Orlov (2005), Ananjeva and Orlova (1979), Ananjeva and Peters (1982), Ananjeva and Tuniev (1994), Ananjeva et. al. (1981, 1990), Anderson (1872), Anderson (1963, 1999), Anderson and Leviton (1969), Andersson (1900), Bahuguna (2008), Baier et. al. (2009), Baig (1988, 1989, 1999), Baig and Böhme (1989),

Bar and Haimovitch (2012), Baran et. al. (2001), Barts and Wilms (2003), Berger-Dell'mour (1986), Beutler and Frör (1980), Bird (1936), Blanford (1874, 1875, 1876), Blyth (1854a, 1854b), Boulenger (1885, 1890), Boulenger et. al. (1907), Brammah et. al. (2010), Broggi (1978), Cheatsazan et. al. (2008), Clark et. al. (1966), Crochet et. al. (2006), Cuvier (1831), Daan (1967), Damhoureyeh et. al. (2009), de Filippi (1843, 1867), Dieckmann (2010), Dodsworth (1913), Duméril and Bibron (1837), Dujsebayaeva et. al. (2007), Eichwald (1831), El-Toubi (1947), Engelmann et. al. (1993), Ficotela et. al. (2010), Fitzinger (1843), Forcart (1950), Freynik (2010), Frommer (2009), Frynta et. al. (1997), Göcmen et. al. (2003), Golubev (1998), Gorman and Shochat (1972), Gruber and Fuchs (1977), Günther (1860), Haas (1951), Haas and Werner (1969), Hall (2009), Heidari et. al. (2010), Hillmann (2003), Honda et. al. (2000), Ilgaz et. al. (2005), Khan (2012), Leviton et. al. (1992), Linnaeus (1758), Lorenz (2006, 2011), Manthey and Schuster (1999), Marx (1976), Minton (1996), Mishagina (2004, 2005), Müller (2006), Murthy (2010), Nevo (1981), Nikolsky (1896, 1897a, 1897b, 1915), Panov and Zykova (1995, 1998), Parker (1935), Roitberg et. al. (2000), Schlüter (2010, 2011), Schmidt (1926, 1939), Sindaco and Jeremcenko (2008), Sindaco et. al. (2000), Smith (1935), Sowig (1989), Stoliczka (1871, 1872), Szczerbak (2003), Thieme (1980), Trapp (2006), Tuniyev et. al. (1991), Venugopal (2010), Waltner (1975), Werner (1897, 1899, 1917), Werner (1971, 1992), Wettstein, and Löffler (1951), Xyda (1983), Zhao (1998a, 1998b), Zhao and Adler (1993).

Phrynocephalus and *Laudakia* have been well-defined previously, so it isn't necessary to redefine them here, although for each a brief diagnosis is given.

GENUS *PHRYNOCEPHALUS* KAUP, 1825

Type species: *Lacerta caudivolvula* Pallas, 1814

Diagnosis: Similar in most respects to *Laudakia sensu lato* (including genera *Ploceoderma*, Blyth 1854 for the species *stellio*, *Adelynkimberleyea* gen. nov. for the *caucasia* group and *Jackyindigoea* gen. nov. for the species taxon *sacra*) by the lacking of an obvious tympanum (or ear drum) in that it is concealed from obvious external view.

This genus is diagnosed from similar agamids by the following suite of characters: Tympanum concealed (separates from *Laudakia*) and the body is dorsoventrally depressed (separates from all other Agamids in the region where these groups of lizards occur (Middle-east, Himalayas and nearby)).

Content of genus *Phrynocephalus*

Phrynocephalus arabicus Anderson, 1894.

Phrynocephalus axillaris Blanford, 1875.

Phrynocephalus clarkorum Anderson and Leviton, 1967.

Phrynocephalus euptilopus Alcock and Finn, 1897.

Phrynocephalus forsythii Anderson, 1872.

Phrynocephalus golubewii Shenbrot and Semyonov, 1990.

Phrynocephalus guinanensis Wang and Wang, 2009.

Phrynocephalus guttatus (Gmelin, 1789).

Phrynocephalus helioscopus (Pallas, 1771).

Phrynocephalus interscapularis Lichtenstein, 1856.

Phrynocephalus luteoguttatus Boulenger, 1887.

Phrynocephalus maculatus Anderson, 1872.

Phrynocephalus mystaceus (Pallas, 1776).

Phrynocephalus ornatus Boulenger, 1887.

Phrynocephalus persicus De Filippi, 1863.

Phrynocephalus przewalskii Strauch, 1876.

Phrynocephalus putjatai Bedriaga, 1909.

Phrynocephalus raddei Boettger, 1888.

Phrynocephalus reticulatus (Eichwald, 1831).

Phrynocephalus roborowskii Bedriaga, 1906.

Phrynocephalus rossikowi Nikolsky, 1898.

Phrynocephalus scutellatus (Oliver, 1807).

Phrynocephalus strauchi Nikolsky, 1899.
Phrynocephalus theobaldi Blyth, 1863.
Phrynocephalus versicolor Strauch, 1876.
Phrynocephalus vlangalii Strauch, 1876.

GENUS LAUDAKIA GRAY, 1845

Type species: *Agama tuberculata* Gray, 1827.

Similar in most respects to *Phrynocephalus* (described above), but with a distinct tympanum (separates it from *Phrynocephalus*) and the body is dorsoventrally depressed (separates it from all other Agamids in the region where these groups of lizards occur as in the Middle-east, Himalayas and nearby). Other genera in the region except genera *Plocoderma*, Blyth 1854 for the species *stellio*, *Adelynkimberleyea* gen. nov. for the *caucasia* group and *Jackyindigoea* gen. nov. for the species *sacra*, all formerly included in this genus have a laterally compressed body.

Laudakia is separated from the other similar genera described within this paper by having the largest dorsal scales, smaller than the ventrals and flanks with few enlarged scales and often a distinct transverse fold across nape.

The tympanum is large, superficial; fifth toe extends beyond second; caudal scales in distinct annuli.

The mid dorsum of the body may or may not have several rows of heterogeneous enlarged scales; scales of dorsal rows are keeled (instead of not keeled in *Adelynkimberleyea* gen. nov.).

The premaxilla has three teeth in this genus versus two in *Adelynkimberleyea* gen. nov..

This lizards in this genus has 15-18 molars, versus 14-15 in all other genera within *Laudakia sensu lato*.

There are usually four (rarely three) whorls in each tail segment versus three or less in other genera within *Laudakia sensu lato*. The only exception is the species *melanura* (within *Laudakia sensu stricto*) which has an inconsistent number in each segment.

Lizards with *Laudakia* are also generally of larger adult size than the lizards in the other genera.

The species within this genus are separated from genera *Plocoderma*, Blyth 1854, *Adelynkimberleyea* gen. nov. and *Jackyindigoea* gen. nov. by the diagnoses below.

Species in those genera are not listed in *Laudakia* (immediately below).

Content of genus *Laudakia*

Laudakia tuberculata (Gray, 1827) (Type species).
Laudakia nupta (De Filippi, 1843).
Laudakia dayana (Stolicza, 1871).
Laudakia fusca (Blanford, 1876).
Laudakia nuristanica (Anderson and Leviton, 1969).
Laudakia agrorensis (Stolicza, 1872).
Laudakia melanura (Blyth, 1854).
Laudakia pakistanica (Baig, 1989).

GENUS PLOCODERMA BLYTH, 1854

Type species: *Lacerta stellio* Linnaeus, 1758

Diagnosis: This genus is similar in most respects to *Phrynocephalus* (described above), but with a distinct tympanum (separates it from *Phrynocephalus*) and the body is dorsoventrally depressed (separates it from all other Agamids in the region where these groups of lizards occur (Middle-east, Himalayas and nearby), except for genera *Laudakia* and *Jackyindigoea* gen. nov. and *Adelynkimberleyea* gen. nov. (both described below).

The tympanum is large, superficial; fifth toe extends beyond second; caudal scales in distinct annuli.

This genus is monotypic for the highly variable taxon *stellio*.

It is separated from all other *Laudakia sensu lato* by the following suite of characters: A middle-sized lizard with a moderately depressed body. Total length reaches up to 35 cm,

or slightly longer. The flat and triangular head is covered with asymmetrically distributed small scales and plates. Snout is longer than the distance eye-tympanum. Spiny scales on the neck and sides of the head. The dorsum is covered with small and large scales. Ventral scales are smooth, callous glands, which are present in males, consist of 3-5 rows of modified scales in pre-cloacal position, and an isolated group of scales in the middle of abdomen, near the umbilical scar. The tail is moderately depressed in its proximal part; the distal part is rounded or slightly oval in cross-section. The scales of the tail are arranged into distinct circular segments, each consisting of two whorls of enlarged mucronate (spiny) scales. The coloration is extremely variable, depending on race, sex, age and substrate.

Distribution: Middle-east from Greece to Egypt and Saudi Arabia and countries in between.

GENUS ADELYNKIMBERLEYEA GEN. NOV.

Type species: *Stellio caucasicus* Eichwald, 1831

Diagnosis: The genus *Laudakia sensu lato* including this genus is separated from most other Agamids in the same region by the following characters: Similar in most respects to *Phrynocephalus* (described above), but with a distinct tympanum (separates it from *Phrynocephalus*). The body is dorsoventrally depressed (separates it from all other Agamids in the region where these groups of lizards occur, namely the Middle-East, Himalayas and nearby), excluding those genera formerly placed within *Laudakia sensu lato*, including *Plocoderma*, Blyth 1854 for the species *stellio*, *Laudakia* and *Jackyindigoea* gen. nov. for the species *sacra* (described below).

The tympanum is large, superficial; fifth toe extends beyond second; caudal scales in distinct annuli.

Adelynkimberleyea gen. nov. is separated from *Laudakia* and *Plocoderma* by the fact that the scales of dorsal rows are smooth (as opposed to keeled).

The premaxilla has two teeth in this genus versus three in *Laudakia*.

This lizards in this genus have 14-15 molars, versus 14-15 in *Laudakia*.

This genus is similar in most respects to *Phrynocephalus* (described above), but with a distinct tympanum (separates it from *Phrynocephalus*) and the body is dorsoventrally depressed (separates it from all other Agamids in the region where these groups of lizards occur (Middle-east, Himalayas and nearby), except for genera *Plocoderma*, *Laudakia* and *Jackyindigoea* gen. nov. (described below).

Jackyindigoea gen. nov. is separated from all other *Laudakia sensu lato* including *Adelynkimberleyea* gen. nov. by the following suite of characters: They are comparatively large lizards with a snout-vent length of 120- 150 mm and a tail length of 180-240 mm.

Gular sac is developed to a greater degree than in all other *Laudakia sensu lato*. Body scales are small and granular. The scales are not well differentiated. There is a very slight but noticeable nuchal crest on the head. It begins from the middle of the occiput and continues as a poorly

differentiated vertebral stripe. The longitudinal rows of enlarged and feebly keeled scales on the vertebral region are arranged parallel to each other. There are neither groups of enlarged scales nor separate enlarged scales on the dorsal lateral regions.

The males have a large patch of callous scales on the belly. The annuli and segmentation of the scales on the basal quarter of the tail are not prominent. On the lateral surface of the tail there are three to four annuli in each segment.

There is a small granular dark pattern on the back. The center of the back tends to have more black and toward the sides a dark golden brown dominates. The separate elements of this pattern are connected to heavily-marked diffuse transverse stripes. The narrow stripes form two rows of the dark colored scales that

continue from the neck to the tail. Overall the lizard is darkly colored but there are a few randomly scattered yellow blotches on the back. Juveniles are lighter in color tending more toward a dark golden brown with darker speckling all over the back. The dark golden brown forms bands across the back which are offset at the spine.

The tympanum is large, superficial; fifth toe extends beyond second; caudal scales in distinct annuli.

The genus *Adelynkimberleyea* gen. nov. is found from the Middle East and nearby areas, across drier parts of south-west Asia through to western China.

Etymology: Named in honor of my daughter Adelyn Kimberley Hoser, in recognition of 8 years working with Snakebusters, Australia's best reptile shows in educating countless others about reptiles.

Content of *Adelynkimberleyea* gen. nov.

Adelynkimberleyea caucasia (Eichwald, 1831) (Type species).

Adelynkimberleyea badakhshana (Anderson and Leviton, 1969).

Adelynkimberleyea bochariensis (Nikolsky, 1897).

Adelynkimberleyea erythrogastra (Nikolsky, 1896).

Adelynkimberleyea himalayana (Steindachner, 1867).

Adelynkimberleyea lehmanni (Nikolsky, 1896).

Adelynkimberleyea microlepis (Blanford, 1874).

Adelynkimberleyea mucronata (Guibe 1957).

Adelynkimberleyea papenfussi Zhao, 1998.

Adelynkimberleyea stoliczkana (Blanford, 1875).

Adelynkimberleyea wui Zhao, 1998.

AGAMATAJIKISTANENSIS SUBGEN. NOV.

Type species: *Stellio lehmanni* Nikolsky, 1896

Diagnosis: This subgenus is monotypic for the species, *Adelynkimberleyea lehmanni*. It is separated from all other lizards in the genus *Adelynkimberleyea* gen. nov. by the following suite of characters: Head and body depressed. The snout is longer than the distance between the eye-tympanum or eye with and more than two times that of tympanum diameter. Tympanum exposed, being deep and more than half the eye width. Nostril is pierced below the canthus rostralis and cannot be viewed from above, equal or more than half of nasal, separated by one or two scales from the rostral directing backwards. No gular pouch, gular plicate, upper head scales, heterogenous, subequal, usually carinated except the supraocular scales which are smooth at the anterior part of the head at the level of the anterior margin of the eye-flower shaped formation

of enlarged scales on the anterior side of the head; color is olivaceous with irregular black spots; head is uniform yellow or grey, upper parts of leg and tail usually speckled with black, but may sometimes show a banded pattern; underparts are usually yellow, usually spotted with black. The throat in live shows yield black and orange spots that may appear and then disappear. There are scales on the body with strong ridges and spines; several vertical rows of highly enlarged spinose scales; no patch on flanks; dorsolateral fold marked with enlarged spinose scales with distinct high ridges; tail segment of three; callous glands present.

There are 11-15 (supra) labials, groups of highly spinose scales present on the sides of the head and neck, preauricle constitutes a circular series; vertebral scales heterogenous, strongly keeled, vertical series of distinctly enlarged scales with distinct ridges and spines interrupted by other moderately enlarged scales; several enlarged mucronate scales randomly present; ventral scales are smooth and smaller than enlarged dorsals, gular scales smooth, 88-109 mid-body rows, limbs strong and covered with large mucronate scales. Hind limb is about equal to or more than the distance between the gular fold and the cloaca; fingers and toes compressed. Tail is depressed, but oval in cross-section. Tail sections are distinct, each

segment consists of 3 whorls of large mucronate scales; near its origin, mid-dorsal rows consist of two whorls in each segment, 22-30 scales in the first complete whorl around the tail, 3-5 rows of callous glands present in males at precloacal, there is no patch in the abdominal position in this species and not represented in females.

This species is endemic to the Pamir mountains, centered in Tajikistan. The area in which this species is distributed is approximately 137,880 square km. This species is found up to 3,400 m above sea level.

Where it is found it is a common species.

In terms of local habitats it's a montane species, inhabiting rocks, precipices, ruins, and ravines. It climbs shrubs and trees and takes refuge in cracks between rocks, voids under stones, and in burrows.

Etymology: Named after the lizard and the location where it is found.

GENUS JACKYINDIGOEA GEN. NOV.

Type species: *Agama himalayana sacra* Smith, 1935

Diagnosis: Separated from all other *Laudakia sensu lato* by the following suite of characters: They are comparatively large lizards with a snout-vent length of 120-150 mm and a tail length of 180-240 mm.

Gular sac is developed to a greater degree than in all other *Laudakia sensu lato*. Body scales are small and granular. The scales are not well differentiated. There is a very slight but noticeable nuchal crest on the head. It begins from the middle of the occiput and continues as a poorly differentiated vertebral stripe. The longitudinal rows of enlarged and feebly keeled scales on the vertebral region are arranged parallel to each other. There are neither groups of enlarged scales nor separate enlarged scales on the dorsal lateral regions.

The males have a large patch of callous scales on the belly. The annuli and segmentation of the scales on the basal quarter of the tail are not prominent. On the lateral surface of the tail there are three to four annuli in each segment.

There is a small granular dark pattern on the back. The center of the back tends to have more black and toward the sides a dark golden brown dominates. The separate elements of this pattern are connected to heavily-marked diffuse transverse stripes. The narrow stripes form two rows of the dark colored scales that continue from the neck to the tail. Overall the lizard is darkly colored but there are a few randomly scattered yellow blotches on the back. Juveniles are lighter in color tending more toward a dark golden brown with darker speckling all over the back. The dark golden brown forms bands across the back which are offset at the spine.

The tympanum is large, superficial; fifth toe extends beyond second; caudal scales in distinct annuli.

This genus is similar in most respects to *Phrynocephalus* (described above), but with a distinct tympanum (separates it from *Phrynocephalus*) and the body is dorsoventrally depressed (separates it from all other Agamids in the region where these groups of lizards occur (Middle-east, Himalayas and nearby), except for *Plocoderma*, *Laudakia* and *Adelynkimberleyea* gen. nov. (described above).

The genus is monotypic for the species *sacra*, and it is only known from the region near the type locality of Lhasa, Tibet, China.

Etymology: Named in honor of my daughter Jacky Indigo Hoser, in recognition of 8 years working with Snakebusters, Australia's best reptile shows in educating countless others about reptiles.

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