

**A New Species of *Bufo* (Anura: Bufonidae) from Myanmar (Burma), and Redescription of the Little-Known Species *Bufo stuarti* Smith 1929**

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**A new species of *Bufo* is described from the Rakhine State near the Rakhine Yoma Elephant Range in western Myanmar. This species is morphologically similar to *Bufo melanostictus*, but it is distinguished by its smaller body size at maturity, the bright breeding coloration of the males, and its advertisement call. The new species brings the total number of bufonid species known to occur in Myanmar to seven; all are referred to the genus *Bufo*. Additionally, *Bufo stuarti* Smith 1929 is redescribed from the type specimen and more recently acquired specimens from the vicinity of the type locality. Lastly, a key to the *Bufo* of Myanmar is provided.**

Recent fieldwork in western Myanmar has resulted in the discovery of a new species of bufonid that appears to be closely related to *Bufo melanostictus*. Further, the senior author during a visit to the Zoological Survey of India, Calcutta was afforded the opportunity to examine the type specimen of *Bufo stuarti*, one of the few southern Asian bufonid types that was not examined and redescribed by Dubois and Ohler (1999). *Bufo stuarti* is a little known species that has been reported only from northern Myanmar and Assam, India (Smith 1929; Frost 2002). Because of the dearth of information on the species, and because we have obtained new material from the vicinity of the type locality, “Putao Plain, N.E. Burma,” the holotype is herein redescribed with additional notes based on our newly acquired materials.

MATERIALS AND METHODS

Animals were collected by hand by the authors. Latitude and longitude were recorded using a Garmin 12 GPS with the datum set to WGS 84. Animals were euthanized and then preserved in 10% buffered formalin before being transferred to 70% ethanol. Specimens are deposited in the California Academy of Sciences (CAS). Museum symbolic codes follow Leviton et al. (1985).

Measurements were taken using digital calipers to the nearest 0.1 mm (instrumental error of  $\pm$  0.2 mm). Measurements follow Dubois and Ohler (1999). The following measurements were used in the analysis: snout vent length (SVL), head length (HL), head width (HW), jaw to nares length (MN), jaw to eye (MPE), jaw to front of eye (MAE), distance between front of eyes (IFE), distance between back of eyes (IBE), internarial space (IN), distance from eye to nares (EN), snout length (SL), nostril to tip of snout (NS), tympanum diameter (TympD), eye to tympanum distance (ET), forelimb length (FLL), hand length (HAL), first finger length (FFL), third finger length (TFL), tibia length (TL), foot length (FL), femur length (F), fourth toe length (FTL), inner metatarsal

tubercle length (IMT), outer metatarsal tubercle length (OMT), parotoid length (ParL), and parotoid width (ParW).

Ranges and means are provided in Table 1 for all of the above measurements and ratios for HL/SVL, HW/SVL, ParW/ParL, FEM/SVL, TL/FEM, OMT/IMT, EN/MN, ParL/SVL, ParW/HW are included.

Statistical analysis was carried out on measurements recorded for the lectotype of *Bufo melanostictus* (ZMB 3462), given in Dubois and Ohler 1999, and from seventeen *Bufo melanostictus* from throughout Myanmar (N=18), the new species (N=5), and *Bufo stuarti* (N=3) in the collections of the California Academy of Sciences. To eliminate the need for allometric corrections (Hayek et al. 2001), only adult specimens were included in analysis. SPSS Base 10.0 for Macintosh (SPSS Inc. 1999) was used for statistical analysis.

Calls were analyzed using Signal 3.1/RTSD 1.1 (Engineering Design 1999) software and a Kay Elemetrics DSP SonaGraph model 5500.

### SPECIES DESCRIPTION

#### *Bufo crocus* Wogan, sp. nov.

Figures 1-3

**HOLOTYPE.**— CAS 220192 adult male from Myanmar, Rakhine State, Gwa Township, Rakhine Yoma Elephant Sanctuary, Ye Bya Stream Camp, 17°41'47.0" N, 94°38'48.7" E., elev. 83 m, collected 25 April 2001 by J.B. Slowinski, G.O.U. Wogan, Htun Win, Thin Thin and Kyi Soe Lwin.

**PARATYPES** (4 specimens).— CAS 220193–220195 from Myanmar, Rakhine State, Gwa Township, Rakhine Yoma Elephant Sanctuary, Ye Bya Stream Camp, 17°41'47.0" N, 94°38'48.7" E, collected 25 April 2001 by J. B. Slowinski, G.O.U. Wogan, Htun Win, Thin Thin and Kyi Soe Lwin. CAS 220331 from Myanmar, Rakhine State, Gwa Township, Rakhine Yoma Elephant Sanctuary, 17°42'14.0" N, 94°38'54.3" E, collected 26 April 2001 by J.B. Slowinski, G.O.U. Wogan, Htun Win, Thin Thin and Kyi Soe Lwin.

**DIAGNOSIS.**— A moderately sized *Bufo*, snout-vent length in males 54.6–59.1 mm females 67.6–67.8 mm, body stout, cornified canthal, pre-orbital and post-orbital crests present, and weakly defined uncornified parietal ridges (terminology follows Dubois and Ohler 1999). *Bufo crocus* possesses a protruding snout and a subterminal mouth and its head is wider than long. It has prominent singular subarticular tubercles. Breeding males are bright yellow in coloration.

**DESCRIPTION OF HOLOTYPE** (Fig. 1).— For ease in comparison with other Asian bufonids, the description follows the format of Dubois and Ohler (1999).

(A) **SIZE AND GENERAL ASPECT:** (1) specimen of medium size (SVL 54.6 mm).

(B) **HEAD:** (2) head width (18.7 mm) is greater than head length (16.1 mm), (3) snout protruding (SL 5.9 mm), (4) canthus rostralis distinct, (5) interorbital space concave, distance between front of eyes (7.9 mm) slightly greater than half of distance between back of eyes (15.1 mm), (6) nostrils rounded, closer to tip of snout (NS 2.1 mm) than to eye (3.8 mm), (7) pupil horizontal, (8) tympanum (TYMPD 2.2 mm) ovular, verticle, distinct and located 1.0 mm from eye (ET), (9) pineal ocellus absent, (10) vomerine ridge absent, (11) tongue longer than wide, and unnotched, (12) supratympanic fold absent, (13) parotoid glands present, oval, prominent, and less than twice as long (ParL 10.7 mm) as wide (ParW 5.7 mm), (14) canthal, preorbital, supraorbital, postorbital, supratympanic and (faint) parietal ridges present.

(C) **FORELIMBS:** (16) forelimb (12.7 mm) longer than hand (11.0 mm), enlarged, (17) fingers long, (18) relative length of fingers, shortest to longest: II<I<IV<III, (19) tips of fingers rounded,



FIGURES 1–2. (1) *Bufo crocus*, holotype, CAS 220192 male; (2) *Bufo crocus*, paratype, CAS 220193 female. Photos by Hla Tun.

not enlarged, without grooves, (20) fingers without dermal fringe, webbing absent, (21) subarticular tubercles prominent, rounded, single, (22) prepollex oval; one palmar tubercle large prominent and reniform; numerous small rounded and pointed tubercles covering palm and fingers.

(D) HINDLIMBS: (23) femur (20.3 mm) and tibia (20.4 mm) of approximately equal length, (24) toes long, toe IV half the length of the femur, (25) relative length of toes shortest to longest  $I < II < V < III < IV$ , (26) tips of toes rounded, not enlarged, without grooves, (27) webbing (follows Myers and Duellman, 1982)  $I2-3III1-2 \frac{1}{2}III1\frac{1}{2}-3 \frac{1}{2}IV3 \frac{2}{3}-1 \frac{1}{2}V$ , (28) dermal fringe along toe V absent, (29) subarticular tubercles more prominent than the supernumerary tubercles, (30) inner metatarsal tubercle prominent and round (1.5 mm), (31) tarsal fold absent, (32) outer metatarsal tubercle prominent (absent from left foot), numerous tubercles on the plantar surface of the foot and toes.

(E) SKIN: (33) anterior of snout and region between eyes and anterior portion of dorsum with dense flattened keratinized warts, posterior portion of dorsum with less dense keratinized flattened warts, flank with scattered glandular warts, (34) dorso-lateral folds absent, (35) forelimb, tarsus, and leg with flattened keratinized warts, tips of fingers and toes keratinized, (36) row of keratinized warts along lower lip, rest of ventral side with glandular flattened warts, not spiculate, (37) parotoid glands present.

(F) COLORATION IN PRESERVATIVE: (38) dorsal and lateral parts of head and body are light tan, keratinized warts are black as are ridges, (39) dorsal parts of limbs are light tan, keratinized warts are black, (40) ventral parts of head body and limbs are light with indistinct dark mottling, throat region blue.

COLORATION IN LIFE: (38B) dorsal and lateral parts of head and body are bright yellow with black keratinized warts, (39B) dorsal parts of limbs are bright yellow with black keratinized warts, tips of toes and fingers are black, (40B) ventral parts of head body and limbs are white with pink, throat yellow.

(G) MALE SEXUAL CHARACTERS: (41) nuptial spines on prepollex and fingers I and II, dorsal side of finger I covered entirely, (42) inner openings of vocal sac present, round, (43) forearm enlarged.

**VARIATION WITHIN THE PARATYPIC SERIES.**— The tubercles on the hands and feet vary in number and density and prominence. The palmar tubercle is reniform or round. The subarticular tubercles of CAS 220195 are more prominent than those of the holotype.

**SKIN:** All of the paratypes agree with the description of the holotype, but the degree of black keratinizations varies. CAS 220193 and 220194 have spiculate warts on the flanks and ventral side.

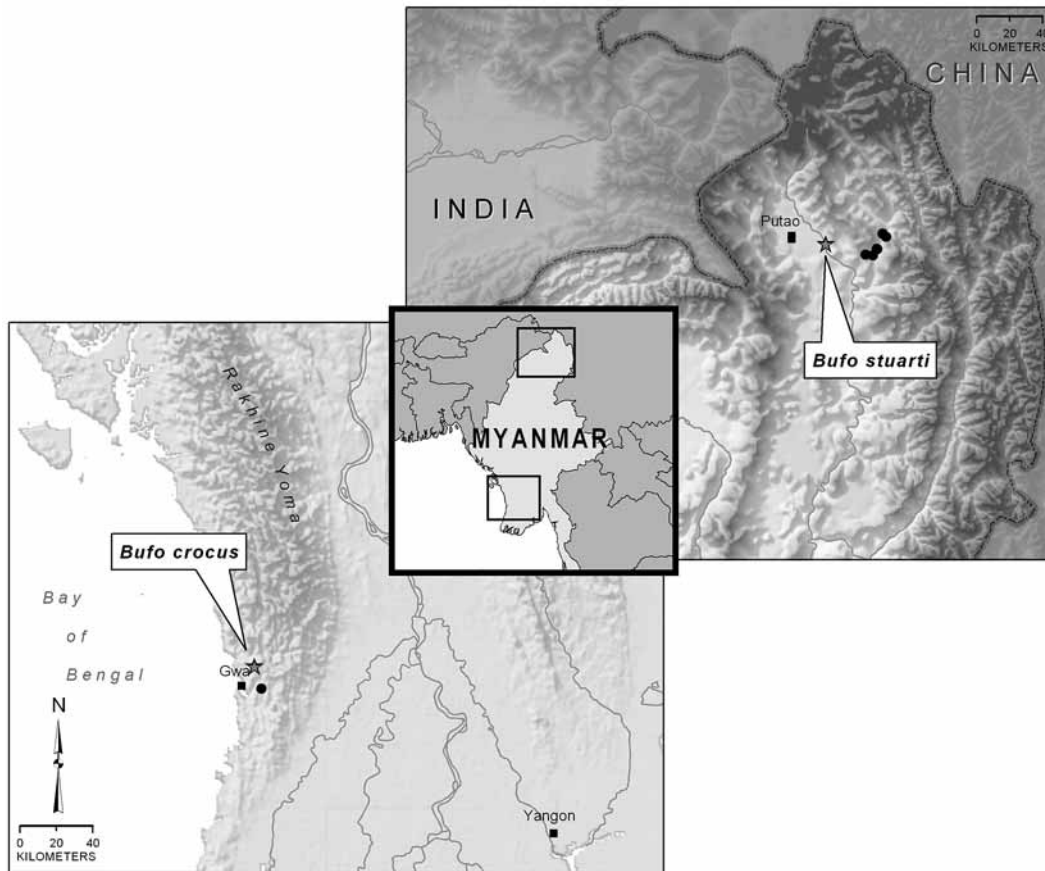


FIGURE 3. Maps with collection localities of *Bufo crocus* and *Bufo stuarti*. Collection localities of holotypes are indicated by stars.

In both of these specimens, the ventrum is almost entirely covered in minute spiculate asperities.

**COLORATION:** The other males of the paratypic series agree with the coloration of the holotype except that they are a slightly darker tan shade, and the degree of mottling on the ventrum varies. The females of this species differ markedly in coloration. In preservative (38) dorsal and lateral parts of the head and body are tan to brown, in CAS 220193 there is an indistinct pattern of black mottling intermixed with an umber background, keratinized warts are black as are ridges, (39) dorsal parts of limbs are brown, (40) ventral parts of head, body and limbs are light with dark mottling, the mottling varies in degree

In life (38B) the dorsal and lateral parts of head and body are brown with black and red marbling, (39B) dorsal parts of limbs are light brown, (40B) ventral parts of head, body, and limbs are white with dark mottling.

**NATURAL HISTORY.**— Description of habitat: *Bufo crocus* is found in primary evergreen forest. Thus far, it is known only from two localities in the Rakhine Division in Myanmar. It is expected that as additional surveys are carried out the range will be extended, however, surveys conducted to the north and south of this region have not produced any individuals of this species.

**REPRODUCTIVE BEHAVIOR.**— Males in breeding condition are bright yellow. This degree of sexual dichromatism has been observed in several other species of *Bufo*: *B. macrotis* (Taylor 1962),

*B. kisoensis* (Drewes and Vindum 1994), *B. periglenes* (Savage 1966), *B. leutkeni* (Villa 1972), *B. peripatetes* (Savage and Donnelly 1992), and *Bufo stuarti* (Smith 1940). Drewes and Vindum (1994) suggest that in voiced species (as is *B. crocus*) it is unlikely that the dichromatism plays a roll in mate selection.

Breeding occurs in congruence with the earliest rains of the monsoons, generally in late April to early May. This species is an explosive breeder, hundreds were observed after heavy rains during the night of April 26, 2001. Individuals were gathered around pooled water bodies. Males were actively calling and amplexus was observed. Neither egg deposition nor larvae were observed.

**COMPARISONS AND REMARKS.**— *Bufo crocus* differs from all of the following Asian *Bufo* belonging to the *Bufo bufo*, *Bufo viridis*, *Bufo stomaticus*, *Bufo stejnegeri*, and *Bufo orientalis* groups (*sensu* Inger 1972) in possessing cephalic crests: *B. bufo*, *B. bankorensis*, *B. gargarizans*, *B. wrighti*, *B. japonicus*, *B. minshanicus*, *B. tibetanus*, *B. viridis*, *B. calamita*, *B. raddei*, *B. surdus*, *B. latastei*, *B. luristanica*, *B. orientalis*, *B. dodsoni*, *B. stomaticus*, *B. olivaceus*, *B. dhufarensis*, *B. beddomi*. It differs from *B. asper* and *B. juxtasper* (Inger's 1972 *Bufo asper* group) in lacking a tarsal ridge. It can be distinguished from *Bufo biporcatus*, *B. divergens*, *B. philippinicus*, *B. parvus*, *B. quadriporcatus*, and *B. claviger*, the members of the *Bufo biporcatus* group (Inger 1972), through the presence of melanophores in tissue surrounding the vocal sac (Inger 1972). It is distinguished from the *B. scaber* group (Dubois and Ohler 1999) (*B. scaber*, *B. parietalis*, *B. silentvalleyensis*, *B. atukoralei*, *B. kotagamai*) in that it lacks very prominent parietal ridges.

*Bufo crocus* is tentatively placed in the *Bufo melanostictus* group based on Inger's (1972) suite of characters, but differs from all other species in this group. Included herein are comparisons with all currently recognized species from Inger's 1972 defined group (*Bufo melanostictus*, *B. parietalis*, *B. stuarti*, *B. himalayanus*), and Dubois and Ohler's (1999) redefined *Bufo melanostictus* group (*B. melanostictus*, *B. himalayanus*, *B. cyphosus*, *B. microtympnum*, *B. noellerti*, *B. stuarti*). From *Bufo stuarti*, *B. crocus* can be distinguished by its very distinct cephalic ridges, which are lacking in *B. stuarti*. From *B. microtympnum*, it differs in having a tympanum that is much larger in relation to the eye and in the absence of double distal tubercles on fingers three and four. It is readily distinguishable from *B. noellerti* both on the basis of geography, *B. noellerti* is endemic to Sri Lanka, and in the absence of a dark patch extending from the tympanum onto the flanks (see Manamendra et al. 1998); from *B. cyphosus* by the absence of symmetrical stripes on the female's ventrum (Dubois and Ohler 1999); and from *B. himalayanus* in that it possesses a distinct supratympanic cephalic crest. *Bufo crocus* differs from *B. melanostictus* in its smaller body size, in possessing weak parietal ridges and singular subarticular tubercles, and in the absence of paired warts between the parotoid glands.

Of the above species, *B. crocus* appears most similar to *Bufo melanostictus*. Besides differing in the above mentioned characters, it also differs in its call, reproductive behavior, and habitat preference. The advertisement calls of the two species differ markedly in structure, dominant frequency, duration and pattern (Figs. 4–5). The *B. melanostictus* call recorded from Myanmar is consistent with findings reported by Grosjean and Dubois (2001) in that it is comprised of a series notes made up of a variable number of pulses. The call of *Bufo crocus* consists of a series of notes without the distinct pulses.

Smith (1917), van Kampen (1923), and Church (1960) reported *Bufo melanostictus* as breeding throughout the year. Boulenger (1912) however, reported the breeding season as March and April on the Malay Peninsula. *Bufo crocus* as reported above is an explosive breeder in which breeding occurs with the earliest monsoon rains. Unlike *B. melanostictus*, it is also not commonly found outside of this breeding period. Additional searches carried out at the type locality in June of 2001, and late January 2002 yielded only one individual. Lastly, the two species are found in

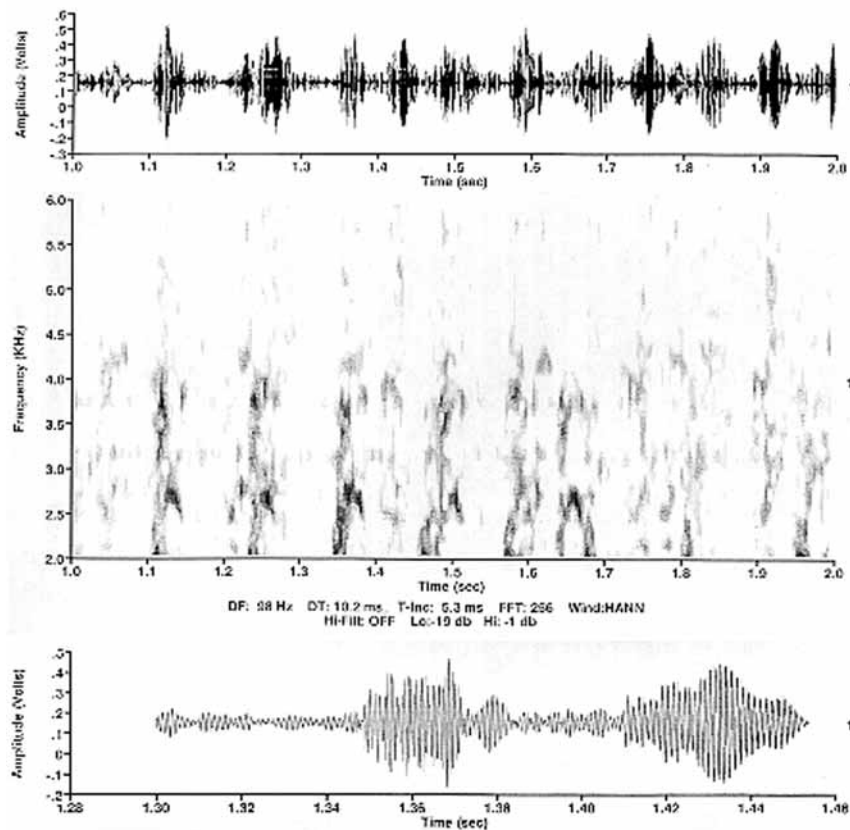


FIGURE 4. Call of *Bufo crocus* (CAS 220331) recorded on April 26, 2001 at 22:35 hrs. Temperature 28.05° C, 90% humidity after heavy rain. Myanmar. (A) spectrogram; (B) oscillogram; (C) detailed oscillogram of notes 3 and 4.

very different habitat types. *Bufo melanostictus* is primarily a commensalistic species (Inger 1966; Berry 1975; Inger et al. 1984; Dutta and Manamendra-Arachchi 1996; Dutta 1997; Inger 1997; Iskandar 1998) and *Bufo crocus* is found in primary evergreen forest.

**ETYMOLOGY.**— The specific epithet, *crocus*, is Latin for yellow or saffron. This is in reference to the bright yellow breeding coloration of the males.

#### REDESCRIPTION OF *BUFO STUARTI* SMITH, 1929

Figures 3, 6-7

In 1929, Malcolm Smith described *Bufo stuarti*<sup>1</sup>, with the type being deposited at the Zoological Survey of India in Calcutta (ZSI 19985). The following redescription of the type specimen (Fig. 6) follows the format of Dubois and Ohler 1999:

(A) **SIZE AND GENERAL ASPECT:** (1) a medium sized frog (SVL 71.3 mm) (note that difference in SVL from Smith's description (73.0 mm) may differ due to time in preservation, or the current use of a more precise measuring device).

(B) **HEAD:** (2) head of medium size, wider (26.2 mm) than long (21.9 mm) (3) snout obtuse, protruding beyond mouth, (4) canthus rostralis distinct, (5) interorbital space slightly concave, (6)

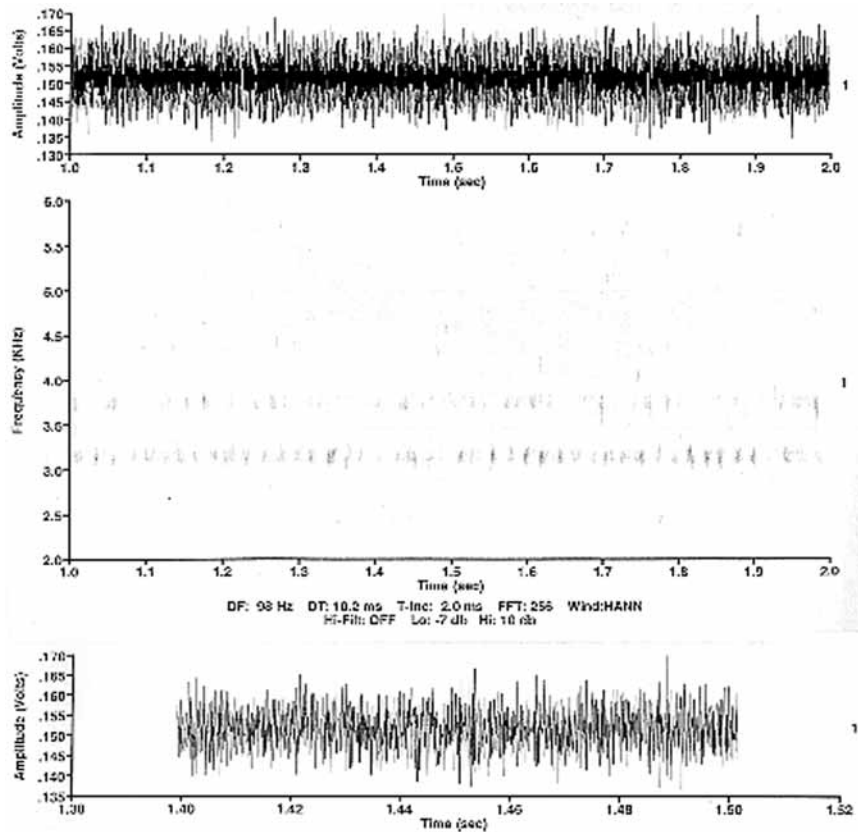


FIGURE 5. Call of *Bufo melanostictus* (USNM/field series 35608) recorded on March 2, 2002 at 21:00 hrs. Temperature 22.0° C. Myanmar. (A) spectrogram; (B) oscillogram; (C) detailed oscillogram of notes between 1.4 and 1.5 seconds.

nostrils closer to snout than eye, (7) pupil not observed, (8) tympanum 2.4 mm in diameter, oval and vertical, distinct, (9) pineal ocellus absent, (10) vomerine ridge not observed, (11) tongue not observed, (12) supratympanic fold absent, (13) parotoid glands present, reniform and long (18.4 mm), (14) cephalic ridges absent.

(C) FORELIMBS: (16) arms robust and enlarged, (17) fingers long and thin, (18) relative length of fingers 3>4>1>2, (19) tips of fingers not enlarged, rounded, grooves absent, (20) fingers without dermal fringe, (21) subarticular tubercles prominent, (22) prepollex rounded and very prominent, one prominent rounded palmar tubercle.

(D) HINDLIMBS: (23) leg measurements not recorded, (24) toes long, (25) relative length of toes 1<2<5<3<4, (26) tips of toes rounded, not enlarged without grooves, (27) webbing formulae I1-2 1/2II2-21/2III2-3IV2 1/2-1 1/2 V (28) dermal fringe along toe V absent, (29) subarticular tubercles indistinct, (30) inner metatarsal tubercle long and prominent, (31) tarsal fold absent, (32) outer metatarsal tubercle present, round and prominent; numerous tubercles on the plantar surface of the foot.

(E) SKIN: (33) head and anterior of dorsum granular, posterior of dorsum with large keratinized spiculate warts, (34) dorso-lateral fold absent, (35) dorsal parts of limbs with keratinized warts, (36) throat, chest, belly and thighs granular, (37) parotoid glands present.



FIGURES 6–7. (6) *Bufo stuarti*, holotype ZSI 19985. Photo by G.O.U. Wogan. (7) *Bufo stuarti*, CAS 224954. Photo by Hla Tun.

(F) COLORATION: (38) dorsal and lateral parts of the head and body are tan olive with brown on warts, (39) dorsal parts of limbs are tan olive, (40) ventral parts of head, body, and limbs are whitish tan.

(G) MALE SEXUAL CHARACTERS: (41) nuptial spines present on digits I, II, III (42) vocal sacs present.

Recent herpetological surveys made in the vicinity of the type locality have yielded three adult *Bufo stuarti* (Fig. 5). Herein I include these specimens in order to provide a more thorough description of *B. stuarti*. Ranges and means are provided in Table 1.

Additional observations on the recent specimens: (5) interorbital space distinctly concave, (7) pupil horizontal (Fig. 7), (10) vomerine ridge absent, (11) tongue not emarginate, (13) parotoid glands of CAS 224954 have a slightly triangular shape, CAS 221317 and 221439 are elongate and approximately twice as long as wide, (30, 32) measurements of the inner and outer metatarsal tubercles show that the outer metatarsal tubercle is larger, (33) the dorsal and lateral parts of the head and body of CAS 221317 and CAS 224954 are more coarsely granular and warty, however, CAS 224954 lacks asperities on the head, (34) dorsal parts of limbs are very granular with large asperities and warts, (38) CAS 221317 dorsal and lateral parts of the head and body are dark brown to tan, with a faint mid-dorsal line, parotoids umber, sides are white with tan and dark brown warts. CAS 224954 dorsal and lateral parts of the head and body are dark brown to umber with a black w shaped pattern, black triangular mark between eyes, faint mid-dorsal line, parotoids umber, (39) CAS 221317 and CAS 224954 dorsal parts of limbs are barred with light tan, (40) CAS 221317 ventral surfaces of head, body, and limbs light with dark brown mottling varying in density, CAS 224954 is heavily mottled with dark brown on a light tan background.

<sup>1</sup> Original description (Smith 1929): “Adult male collected on the Putao plain, N.E. Burma, near the Tibetan frontier by Dr. Murray Stuart, after whom it is named. Habit like that of *B. melanostictus*. Crown without bony ridge; snout as long as the upper eyelid, prominent, projecting forwards beyond the lower jaw; canthus rostralis distinct; loreal region almost verticle; interorbital space a little broader than the upper eyelid; tympanum distinct, half the diameter of the eye. First finger a little longer than second, third finger nearly twice as long as second; two well marked carpal tubercles, the outer larger and flatter than the inner. Toes half webbed, the membrane not reaching the tips of the third and fifth toes, subarticular tubercles, not very prominent; no tarsal fold, two well marked metatarsal tubercles. The tarso-metatarsal articulation reaches to the tip of the snout; the heels meet when the legs are folded at right angles to the body. Skin of the head fairly smooth, of the back and limbs above with smooth warts of moderate size. Parotoids well developed, elongate, twice as long as broad, parallel with each other. Skin of the lower parts coarsely granular. Nuptial asperities on the inner three fingers. Pale olive above, uniform; brownish-white below. From snout to vent 73 mm. *Bufo stuarti* is closely related to *B. stomaticus* Lutken from which it can be distinguished by the more prominent snout, the strong canthal ridges and by the absence of a tarsal fold.”



TABLE 1. Means and ranges for morphometric characters.

Character state	<i>Bufo crocus</i>			<i>Bufo crocus</i>			<i>Bufo melanostictus</i>			<i>Bufo melanostictus</i>			<i>Bufo stuarti</i>	<i>Bufo stuarti</i>		
	males (N=3)			females (N=2)			males (N=9)			females (N=9)			male	females (N=2)		
	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.		Min.	Mean	Max.
SVL	54.6	<b>56.533</b>	59.1	67.6	<b>67.7</b>	67.8	70.5	<b>77.878</b>	93.4	67.8	<b>91.644</b>	150.4	60.7	61.0	<b>68.6</b>	76.2
HL	16.1	<b>17.233</b>	18.0	19.2	<b>19.35</b>	19.5	21.7	<b>23.867</b>	28.5	20.7	<b>28.611</b>	46.1	17.2	17.0	<b>18.95</b>	20.9
HW	18.7	<b>20.567</b>	21.5	24.2	<b>24.2</b>	24.2	27	<b>30.822</b>	38.9	26.2	<b>36.122</b>	62.2	21.6	23.3	<b>25.05</b>	26.8
MN	13.6	<b>15.033</b>	16.9	16.0	<b>16.4</b>	16.8	18.6	<b>20.222</b>	23.1	16.8	<b>24.611</b>	37.3	14.2	13.9	<b>16.0</b>	18.1
MPE	5.4	<b>6.0</b>	6.5	6.0	<b>6.35</b>	6.7	5.8	<b>7.956</b>	11.5	4.9	<b>11.233</b>	18.5	3.6	4.0	<b>5.3</b>	6.6
MAE	11.2	<b>11.567</b>	11.8	11.9	<b>12.25</b>	12.6	15.2	<b>16.244</b>	18.1	12.0	<b>18.711</b>	28	10.4	9.9	<b>11.5</b>	13.1
IFE	7.5	<b>7.767</b>	7.9	8.9	<b>9.05</b>	9.2	8.0	<b>9.911</b>	14.3	7.2	<b>11.311</b>	18.8	8.2	8.1	<b>8.8</b>	9.5
IBE	15.1	<b>16.0</b>	16.5	17.7	<b>18.45</b>	19.2	17.9	<b>20.789</b>	25.7	17.4	<b>22.822</b>	35.7	15.6	15.9	<b>17.0</b>	18.1
IN	2.6	<b>3.233</b>	3.8	4.2	<b>4.2</b>	4.2	3.5	<b>4.522</b>	6.0	3.1	<b>5.244</b>	8.7	3.6	3.5	<b>3.9</b>	4.3
EN	3.8	<b>4.867</b>	6.8	4.5	<b>4.55</b>	4.6	4.1	<b>4.744</b>	5.9	3.7	<b>5.667</b>	8.3	3.7	4.1	<b>4.7</b>	5.3
SL	5.9	<b>6.567</b>	7.1	8.4	<b>8.5</b>	8.6	6.9	<b>8.278</b>	10.4	7.0	<b>9.5</b>	15.9	6.5	6.2	<b>7.1</b>	8.0
NS	2.1	<b>2.3.0</b>	2.6	2.7	<b>2.75</b>	2.8	2.1	<b>2.867</b>	4.3	2.0	<b>3.111</b>	5.6	6.5	2.2	<b>4.2</b>	6.2
TYMPD	2.1	<b>2.433</b>	3.0	2.9	<b>3.3</b>	3.7	4.2	<b>5.027</b>	6.1	4.2	<b>5.211</b>	7.2	2.2	1.7	<b>2.45</b>	3.2
ET	1.0	<b>1.067</b>	1.2	1.5	<b>1.55</b>	1.6	0.8	<b>1.727</b>	2.5	1.4	<b>3.011</b>	6.2	1.2	1.4	<b>1.65</b>	1.9
PAROTW	5.7	<b>6.233</b>	6.8	7.9	<b>7.9</b>	7.9	6.8	<b>8.0</b>	9.5	5.6	<b>7.144</b>	11.0	13.4	10.9	<b>12.35</b>	13.8
PAROTL	10.7	<b>11.133</b>	11.4	11.9	<b>12.4</b>	12.9	14.1	<b>16.878</b>	21.1	13.8	<b>21.211</b>	37.2	5.3	6.4	<b>14.25</b>	22.1
FLL	12.7	<b>13.3</b>	13.9	15.3	<b>15.95</b>	16.6	16.1	<b>18.711</b>	25.2	14.4	<b>20.389</b>	29.7	16.1	16.3	<b>18.15</b>	20.0
HAL	11.0	<b>13.2</b>	14.8	15.8	<b>16.0</b>	16.2	16.0	<b>18.478</b>	21.2	15.7	<b>21.3</b>	34.5	15.9	15.4	<b>17.9</b>	20.4
TL	20.4	<b>20.9</b>	21.3	24.7	<b>24.8</b>	24.9	25.5	<b>29.944</b>	36.0	24	<b>32.564</b>	51.7	25.8	24.9	<b>28.45</b>	32.0
FL	20.3	<b>21.3</b>	22.3	23.7	<b>23.85</b>	24	25.8	<b>28.589</b>	32.4	22.2	<b>31.878</b>	52.8	26.3	24.7	<b>28.55</b>	32.4
FEMEM	20.3	<b>21.567</b>	22.8	24.6	<b>26.35</b>	28.1	28.4	<b>33.175</b>	41.5	24.7	<b>34.811</b>	55.8	26.8	25.7	<b>26.15</b>	26.6
IMT	1.5	<b>2.033</b>	2.5	2.5	<b>2.55</b>	2.6	1.4	<b>3.311</b>	4.3	2.1	<b>3.922</b>	6.6	3.2	2.5	<b>3.5</b>	4.5
OMT	0.6	<b>1.2.0</b>	1.8	1.7	<b>1.8</b>	1.9	2.1	<b>2.916</b>	4.1	2.3	<b>2.967</b>	4.0	3.8	3.7	<b>3.75</b>	3.8
MPMAE	0.48	<b>0.5181</b>	0.55	0.5	<b>0.518</b>	0.53	0.37	<b>0.4885</b>	0.66	0.36	<b>0.6375</b>	1.54	0.35	0.4	<b>0.4539</b>	0.5
HLSVL	0.29	<b>0.3049</b>	0.32	0.28	<b>0.2858</b>	0.29	0.29	<b>0.3064</b>	0.32	0.3	<b>0.3132</b>	0.33	0.28	0.27	<b>0.2765</b>	0.28
HWSVL	0.34	<b>0.3636</b>	0.38	0.36	<b>0.3575</b>	0.36	0.37	<b>0.3945</b>	0.43	0.37	<b>0.3927</b>	0.41	0.36	0.35	<b>0.3668</b>	0.38
PWPL	0.53	<b>0.5593</b>	0.6	0.61	<b>0.6381</b>	0.66	0.42	<b>0.4753</b>	0.52	0.27	<b>0.349</b>	0.43	2.53	0.49	<b>1.3247</b>	2.16
FEMSVL	0.37	<b>0.3817</b>	0.41	0.36	<b>0.3892</b>	0.41	0.4	<b>0.4203</b>	0.45	0.36	<b>0.3813</b>	0.42	0.44	0.35	<b>0.3852</b>	0.42
TLFE-	0.93	<b>0.9705</b>	1.0	0.89	<b>0.9451</b>	1.0	0.87	<b>0.9234</b>	0.99	0.89	<b>0.9379</b>	0.97	0.96	0.97	<b>1.0859</b>	1.2
OMTIMT	0.4	<b>0.5638</b>	0.72	0.68	<b>0.7054</b>	0.73	0.22	<b>0.7531</b>	1.08	0.61	<b>0.7962</b>	1.14	1.19	0.82	<b>1.1711</b>	1.52
ENMN	0.27	<b>0.3186</b>	0.4	0.27	<b>0.2775</b>	0.28	0.21	<b>0.234</b>	0.26	0.21	<b>0.2316</b>	0.27	0.26	0.29	<b>0.2939</b>	0.29
PLSVL	0.19	<b>0.197</b>	0.2	0.18	<b>0.1832</b>	0.19	0.2	<b>0.2162</b>	0.23	0.2	<b>0.2294</b>	0.29	0.09	0.1	<b>0.1975</b>	0.29
PWHW	0.29	<b>0.3032</b>	0.32	0.33	<b>0.3264</b>	0.33	0.24	<b>0.26</b>	0.29	0.16	<b>0.2016</b>	0.23	0.62	0.41	<b>0.4995</b>	0.59

## DISCUSSION

Despite the taxonomic confusion within the Asian Bufonidae and particularly the genus *Bufo*, recent work (Dubois & Ohler 1999; Macey et al. 1998; Liu et al. 2000) has started to untangle the confusion surrounding these taxa. The taxonomic position of *Bufo stuarti* has remained uncertain because of its rarity in collections. Inger (1972) originally placed it in the *Bufo melanostictus* group thereby indicating the presence of cephalic ridges, however, Smith (1929) mentions a similarity with *Bufo stomaticus* in the original description (refer to footnote 1). In our examination of the type

and subsequent collections, no cephalic ridges were found. We suggest that additional studies should be undertaken before reassigning it to a different species group. *Bufo crocus* as mentioned previously is tentatively assigned to the *Bufo melanostictus* group based on the prescribed suite of characters from Inger's 1972 designation. Its taxonomic position, however, is uncertain pending additional analysis.

As the Myanmar Herpetological Survey moves into new areas, assuredly new and interesting bufonids will be found in Myanmar. To date, no representatives of the genera *Ansonia*, *Leptophryne*, and *Pedostibes* have been found within Myanmar, although each has been reported in neighboring countries. Frost (2002), for instance, suggests that at least three bufonid species, two of *Ansonia* (*A. penangensis*, *A. malayana*) and one *Leptophryne* (*L. borbonica*) should occur in Myanmar. In addition, as work is carried out on widespread composite species, such as *Bufo melanostictus*, it is likely that additional species masquerading under this name will be discovered within Myanmar.

#### KEY TO THE *BUFO* OF MYANMAR

1. Cephalic ridges present . . . . . 2  
Cephalic ridges not present . . . . . 3
2. Cephalic ridges run parallel to parotoids . . . . . *B. parvus*  
Cephalic ridges not parallel . . . . . 5
3. Tympanum distinct . . . . . 4  
Tympanum not visible . . . . . *B. burmanus*<sup>2</sup>
4. Tympanum of equal size to eye, parotoids small and round . . . . . *B. macrotis*  
Tympanum much smaller than eye, parotoids elongate . . . . . *B. stuarti*
5. Tarsal ridge present, supratympanic ridges prominent . . . . . *B. asper*  
Tarsal ridge absent . . . . . 6
6. Adult size, 62–150 mm; paired dorsal warts between parotoid glands . . . . . *B. melanostictus*  
Adult size, 54–67 mm; paired warts between parotoid glands absent . . . . . *B. crocus*

#### MATERIAL EXAMINED

*Bufo andrewsi*: China, CAS 214911–214915, Yunnan Province, Nu Jiang Prefecture, village S of Gongshan, 27°42'13.7" N, 98°42'10.2" E, ca 1451 m.

*Bufo asper*: Malaysia, CAS-SU 14833, Pinang; Thailand, CAS 73689, Sritamarat, Nakon; Myanmar, CAS 222196, Mon State, Kyaik Hto Township, Kyaik-Hti-Yo Wildlife Sanctuary, tributary of Moe Baw Chaung, 17°29'48.5" N, 97°04'49.6" E.

*Bufo bufo*: China, CAS 16484–16487, Shanghai.

*Bufo burmanus*: Myanmar, MCZ 23440–23444, Chin State

*Bufo crocus*: Myanmar, CAS 220192–220195, Rakhine State, Gwa Township, Rakhine Yoma Elephant Sanctuary, Ye Bya stream camp, 17°41'47.0" N, 94°38'48.7" E; CAS 220331, Rakhine State, Gwa Township, Rakhine Yoma Elephant Sanctuary, 17°42'14.0" N, 94°38'54.3" E; CAS

<sup>2</sup> *Bufo burmanus* is maintained in this key in accordance with Frost 2002, but it should be noted that Dubois and Ohler (1999) synonymized this species with *B. pageoti*. *B. burmanus* is known only from Myanmar and has not been obtained in recent collections.

222923, Rakhine State, Gwa Township, Rakhine Yoma Elephant Wildlife Sanctuary, 17°35'03.9" N, 94°40'52.6" E; CAS 222970, Rakhine State, Gwa Township, Daung stream, 17°35'03.9" N, 94°40'52.6" E.

*Bufo dhufarensis*: Saudi Arabia, CAS 134168–134169, vicinity of Matri and Khasawiyah [16°58' N., 42°42' E – 16°56' N, 42°37' E], 20–25 m.

*Bufo gargarizans*: China, CAS 194198–194201, Anhui Province, Luan Prefecture, 23 km SW and 10 km south of Yanzhihe, also 20 km WSW of Manshuihe (31°08' N, 116°01' E), Beimazhei.

*Bufo himalayanus*: China, CAS 177560–177568, Xizang (Tibet) Autonomous Region, Xigaze Prefecture, between Chinese check point at Zhangmu (Khasa) [28°07' N, 85°59' E] and the Nepal border on the Lhasa-Kathmandu Rd., 2100–2300 m.

*Bufo macrotis*: Myanmar, CAS 213551–213558, Yangon Division, Hlaw Ga Park, Mingalardon Township, 17°02'08.2" N, 96°06'00.6" E.

*Bufo melanostictus*: Myanmar, CAS 205186–205187, Rakhine State, Gwa Township, ca 300 m E of Pleasant Beach Resort, 17°43'28.8" N, 94°32'36.1" E; CAS 222981, Rakhine State, Taung Gok Township, Taung Gok Town, 18°50'31.8" N, 94°12'31.8" E, 11 m; CAS 213763, Magwe Division, Shwe Set Taw Wildlife Sanctuary, Pwint Byu Township, Oak Pho Camp, 20°19'38.5" N, 94°34'27.1" E; CAS 213621, Magwe Division, Shwe Set Taw Wildlife Sanctuary, Mimbu (Sagu) Township, 20°03'34.3" N, 94°35'37.7" E; CAS 220562, Magwe Division, Saw Township, Saw Town, Forest Department office, 21°08'52.9" N, 94°09'36.6" E; CAS 219956–219957, Chin State, Min-Dat District, Kanpetlet Township, Nat Ma Taung National Park, Saw stream, 21°10'16.0" N, 94°04'26.1" E; CAS 219775, Ayeyarwady Division, Pya Bon District, Bogalay Township, Mein Ma Hla Kyun Wildlife Sanctuary, West Htaung Pai Camp, 15°51'06.3" N, 95°18'40.6" E; CAS 213880, Magwe Division, Shwe Set Taw Wildlife Sanctuary, Lap Pan Taw Camp, Minbu (Sagu) Township, 20°06'56.1" N, 94°36'38.4" E.

*Bufo microtypanum*: India, CAS 94446, 12.9 km NE of Munnar; CAS 104227–104228, India, Madras State, Palni Hills, Kodaikanal.

*Bufo orientalis*: Saudi Arabia, CAS 139542–139543, near Al Hada at 20°22' N, 40°16' E, ca 2000 m.

*Bufo parvus*: Malaysia, CAS-SU 3242–3243, Perak; CAS-SU 3237, Perak, Gunong Kledang.

*Bufo pentoni*: Saudi Arabia, CAS 119214, Al Lith, 20°09' N, 40°17' E, ca 20 m.

*Bufo raddei*: China, CAS 166809–166819, Ningxia Hui Autonomous Region, Yinnan Prefecture, along the south shore of the Yellow River (Huang He), Shenjiatan (37°28' N, 105°18' E).

*Bufo scaber*: Sri Lanka, CAS 85271, India, CAS 104139, Madras State, Kanyakumari District (Cape Comorin District) Mylaudi Village, 4 mi. W. Jamestown.

*Bufo stomaticus*: Afghanistan, CAS 96172, Khost; Nepal, CAS-SU 15315, above Tambur River.

*Bufo stuarti*: Myanmar, CAS 221436, Kachin State, Putao District, Naung Mon Township, Aureinga Camp, 27°17'36.4" N, 97°51'50.0" E; CAS 221432, Kachin State, Putao District, Naung Mon Township, Aureinga Camp, 27°17'32.4" N, 97°51'56.4" E; CAS 221317, Kachin State, Putao District, Machanbaw Township, Ahtonga Village, 27°15'41.8" N, 97°48'06.9" E; CAS 221485, Kachin State, Putao District, Machanbaw Township, rd between Ahtonga and Babaw, 27°15'27.2" N, 97°50'32.4" E; CAS 224954, Kachin State, Putao District, Ba Bawt Village, 27°21'33.4" N, 97°54'56.1" E, 640 m; CAS 224955, Kachin State, Putao District, Ba Bawt Village, 27°22'39.3" N, 97°53'46.7" E, 556 m; ZSI 19958, "Putao Plain, N. Myanmar" (Kachin State).

*Bufo surdus*: Iran, CAS 158247, Seistan and Baluchestan Province, W slope of Kuh-e-Taftan, 2250 m.

*Bufo viridis*: Turkey, CAS 217837–217845, Icel Province, Anamur, 36°04'17.7" N, 32°52'03.4" E, 6 m.

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