The Natural History Journal of Chulalongkorn University 4(1): 1-13, April 2004

The Recent Distribution of *Rana milleti* Smith, 1921 in Mainland Southeast Asia with the First Record of Cambodia

YODCHAIY CHUAYNKERN[1]*, ANNEMARIE OHLER[2], CHANTIP INTHARA[3], PONNARIN KUMTONG[4] AND ALAIN DUBOIS[2]

[1] *Thailand Natural History Museum, National Science Museum, Technopolis,Khlong 5, Khlong Luang, Pathum Thani 12120 THAILAND*
[2] *Laboratoire des Reptiles et Amphibiens, Muséum National d'Histoire Naturelle, 25 rue Cuvier, F-75005 Paris, FRANCE*
[3] *Department of Biology, Faculty of Science, Khon Kaen University, Khon Kaen 40002 THAILAND*
[4] *Khao Ang Rui Ni Wildlife Sanctuary, P.O. Box 4, Sanam Chaiket, Chachoengsao 24160 THAILAND*

ABSTRACT.–**Fourteen specimens of frogs are examined to clarify their identity. These frogs were collected from Cambodia (1 frog) and Thailand (13 frogs). All these frogs belong in *Rana milleti* Smith, 1921 the recent distribution of which is as follow: Cambodia: Phnom Aural in the Phnom Aural Wildlife Sanctuary, Kampong Speu Province, Southwest Cambodia; Thailand: Khao Yai, Nakhon Ratchasima Province, Ubon Ratchathani Province and Khao Ang Rui Ni Wildlife Sanctuary, Chachoengsao Province; Vietnam: Da Lat, Dran, Langbian Peak, Boun Luoi, Tram Lap and Kon Cha Rang.**

KEY WORDS: First record; *Rana milleti*; Cambodia; Thailand; Vietnam

INTRODUCTION

The Dalat Frog *Rana milleti* Smith, 1921 was described on the basis of the ten syntypes (BMNH 1947.2.1.37-1947.2.1.46 corresponding to MAS 2571, 2600, 2602, 4818, 5103, 5107, 5119, 5128, 5129, 5176) from Đà Lạt [Dalat] (108°35' E, 11°51' N, alt. 1460 m), Đran [Dran] (108°35' E, 11°51' N, alt. 1150 m), Lang Bian Nui [Lang Bian Peak] (108°30' E, 12°05' N, 1875 m), Tinh Lâm Đông, Vietnam by Smith in 1921. Inger et al. (1999) added to the distribution of this species Boun Luoi (alt. 700-750 m), Tram Lap (alt. 900 m) and Kon Cha Rang (alt. 1000-1200 m) near Kannack (108°36' E, 14°20' N) from Tinh Gia Lai, Vietnam. The first record of this species in Thailand came from Chan-ard (2003) in two provinces, Nakhon Ratchasima and Ubon Ratchathani. These records constitute the previously known distribution of the Dalat Frog in mainland Southeast Asia. In the publications reporting on amphibians of Cambodia by Boulenger (1882), Tirant, (1885), Flower (1896, 1899), Mocquard (1904), Bourret (1942), Frost (1985), Inger et al.(1999), Iskanda and Colijn (2000), Khonsue and Thirakhupt (2001) and Ohler et al. (2002),

* Corresponding author.
Tel: (662) 577-9999 ext. 1508
Fax: (662) 577-9991
E-mail: aong58@hotmail.com

Rana milleti was not recorded. The discovery of this species in Cambodia is very interesting because it fills up the gap between the western and eastern areas of occurrence of this species. This study confirms the presence of the Dalat Frog *Rana milleti* in Cambodia based on the specimens examined and allows to redefine the range of the species.

Rana milleti was transferred to the genus *Hylarana* by Bourret in 1939. In his 1942 book Bourret took a more conservative position and considered *Hylarana* to be a subgenus of *Rana*. Dubois (1992) created a subgenus *Sylvirana* for the brown "Hylarana" from Asia based on morphological characters and considered *Rana milleti* as a member of this subgenus.

MATERIALS AND METHODS

We examined 25 specimens of frogs preserved at the Muséum National d'Histoire Naturelle (MNHN), Paris (France) and in the Thailand Natural History Museum (THNHM), Pathum Thani (Thailand) to identify the species. Twenty-four frogs were collected from Khao Yai National Park (740-770 m, 101°50' E, 14°20' N)), Nakhon Ratchasima and Khao Ang Rui Ni Wildlife Sanctuary, Chachoengsao Province, Thailand and one frog from Phnom Aural Wildlife Sanctuary (above 700 m, 104°10' E, 12°00' N) (Kampong Speu Province, Southwest Cambodia). Of these 20 adult and subadult specimens were compared in external characters and morphometry with three species of the subgenus *Sylvirana*, *Rana faber* Ohler, Swan and Daltry, 2002, *Rana mortenseni* Boulenger, 1903 and *Rana nigrovittata* (Blyth, 1855) which occur in southern Indochinese region. The specimen MNHN 2001.0262, designated as *Rana faber* in Ohler et al. (2002), was re-studied and included in this study. To confirm identity of Thai frogs we studied the syntypes of *Rana milleti* from the Natural History Museum in London. The measurements of hundred and two specimens of frogs of four species were taken with slide calliper to 0.1 mm accuracy for measurements larger than 5 mm and with ocular micrometer with an accuracy of 0.01 mm for measurements smaller than 5 mm. Morphometrical analysis used SPSS statistical programs (Tables 1 and 2). The comparisons, the description's methodology and plan used the same and following works: Ohler (1995, 1996), Ohler and Dubois (1989, 1999), Dubois and Ohler (1998, 1999, 2000, 2001), Ohler et al. (2000, 2002), Bossuyt and Dubois (2001), Dubois et al. (2001), Veith et al. (2001).

The following abbreviations are used for measurements: SVL: snout vent length.

Head: HW: head width; HL: head length (from the back of the mandible to the tip of snout); MN: distance from the back of the mandible to the nostril; MFE: distance from the back of the mandible to the front of the eye; MBE: distance from the back of the mandible to the back of the eye; IFE: distance between the front of the eyes; IBE: distance between the back of the eyes; IN: internarial space; EN: Distance from the front of the eye to the nostril; EL: eye length; SN: distance from the nostril to the tip of the snout; SL: distance from the front of the eye to the tip of the snout; TYD: greatest tympanum diameter; TYE: distance from tympanum to the back of the eye; IUE: minimum distance between upper eyelids; UEW: maximum width of inter upper eyelid.

Forearm: HAL: hand length (from the base of the outer palmar tubercle to the tip of the toe); FLL: forelimb length (from the elbow to the base of the outer tubercle); TFL: third finger length (from the base of the first subarticular tubercle); fd1-fd4: width of pads of finger 1 to 4; fw1-fw4: width of fingers 1 to 4;

Hindlimb: FL: femur length (from vent to knee); TL: tibia length; FOL: foot length (from the base of the inner metatarsal tubercle to the tip of the toe); FTL: fourth toe length (from the base of the first subarticular tubercle to the tip of the toe); td1-td5: width of pads of the toes 1

to 5; tw1 to tw5: width of toes 1 to 5; IMT: length of inner metatarsal tubercle; ITL: inner toe length. Webbing: MTTF: distance from the distal edge of the metatarsal tubercle to the maximum incurvation of the web between third and fourth toe; TFTF: distance from the maximum incurvation of the web between third and fourth toe to the tip of the fourth toe; MTFF: distance from the distal edge of the metatarsal tubercle to the maximum incurvation of the web between fourth and fifth toe; FFTF: distance from the maximum incurvation of the web between fourth and fifth toe to the tip of fourth toe; WTF: webbing between third and fourth toe (from the base of the first subarticular tubercle); WFF: webbing between fourth and fifth toe (from the base of the first subarticular tubercle); WI: webbing between third and fourth toe when folded along fourth toe (from the base of the first subarticular tubercle); WII: webbing between fourth and fifth toe when folded along fourth toe (from the base of the first subarticular tubercle).

Museum abbreviations:-BMNH: Natural History Museum, London, United Kingdom; MAS, Malcolm A. Smith collection; MNHN: Muséum National d'Histoire Naturelle, Paris, France; THNHM: Thailand Natural History Museum, Pathum Thani, Thailand.

TABLE 1. Measurements (mm), means and standard deviations for specimens of *Rana milleti* from Vietnam (Syntypes and Topotypes), Khao Yai (Nakhon Ratchasima Province) and Khao Ang Rui Ni Wildlife Sanctuary in Thailand compared to specimen collected from Cardamom Mountains in Cambodia. SVL measurements are given in mm, other measurements are presented in per thousands of SVL. Ad. adult; Juv. juvenile; Ma. male; Fem. female.

Measurement	Vietnam		Thailand			Cambodia
	Langbian Plateu, Lam Dong Thin		Khao Yai, Nakhon Ratchasima Province		Khao Ang Rui Ni Wildlife Sanctuary, Chachoengsao Province	Cardamom Mountains
	Ad. Ma. N=11	Ad. Fem. N=7	Ad. Ma. N=14	Juv. Ma. N=5	Ad. Fem. N=1	Ad. Ma. N=1
SVL	35.1±1.51 (32.6-37.9)	45.9±1.81 (42.7-47.8)	40.0±1.14 (38.3-41.7)	35.12±2.86 (32.7-39.1)	49.4	39.5
RHW	346±12.5 (318-363)	323±9.5 (310-336)	303±11.0 (288-327)	321.79±21.61 (287-339)	318	327
RHL	390±10.2 (375-407)	375±17.0 (354-401)	381±9.1 (367-394)	409.23±20.55 (375-428)	381	394
RFLL	214±10.5 (202-238)	208±10.0 (191-222)	214±7.7 (204-232)	253.05±12.55 (236-269)	209	213
RHAL	266±9.0 256-285	262±11.0 (251-282)	279±8.3 (266-294)	219.48±10.48 (205-234)	261	294
RTL	539±15.0 (521-560)	544±23.4 (506-574)	555±22.4 (528-618)	154±7.95 (142-163)	540	618
RFOL	557±21.7 (515-586	547±22.6 (513-581)	548±21.1 (516-605)	531.69±25.57 (505-574)	508	605
RTYD	98±7.7 (88-113)	82±7.4 (75-91)	101±4.4 (94-112)	85.48±2.16 (83-88)	95	98
RMTTF	211±14.7 (191-237)	213±6.7 (202-220)	244±12.3 (221-262)	275.73±34.47 (236-328)	219	238
RMTFF	237±17.8 (208-266)	245±11.0 (232-261)	269±12.7 (243-287)	295.93±24.80 (269-336)	255	263
RTFTF	296±18.0 (257-327)	288±17.3 (267-312)	289±15.5 (258-318)	217.97±33.68 (199-278)	263	258
RFFTF	293±20.3 (257-327)	277±18.0 (254-307)	280±17.1 (243-301)	227.82±26.42 (202-272)	241	243

TABLE 2. Measurements (mm), means and standard deviations for specimens of *Rana milleti* from Khao Yai (Nakhon Ratchasima Province) and Khao Ang Rui Ni Wildlife Sanctuary in Thailand compared to specimen collected from Cardamom Mountains in Cambodia. SVL measurements are given in mm, other measurements are presented in per thousands of SVL. Ad. adult; Juv. juvenile; Ma. male; Fem. female.

	R. faber		*R. mortenseni*			*R. nigrovittata*				**Kruskal-Wallis test for males**
	Ad. Ma.	Ad. Fem.	Ad. Ma.	Juv. Ma.	Juv. Fem.	Ad. Ma.	Juv. Ma.	Ad. Fem.	Juv. Fem.	Chi-Square
	N=17	N=2	N=8	N=2	N=1	N=17	N=2	N=11	N=3	Significance
SVL	60.15±7.29	80.75±5.02	60.56±6.20	43.80±9.19	31.5	45.39±4.72	34.1±5.37	46.41±3.12	38.13±8.61	χ=44.6
	(51.0-79.3)	(77.2-84.3)	(50.6-67.8)	(37.3-50.3)	(31.5-31.5)	(37.9-58.5)	(30.3-37.9)	(39.6-50.1)	(28.2-43.4)	p=0.000 ***
RHW	332±16.1	341±10.7	375±12.6	351±23.1	356	358±16.0	327±14.2	369±66.0	339±2.0	χ=41.6
	(302-368)	(333-348)	(352-391)	(335-368)	(356-356)	(336-387)	(317-337)	(326-562)	(336-340)	p=0.000 ***
RHL	375±15.3	372±5.6	406±21.8	402±23.0	378	403±15.8	424±17.0	391±12.3	422±28.4	χ=24.5
	(355-414)	(368-376)	(361-435)	(386-418)	(378-378)	(381-444)	(412-436)	(377-416)	(400-454)	p=0.000 ***
RFLL	236±13.3	256±1.0	230±11.5	238±9.9	219	228±12.8	200±7.8	221±11.1	210±4.3	χ=19.7
	(217-268)	(255-256)	(210-246)	(231-245)	(219-219)	(195-245)	(195-206)	(204-239)	(206-214)	p=0.000 ***
RHAL	258±15.7	267±11.4	254±10.0	257±0.8	251	266±19.5	264±14.6	258±15.0	251±15.9	χ=17.5
	(233-287)	(259-277)	(239-271)	(257-258)	(251-251)	(228-286)	(253-274)	258±15.0	(240-270)	p=0.001 ***
RTL	614±40.8	650±46.5	548±25.4	598±44.9	565	558±34.3	600±1.2	557±24.6	599±27.7	χ=19.7
	(513-668)	(617-683)	(507-577)	(567-630)	(565-565)	(470-610)	(599-601)	(515-587)	(571-626)	p=0.000 ***
RFOL	552±34.0	562±13.2	512±24.7	537±8.4	508	534±39.1	533±48.8	531±34.8	528±7.4	χ=9.9
	(483-595)	(553-572)	(464-548)	(531-543)	(508-508)	(463-593)	(499-568)	(469-577)	(523-537)	p=0.020 *
RTYD	82±8.5	83±0.9	85±4.8	88±2.3	87	91±9.8	88±3.7	79±5.2	79±7.1	χ=42.7
	(69-108)	(82-84)	(77-90)	(87-90)	(87-87)	(67-107)	(85-90)	(71-87)	(71-85)	p=0.000 ***
RMTTF	311±33.0	297±2.5	(77-90)	285±8.1	283	284±26.7	278±13.0	288±21.8	263±30.0	χ=28.6
	(260-385)	(295-299)	(239-304)	(279-290)	(283-283)	(225-323)	(269-287)	(258-323)	(229-286)	p=0.000 ***
RMTFF	327±38.8	342±25.2	310±22.0	303±4.2	311	308±34.6	293±0.1	305±19.6	308±48.9	χ=20.4
	(258-388)	(324-359)	(285-346)	(300-306)	(311-311)	(228-370)	(293-293)	(275-342)	(257-355)	p=0.000 ***
RTFTF	196±15.9	203±10.9	190±13.1	215±29.1	190	210±19.2	197±36.7	210±20.2	219±9.6	χ=37.3
	(164-231)	(196-211)	(167-208)	(195-236)	(190-190)	(164-243)	(172-223)	(179-254)	(210-229)	p=0.000 ***
RFFTF	210±18.0	209±16.5	195±29.9	216±27.7	178	218±15.8	209±5.0	224±29.2	217±9.6	χ=33.1
	(183-242)	(197-220)	(133-228)	(197-236)	(178-178)	(181-236)	(206-213)	(177-268)	(206-223)	p=0.000 ***

Other abbreviations:- Ad. = Adult, Juv. = Juvenile, Ma = Male, Fem. = Female, pm = per thousand.

RESULTS

Figure 1. *Rana milleti* Smith, 1921. Specimen, MNHN 1987.3446, adult male, SVL 39.4 mm, dorsal view, ventral view and lateral view of head.

***Material examined*:-** MNHN 1987.3433-3446, 3448-3456, 3458-3461, 14 adult males, 5 juvenile males, 5 young of undeterminded sex, Khao Yai, Nakhon Ratchasima Province, Thailand; collected by Alain Dubois and Jean-Paul Risch, August 1986; THNHM 00086, 1 adult female, Khlong Takrao, Lum Changwat Forest Protected Unit, Khao Ang Rui Ni Wildlife Sanctuary, Nongkok Subdistrict, Tha Takhieb District, Chachoengsao Province, Thailand, collected by Yodchaiy Chuaynkern and Chantip Inthara, January 30, 2003; MNHN 2001.0262, adult male, Phnom Aural in the Phnom Aural Wildlife Sanctuary, Kampong Speu Province, Southwest Cambodia, collected by Jenny Daltry and Steven Swan.

***Description of specimen*:-** MNHN 1987.3446, adult male (figure 1), Khao Yai, Nakhon Ratchasima Province, Thailand.

(A) Size and general aspect:- (1) Frog of small size (SVL 39.4 mm), body slender.

(B) Head:- (2) Head small size, longer than wide (HW 12.5 mm; HL 14.9 mm; MN 12.5 mm; MFE 8.7 mm; MBE 4.5 mm), flat above. (3) Snout pointed, slightly protruding, its length (SL 6.3 mm) longer than horizontal diameter of eye (EL 4.35 mm). (4) Canthus rostralis rounded, loreal region concave, vertical. (5) Interorbital space flat, wider (IUE 4.03 mm) than upper eyelid (UEW 2.90 mm) and narrower than internarial distance (IN 4.35 mm); distance between front of eyes (IFE 7.3 mm) 1.3 times in distance between back of eyes (IBE 9.4 mm). (6) Nostrils oval with flap of skin laterally, closer to tip of snout (NS 2.1 mm) than to eye (EN 3.39 mm). (7) Pupil not to be seen in this specimen. (8) Tympanum (TYD 3.87 mm) distinct, rounded, 89% of eye diameter; tympanum-eye distance (TYE 0.81 mm) 21% of tympanum diameter. (9) Pineal ocellus present, between anterior border of eye. (10) Vomerine ridge present, bearing numerous small teeth (N=8); with an angle of 45° to body axis, closer to choanae than each other, longer than distance between them. (11) Tongue moderate, spatulate; emarginated, bearing no

median lingual process. Tooth-like projections on lower jaw absent.

(C) Forelimbs:- (12) Arm long, thin; fore-arm (FLL 8.2 mm) shorter than hand (HAL 10.9 mm); not enlarged. (13) Finger II short and thin; fingers I, III (TFL 6.7 mm) and IV long and thin. (14) Relative length of fingers: II < I < III < IV. (15) Tips of fingers rounded not enlarged with latero-ventral grooves, rather wide compared to finger width (fd1 0.96 mm, fw1 0.88 mm;fd2 0.96 mm, fw2 0.76 mm; fd3 1.24 mm, fw3 0.72 mm; fd4 1.12 mm, fw4 0.76 mm). (16) Finger without dermal fringe on inside of finger I-II-III-IV; webbing on fingers absent. (17) Subarticular tubercles rather prominent, oval, single, all present. (18) Prepollex distinct, oval; two oval, distinct palmar tubercles; a distinct supernumerary tubercle on base of each finger.

(D) Hind limbs:- (19) Hind limbs long, heels overlapping when limbs are folded at right angles to body. Tibia 5.6 times longer (TL 22.1 mm) than wide (TW 4.0 mm), longer than thigh (FL 21.1 mm) and about as long as distance from base of internal metatarsal tubercle to tip of toe IV (FOL 22.2 mm). (20) Toes long and thin, toe IV (FTL 12.8 mm) longer than third of distance from base of tarsus to tip of toe IV (TFOL 31.5 mm). (21) Relative length of toes: I < II < III < V < IV. (22) Tips of all toes rounded, enlarged; disks present on toes I-II-III-IV-V, with distinct latero-ventral grooves, rather wide compared to toe width (td1 1.08 mm,tw1 0.72 mm; td2 1.32 mm, tw2 0.64 mm; td3 1.32 mm, tw3 0.68 mm; td4 1.12 mm, tw4 0.68 mm; td5 0.84 mm, tw5 0.60 mm). (23) Webbing present, moderate: I1½-2II1-2½III2-3IV3-1½V (WTF 1.94 mm, WFF 3.87 mm; WI 1.16 mm, WII 2.90 mm; MTTF 9.3 mm, MTFF 11.1 mm, TFTF 10.9 mm, FFTF 10.1 mm). (24) Dermal ridge along toe V present: from tip of toe to the heel; poorly developed. (25) Subarticular tubercle rather prominent, oval, simple, all present. (26) Inner metatarsal tubercle distinct, elongated; its length (IMT 1.77 mm) 3.2 times in length of toe I (ITL 4.52 mm). (27) Tarsal fold absent. (28) Outer metatarsal tubercle present, rounded; supernumerary tubercles absent; tarsal tubercle absent.

(E) Skin:- (29) Snout, between eyes, side of head and anterior part of back finely granular; posterior part of back numerous granular with horny spinules; upper part of flank, to line from insertion of arm to groin granular with granular and glandular warts; lower part of flank smooth. (30) Dorso-lateral folds present prominent, from back of eye to vent, narrow; supratympanic fold absent; parotoid glands absent; cephalic ridges absent; co-ossified skin absent. (31) Dorsal parts of forelimb smooth; thigh, tibia and tarsus with granular and glandular warts in longitudinal lines. (32) Throat, chest, belly and ventral part of thighs smooth; posterior part of thigh around vent with dense glandular warts. (33) Macroglands: distinct rictal gland in posterior corner of mouth; prominent distinct humeral glands.

(F) Colouration (in alcohol):- (34) Dorsal parts olive-green with slightly dark brown dots; upper part of flank dark olive-green and lighter in lower part; loreal, tympanic region, dorso-lateral fold and tympanum dark brown; upperlip with white striped. (35) Dorsal part of forelimb dark brown; dorsal part of thigh, tibia and foot olive-green with few slightly dark brown cross bands; posterior part of thigh unique colour. (36) Throat, margin of throat, chest; belly and thigh yellow-white; margin of throat with dark brown cross bands; webbing dark brown in all dorsal and ventral part. (*in life)*: – Upper parts light golden, loreal and tympanic zone brownish; upper lip pearly light golden; lower parts pearly golden; side of throat translucent whitish (vocal sacs); iris light golden with a dark zone in its upper part.

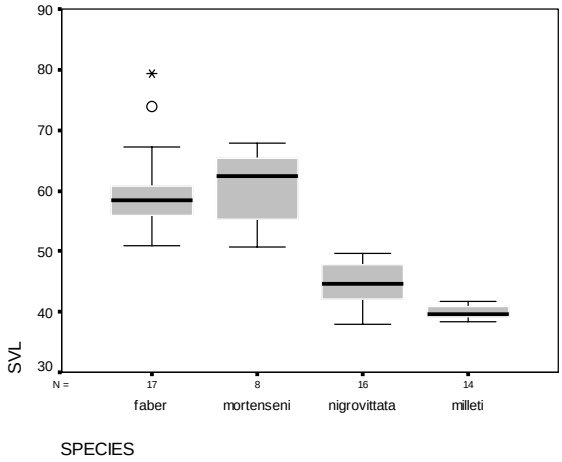

Figure 2. Boxplot showing size differences in males of *Rana faber, Rana mortenseni, Rana nigrovittata* and *Rana melleti* from Cambodia, Laos, Thailand and Vietnam.

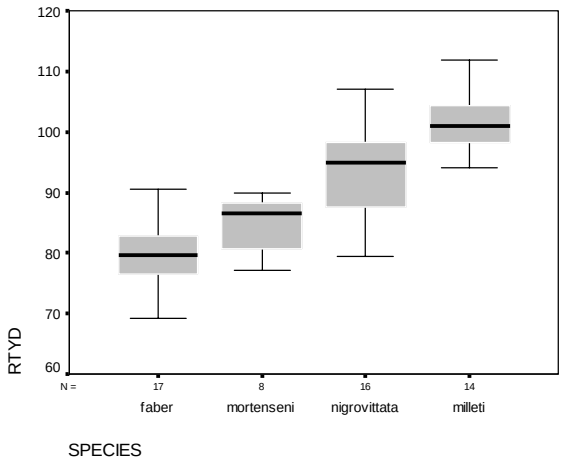

Figure 3. Boxplot showing differences in tympanum size in males of *Rana faber, Rana mortenseni, Rana nigrovittata* and *Rana melleti* from Cambodia, Laos, Thailand and Vietnam.

(G) Male secondary characters:- (37) A single continuous, oval shaped nuptial pad on finger I, small, cream coloured spines. (38) Vocal sacs present, indistinct on throat; a pair of distinct, rounded openings at base of jaw. (39) Other secondary sexual characters: humeral glands distinct, prominent.

***Variation*:-** The coloration in life of the back can be light golden to brownish golden. The ventral side can be distinctly pearly intensely golden to pearly white with only a feeble golden shine. The golden colour is more intense in reproductive males and might be linked to sexual activity. Ventral skin might bear dark brown spots or be of uniform colouration.

Concerning morphometric variation (Table 1), the syntypes and topotypes of *Rana milleti* are significantly smaller than *R. milleti* from

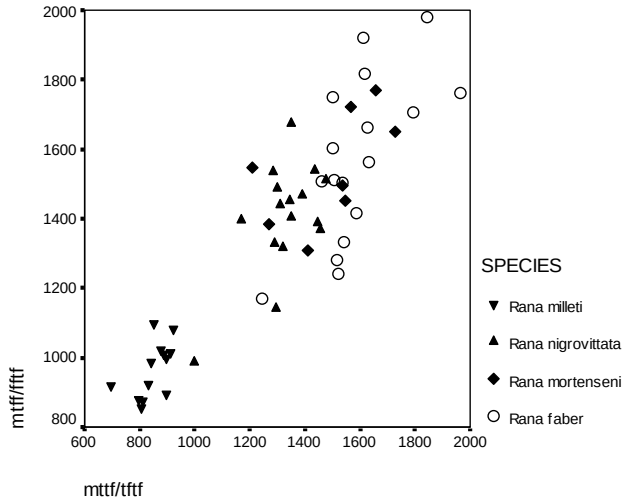

Figure 4. Differences in web extension in males of *Rana faber, Rana mortenseni, Rana nigrovittata* and *Rana melleti* from Cambodia, Laos, Thailand and Vietnam. Smaller values of ratios mttf/tftf and mtff/fftf indicate smaller webbing.

Thailand and Cambodia (SVL: Mann-Whittney U= 0.0, n_1=13, n_2=11, p=0.000, ***), but they have relatively larger head (HW: Mann-Whittney U= 1.0, n_1=13, n_2=11, p=0.000, ***). For the other measurements and for morphological characters they do not show any difference that outlines the intra-populational variation.

All morphometric characters studied show variation between the species (Table 1 and 2, figs 2-4). *Rana milleti* can be distinguished from all other species studies by smaller size (Kruskal-Wallis test for SVL: Chi=44.6; p=0.000 ***), by its relatively smaller head (Kruskal-Wallis test for HW/SVL: Chi=41.6; p=0.000 ***), its relatively shorter forearms (Kruskal-Wallis test for FLL/SVL: Chi=19.7; p=0.000 ***), and its smaller webbing (Kruskal-Wallis test for MTTF/SVL: Chi=28.6; p=0.000 ***; Kruskal-Wallis test for MTFF/SVL: Chi=20.4; p=0.000 ***; Kruskal-Wallis test for TFTF/SVL: Chi=37.3; p=0.000 ***; Kruskal-Wallis test for FFTF/SVL: Chi=33.1; p=0.000 ***). *Rana milleti* has a tympanum relatively larger than all the other species studied (Kruskal-Wallis test for TYD/SVL: Chi=42.7; p=0.000 ***).

***Ecological notes*:-** Thirteen adult males and five juvenile males were collected from Khao Yai in Nakhon Ratchasima Province, Thailand, in dry evergreen forest at about 800 m altitude. Males were found calling hidden at the edges of ponds surrounded by dense vegetation. Part of these ponds extends to flooded areas between bushes, trees and roots, difficult to access for humans. The frogs hide under this dense vegetation that hangs over the bank of the ponds, sit on the ground, not far from the water but never at the very edge of the water. Their coloration resembles the brown of the soil, of dead leaves and of branches under which they sit and when disturbed, they stop calling but rarely move. When leaping to hide, they do not choose to go to the water, but try to escape by disappearing to the dense vegetation. Youngs and juveniles where found moving in sunshine after a light rain in secondary grassland at 700-760 m. The adult female specimen from Khao Ang Rui Ni Wildlife Sanctuary, Chachoengsao Province, Thailand, was collected from the stream bank in

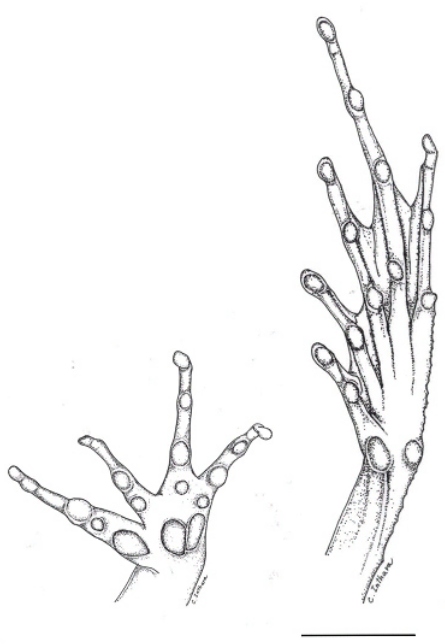

Figure 5. Hand and Foot of *Rana milleti*, 1921. Specimen, THNHM 00086, adult female from Khao Ang Rui Ni Wildlife Sanctuary, Chachoengsao Province, Thailand. Bar scale = 1 cm. The figure was drawn by Chantip Inthara using a camera lucida.

dry dipterocarp forest. The elevation of the collection site is 120 m above the mean sea level. And the last one, an adult male specimen came from Phnom Aural in the Phnom Aural Wildlife Sanctuary, Kampong Speu Province, Southern Cambodia, and was collected in the same place as *Rana faber* throughout the Cadamom Mountains.

***Comparisons*:-** *Rana milleti* is compared here with three similar species of the *Rana (Sylvirana)* as defined by Dubois (1992), *Rana faber* Ohler, Swan and Daltry, 2002, *Rana mortenseni* Boulenger, 1903 and *Rana nigrovittata* (Blyth, 1856). *Rana milleti* is distinctly smaller than the other species, the body slightly elongated, glands on back are more distinct. *Rana milleti* has prominent distinct humeral glands similar to those of *Rana mortenseni* and *Rana nigrovittata* wheras they are only slightly prominent in *Rana faber*. The posterior part of the thigh is uniform brown, that differs from the others. *Rana faber*, *Rana mortenseni* and *Rana nigrovittata* are blackish with numerous light grey spots. The webbing of *Rana milleti* is less extended than the other species. The ventral part of finger and toe are shown in figure 5. The species of *Rana faber*, *Rana milleti*, *Rana mortenseni* and *Rana nigrovittata* can be distinguished as follows:

1a. Small sized (adult males: 32.6-41.7 mm, adult females: 42.7-49.4 mm), webbing small, tympanum relatively large, skin with numerous finely granular with horny spinules .... *Rana milleti*
1b. Adult body size larger, webbing more than half, tympanum distinctly smaller than eye size, skin with few granular with horny spinules 2

2a. Adult size moderate (adult males: 37.9-58.5 mm, adult females: 39.6-50.1 mm); tympanum size moderate ..... *Rana nigrovittata*
2b. Adult large size (adult males: 50-80 mm, adult females: 78-85 mm) 3

3a. Head narrow, width up to 360 p. m. of SVL, tibia long, length up to 640 p. m. of SVL, humeral glands flat, not convex ..... *Rana faber*
3b. Head wide, width up to 390 p. m. of SVL, tibia shorter, length up to 560 p. m.of SVL, humeral glands convex ..... *Rana mortenseni*

The characteristics of *Rana milleti* Smith, 1921 in this study are similar to those described by Smith (1921), Bourret (1942) and Inger et al. (1999). Very little interpopulational variation could be observed. Character of size difference should be used in systematics with precaution as there is variation of size throughout the life in anurans. Thus age structure of a sample might considerably

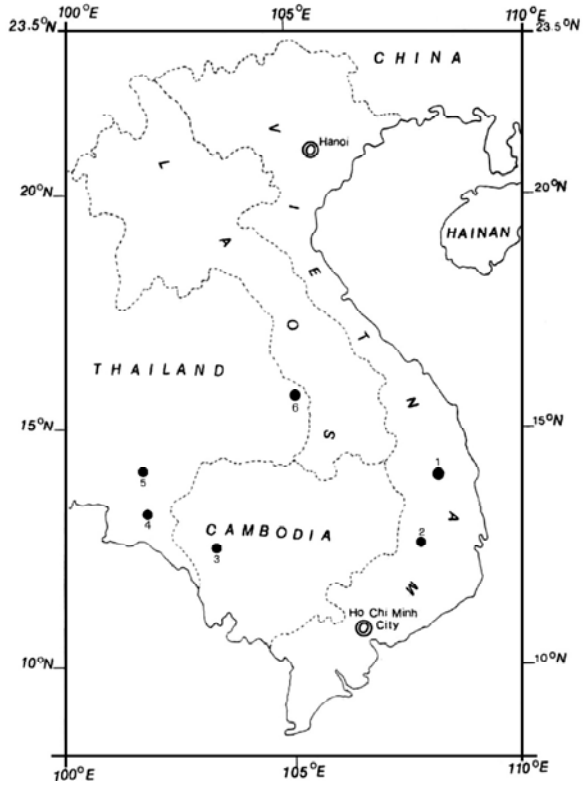

Figure 6. Known localities of *Rana milleti* Vietnam: 1, An Khe District; 2, Dalat. Cambodia: 3, Kampong Speu Province. Thailand: 4, Chachoengsao Province; 5, Nakhon Ratchasima Province; 6, Ubon Ratchathani Province. Modified from Inger et al.(1999).

influence size, even if only adults are considered. Even though we have differences between these populations these populations should be treated as conspecific without other data.

***Distribution*:-** Smith (1921) recorded *Rana milleti* from three localities: Dalat, which he considered as type locality, Langbian peaks and Dran. As no holotype was designated in this work, all specimens have to be considered syntypes, and the origins of all syntypes have to be considered altogether as the type locality. Inger et al. (1999) and Orlov et al. (2002) added Boun Luoi, Tram Lap, and Kon Cha Rang in An Khe Province to the original range of distribution. The present study adds several localities from Cambodia (Phnom Aural in the Phnom Aural Wildlife Sanctuary, Kampong Speu Province) and Thailand (Khao Yai, Nakhon Ratchasima Province and Khao Ang Rui Ni Wildlife Sanctuary, Chachoengsao Province) to the range of *Rana milleti*. The known distribution of the species is shown in Figure 6.

DISCUSSION

In our specimens, we found similarity to a picture of frog on page 13 in Matsui et al. (1996). They identified the species as *Rana* sp. and recorded the locality of this frog as near Research Station, Sanam Chaiket Wildlife Sanctuary, Chachoengsao Province. We have confidence that this locality is wrong because in

this province or in Thailand this Wildlife Sanctuary does not exist. The only park in this province is Khao Ang Rui Ni Wildlife Sanctuary which might be the actual locality of the specimen shown in this photograph. Matsui et al. (1996) did not mention the name *Rana milleti* and we did not have the opportunity to examine their specimen. Other authors also failed to refer to this species in this province (i.e. Smith, 1915, 1921, 1922; Taylor, 1962; Chuaynkern, 2001; Matsui et al., 2001; Noitkotr and Lauhachinda, 2002).

The currently known distribution (figure 6), suggests the occurrence of this species in Laos. As Chan-ard (2003) recorded this species from Ubon Ratchathani, it is possible that *Rana milleti* exists in Laos too. Further field studies should increase knowledge about distribution of this species in Thailand and adjacent countries.

CONCLUSION

In this study, twenty one specimens were identified as Rana milleti Smith, 1921 by external morphological features as follows: elongated frogs with distinct prominent humeral glands, glandular warts with spinules on back and rather small webbing. Previously this species was thought to occur in Vietnam only. This report adds the following localitites to the known distribution: Cambodia: Phnom Aural in the Phnom Aural Wildlife Sanctuary, Kampong Speu Province; Thailand: Khao Yai, Nakhon Ratchasima Province and Khao Ang Rui Ni Wildlife Sanctuary, Chachoengsao Province. So the recent distribution of this species includes the three countries Cambodia, Thailand and Vietnam.

ACKNOWLEDGMENTS

We are grateful to our organizations, National Science Museum (Thailand), Muséum National d'Histoire Naturelle (France), Khon Kaen University (Thailand) and Khao Ang Rui Ni Wildlife Sanctuary (Thailand), for permission to study. We wish to thank the persons from many following organizations and institutes: Assoc.Prof. Sithichai Egoramaiphol, Mr. Sommai Khowkachaporn, Mr. Supachai Sittilert, Mr. Jarujin Nabhitabhata, Mrs. Bharadee Bunnag, Mr. Malcolm Bay, Mr. Tanya Chan-ard, Miss Atchara Teerawattananon, Mr. Bhanumas Chantarasuwan, Mr. Weeyawat Jaitrong, Mr. Sumet Aowsakulsuthi (National Science Museum, Thailand). Dr. Robert F. Inger, Dr. Harold K. Voris and Mr. Bryan L. Stuart (The Field Museum of Natural History, Chicago, USA). Mr. Tzi M. Leong (National University of Singapore, Republic of Singapore), Mr. Nguyen Quang Truong (Institute of Ecology and Biological Resources, Vietnam), Mr. Jarupon Prabnasak (Khao Ang Rui Ni Wildlife Sanctuary, Chachoengsao Province, Thailand) and Ass. Prof. La-Orsri Sanoamuang (Department of Biology, Faculty of Science, Khon Kaen University, Thailand). The specimen from Khao Ang Rui Ni Wildlife Sanctuary, THNHM 00086, came from the project-Species Diversity of Amphibians and Reptiles in Khao Ang Rui Ni Wildlife Sanctuary, Chachoengsao Province. This project was conducted by three organizations, Khao Ang Rui Ni Wildlife Sanctuary, National Science Museum, Khon Kaen University, and the permission are following the official letters: Ministry of Agriculture no. 0712.855/548, Ministry of Science and Technology no. 5305/835 and Ministry of State University affairs no. 0502.6/400.

The first author, Yodchaiy Chuaynkern, is grateful to Muséum National d'Histoire Naturelle (Paris, France) and National Science Museum (Pathum Thani, Thailand), for supporting to study type specimens in Paris and special thanks to Dr. Annemarie Ohler and Dr. Alain Dubois for teaching in method of specimens study.

LITERATURE CITED

Bossuyt, F. and A. Dubois. 2001. A review of the frog genus *Philautus* Gistel, 1848 (Amphibia, Anura, Ranidae, Rhacophorinae). Zeylanica, 1: 1-108.

Boulenger, G.A. 1882. Catalogue of the Batrachia Gradentia s. Caudata in the collection of the British Museum. London, Taylor & Francis. xvi+503 pp., 30 pls.

Bourret, R. 1942. Les Batraciens de l'Indochine. Institute Océanographique de l'Indochine, Hanoi. x+547 pp., 4 pls.

Chan-ard, T. 2003. A Photographic Guide of Amphibians in Thailand. Darnsutha Press Co., Ltd., Bangkok. 175 p. (In Thai).

Chuaynkern, Y. 2001. Species diversity of Amphibians and Reptiles at Pang Sida National Park, Sakaeo Province. Graduated School, Kasetsart Universtiy, Bangkok (In Thai with English Abstract).

Dubois, A. 1992. Notes sur la classification des Ranidae (Amphiens, Anoures). Bulletin de la Societe Linneene de Lyon, 61: 305-352.

Dubois, A. and A. Ohler. 1998. A new species of *Leptobrachium* (*Vibrissaphora*) from northern Vietnam, with a review of the taxonomy of the genus *Leptobrachium* (Pelobatidae, Megophryinae). Dumerilia, 4: 1-32.

——— 1999. Asian and Oriental toads of the *Bufo melanostictus*, *Bufo scaber* and *Bufo stejnegeri* groups (Amphibia, Anura) : a list of available and valid names and redescription of some name-bearing types. Journal of South Asian Natural History, 4: 133-180.

——— 2000. Systematics of *Fejervarya limnocharis* (Gravenhorst, 1829) (Ampphibia, Anura, Ranidae) and related species.1. Nomenclatural status and type-speciemens of the nominal species *Rana limnocharis* Gravenhorst. Alytes, 18: 15-50.

——— 2001. A new genus for and aquatic ranid (Amphibia, Anura) from Sri Lanka. Alytes, 19: 81-106.

Dubois, A., A. Ohler and S. D. Biju. 2001. A new genus and species of Ranidae (Amphibia, Anura) from south-western India. Alytes, 19: 53-79.

Flower, S. S. 1896. Notes on a collection of reptiles and batrachians made in the Malay Peninsular in 1895-96; with a list of the species recorded from that region. Proceeding of the Zoological Society of London, 1896: 856-914.

——— 1899. Notes on a second collection of batrachians made in the Malay Peninsular and Siam, from November 1896 to September 1898; with a list of the species recorded from those countries. Proceeding of the Zoological Society of London, 1899: 600-696.

Frost, D. R. 1985. Amphibian Species of the World: A Taxonomic and Geographical Reference. Allen Press, Inc. and the Association of Systematics Collection, Lawrence. 732 p.

Inger, R. F., N. Orlov and I. Darevsky. 1999. Frogs of Vietnam: a report on new collections. Fieldiana: Zoology Memoires, New series, 92: 1-46.

Iskanda, D. and E. Colijn. 2000. Preliminary checklist of Southeast Asian and New Guinean herpetofauna.I. amphibians. Treubia, 31, part 3 (supplement): 1-134.

Khonsue, W.and K. Thirakhupt. 2001. A checklist of the amphibians in Thailand. The Natural History Journal of Chulalongkorn University, 1: 69-82.

Matsui, M., J. Nabhitabhata, T. Chan-ard and K. Thirakhupt. 1996. Amphibian fauna of Thailand. Pp.28-63, in Evolutionary Studies of Small Animals Living in Asian Tropics 1994-1995. edited by M. Matsui. Graduate School of Human and Environment Studied, Kyoto University.

Matsui, M., K. Nishikawa, W. Khonsue, S. Panha and J. Nabhitabhata. 2001. Allozymic variation in *Rana nigrovittata* (Amphibia: Anura) within Thailand with special reference to the taxonomic status of *R. mortenseni*. The Natural History Journal of Chulalongkorn University, 1: 15-22.

Mocquard, R. 1904. Batraciens recuillis par M.A. Pavie en Indohine. In Pavie, A., Mission Pavie Indo-Chine. 1879-1895. Etudes diverses. III. Recherches sur l'histoire naturelle de l'Indo-Chine orientale. Paris Ernest Lernest Leroux: 473-474.

Noikotr, K. and V. Lauhachinda. 2002. Diversity of anurans in Khaokitchakut, Chanthaburi Province. Journal of Wildlife in Thailand, 10: 7-16 (in Thai with English Abstract).

Ohler, A. 1995. Digital pad morphology in torrent-living ranid frogs. Asiatic Herpetological Research, 6: 85-96.

——— 1996. Systematic, morphometrics and biogeography of the genus *Aubria* (Ranidae, Pyxicephalinae). Alytes, 13: 141-166.

Ohler, A. and A. Dubois. 1989. Démonstration de l' origine indépendante des ventouses digitales dans deux lignées phylogénétiques de Ranidae (Amphibiens, Anoures). C. R. Acad. Sci. Paris, 309, série III: 419-422.

——— 1999. The identity of *Elachyglossa gyldenstolpei* Anderson, 1916 (Amphibia, Ranidae), with comment on some aspects of statistical support to taxonomy. Zoologica Scripta, 28: 269-279.

Ohler, A., O. Marquis, S. R. Swan and S. Grosjean. 2000. Amphibian diversity of the Hoang Lien Nature Reserve (Lao Cai Province, northern Vietnam), with a description of two new species. Herpetozoa, 13: 71-87.

Ohler, A., S. R. Swan and J. C. Daltry. 2002. A recent survey of the amphibian fauna of the Cardamom Mountains, southwest Cambodia with descriptions of three new species. The Raffles Bulletin of Zoology, 50: 465-481.

Orlov, N., R. W. Murphy, N. B. Anajeva, S.A. Ryabov and H.T. Cuc. 2002. Herpetofauna of Vietnam, A Checklist. Part I. Amphibia. Russian Journal of Herpetology, 9: 81-104.

Smith, M. A. 1915. On reptiles and batrachians from the Coast and Island of South-east Siam. Journal of the Natural History Society of Siam, 1: 237-249.

——— 1921. New or little-known reptiles and batrachians from southern Annam (Indo-China). Proceeding of the Zoological Society of London, 1921: 423-440.

——— 1922. On a collection of reptiles and batrachians from Siam and Indo-China. Journal of the Natural History Society of Siam, 4: 203-214, pl.8.

Taylor, E. H. 1962. The amphibians fauna of Thailand. The Universtiy of Kansas Science Bulletin, 43: 265-599.

Tirant, G. 1885. Notes sur les reptiles et batraciens du Cochinchine. Excursions et Reconnaissances, 21: 236-246.

Veith, M. J. Kosuch, A. Ohler and A. Dubois. 2001. Systemtics of *Fejervarya limnocharis* (Gravenhorst, 1829) (Amphibia, Anura, Ranidae) and related species.2. Morphological and molecular variation in frogs from the Greater Sunda Islands (Sumatra, Java, Borneo) with the definition of two species. Alytes, 19: 5-28.

APPENDIX

Material studied - Rana faber: BMNH 2000.0134, 2000.0136-0141, MNHN 2001.0256-0261 and 0924F, 15 adult males, Phnom Aural in the Phnom Aural Wildlife Sanctuary (alt. above 700 m, 104°10' E, 12°00' N), Kampong Speu Province,: MNHN 1924.0063-0064, 1 adult male, 1 adult female, Cambodia: MNHN 1928.0034, 1992.5370, 1 adult male, 1 adult female, Bokhor Mountains, Kam Chay, Cambodia.,

Rana mortenseni: BMNH 2000.0133, 0135, 2 adult males, Cambodia: MNHN 2001.0250-0251, 0253-0255 and 0263, 6 adult males, 1 juvenile male, Cardamom Mountains, Cambodia; MNHN 1974.1209-1211, 1 adult male, 1 juvenile male, 1 juvenile female, Ha Tiah (Annam), Vietnam.

Rana nigrovittata: MNHN 1987.3463 and 3464, 2 adult males, Khao Chong, Trang Province, Thailand; MNHN 1987.3476-3482, 3484 and 3485, 3 adult males, 3 adult females, 1 juvenile male and 2 juvenile males, Phu Kradung, Loei Province, Thailand; MNHN 1987.3486-3488 and 3489, 2 adult males, 1 adult female, 1 juvenile female, Phu Kradung, Loei Province, Thailand; MNHN 1987.3455, 3466, 1 adult male, 1 juvenile male, Khao Yai, Nakhon Ratchasima Province, Thailand; MNHN 1997.4490-4492, 2 adult males, 1 adult female, Huang Lien Nature Reserve, Lai Chau Province, Vietnam; MNHN 1997.3960, 3965, 3969, 3971-3972, 3977, 3979-3980 and 3982-3983, 5 adult males, 5 adult females, Nam Kan, Bokeo Province, Laos.

Received: 16 January 2004
Accepted: 23 August 2004