

Two Distinctive Color Patterns of the Himalayan Newt *Tylototriton verrucosus* (Urodela: Salamandridae) Found in Thailand and Its Implication on Geographic Segregation

PORRAWEE POMCHOTE, PUTSATEE PARIYANONTH
AND WICHASE KHONSUE*

*Amphibian and Reptile Research Unit, Department of Biology, Faculty of Science,
Chulalongkorn University, Bangkok 10330, Thailand.*

ABSTRACT.– Field surveys were carried out at 14 locations in seven provinces of Thailand, from December 2001 to September 2006, searching for the Himalayan newt (*Tylototriton verrucosus* Anderson, 1871). The newt was found at 11 of the 14 locations visited, eight of which constitute new locality records for the species within Thailand. Our observations show that the Himalayan newts in Thailand can be divided into two types based on their distribution, body coloration, and female size. This species was generally found in small streams and ponds, usually in mountainous areas at least 1,000 m above sea level. The ecological and conservation implications of *Tylototriton verrucosus* in Thailand are discussed.

KEY WORDS: Body coloration, new localities, newt, Thailand, *Tylototriton verrucosus*

INTRODUCTION

Newts, urodelan amphibians, belong to the family Salamandridae, which includes 18 genera and 73 described species in North America and Eurasia (Stuart and Papenfuss, 2002; Frost et al., 2006). The five genera in Asia are *Cynops*, *Echinotriton*, *Pachytriton*, *Paramesotriton* and *Tylototriton* (Stuart and Papenfuss, 2002). *Tylototriton* has been reported from eastern and western China,

Nepal, Sikkim and Darjeeling in India, Burma, northern Thailand, northern Vietnam, and Okinawa in Japan (Zhao et al., 1988). This genus consists of eight species: *Tylototriton verrucosus*, *T. asperrimus*, *T. kweichowensis*, *T. taliangensis*, *T. hainanensis*, *T. wenxianensis*, *T. shanjing*, and *T. vietnamensis*.

Most reports of *Tylototriton verrucosus* in Thailand were published 20-40 years ago, including some in the non-scientific literature. So far only this species in the genus has been reported from Thailand (Taylor, 1962; Wongratana, 1984; Nabhitabhata et al., 2000; Chan-ard, 2003), and

*Corresponding author:

Tel: (662)-218-5258

Fax: (662)-2185256

E-mail: wichase.k@chula.ac.th

TABLE 1. Locations and number of newts observed in our surveys.

Region	No.	Province	Location	Coordinate	Altitude (m)	Number found	Survey date
North	1	Chiang Mai	Watershed management station, Doi Ang Khang	19° 53' 42.4" N, 99° 03' 02.2" E	1,492	11	Dec 2001
	2	Nan	Doi PhuKa NP	19° 12' 33.0" N, 101° 04' 15.8" E	1,130	0	May 2005
	3	Mae Hong Son	Namtok Mae Surin NP	18° 56' 27.3" N, 99° 04' 23.0" E	1,267	8	Oct 2004
	4	Chiang Rai	Doi Lahnga, Khun Chae NP	18° 56' 04.4" N, 99° 22' 47.8" E	1,443	10	May 2006
	5	Chiang Mai	Phuping Rajanives, Doi Suthep	18° 48' 16.0" N, 99° 54' 09.3" E	1,436	68	Jun 2005
	6	Chiang Mai	Doi Chang Kien, Doi Pui	N/A	N/A	1	Oct 2004
	7	Chiang Mai	Royal Garden Siribhume, Doi Inthanon	18° 32' 46.4" N, 99° 31' 13.7" E	1,313	13	May 2005, June 2005
	8	Chiang Mai	Watershed management station, Doi Inthanon	18° 30' 51.5" N, 99° 28' 29.3" E	1,584	3	Jan 2003
	9	Chiang Mai	Doi Inthanon NP	N/A	N/A	1	Jan 2004
Northeast	10	Loei	Phu Suan Sai NP	17° 31' 48.9" N, 100° 58' 44.7" E	1,119	5	May 2006
	11	Loei	Phu Reua NP	17° 29' 58.5" N, 101° 20' 29.8" E	1,183	0	May 2006
	12	Loei	Phu Luang WS	17° 16' 23.9", 101° 31' 18.8"	1,515	16	July 2003, May 2006
	13	Phitsanulok	Phu Hin Rong Kla NP	16° 59' 17.8" N, 101° 00' 05.4"	1,285	29	May 2003, May 2006
	14	Phetchabun	Nam Nao NP	16° 45' 02.0" N, 101° 33' 54.6" E	945	0	May 2005
Total number						165	

N/A = Not available; NP = National Park; WS = Wildlife Sanctuary

only from the northern and northeastern mountain ranges (Nabhitabhata et al., 2000; Chan-ard, 2003). There has been no report on geographic distribution of color patterns.

Tylotriton verrucosus is considered a sensitive species in Thailand, based on the patchy known distribution and isolated populations (Wongratana, 1984). Because of extensive deforestation and agricultural

development, much of their potential habitats have either been altered or destroyed. Thus, it is likely that their current distribution pattern is now different from that previously reported.

Therefore, field surveys were carried out in an attempt to assess the present distribution and status of the Himalayan newt in Thailand. The field sites surveyed

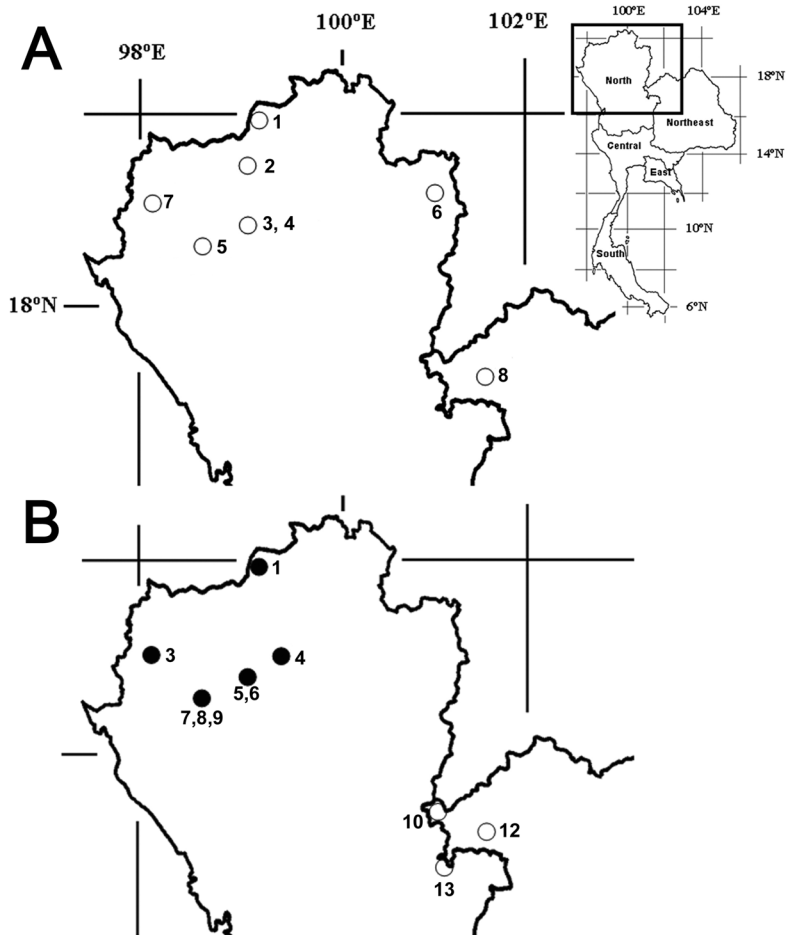


FIGURE 1. A. Distribution of Himalayan newts (*Tylototriton verrucosus*) gathered from old published literatures. Numbers refer to the locations in Table 2. **B.** Distribution of Himalayan newts (*Tylototriton verrucosus*) from our survey. (●) Indicate Type I newts (orange to yellow body coloration). (○) Indicate Type II newts (dull body coloration). The numbers refer to the locations in Table 1.

were mountainous areas in northern and northeastern Thailand. In addition to distribution and status, information regarding habitat, reproduction, and morphology were recorded. The knowledge gained from this study can be used in implementation of future conservation efforts.

MATERIALS AND METHODS

In this study, data regarding the morphology and distribution of *Tylototriton verrucosus* were obtained by 1) reviewing the existing published literature (scientific and non-scientific), 2) examining available museum specimens and reference collections, and 3) conducting field surveys in the northern and northeastern parts of Thailand.

The preliminary data in this study were gathered from the literature published

between 1924 to 2003 (Smith, 1924; Taylor, 1962; Suvatti, 1965; Beaver, 1982; Wongratana, 1984; Matsui et al., 1996; Chan-ard et al., 1999; Nabhitabhata et al., 2000; Chan-ard, 2003) and from the non-scientific literatures i.e. nature magazines, photographs taken by tourists or park rangers and Thai websites.

Additional information was obtained by examining preserved specimens kept at the Kasetsart University Museum of Fisheries (KUMF), the Centre for Thai National Reference Collections (CTNRC) and the Chulalongkorn University Museum of Zoology (CUMZ).

Field surveys using the visual encounter survey method were conducted at 14 locations in seven northern and northeastern provinces of Thailand (Table 1) between December, 2001 and September, 2006. The previously reported habitats of newts (Wongratana, 1984; Chan-ard, 2003), e.g., small streams, ponds, and under stones and logs on mountain slopes, were searched at all 14 locations. Newts were captured by hand or by dip net. Each captured individual was photographed *in situ* for color pattern analysis. Microhabitat type, altitude, geographic coordinates, numbers of individuals found, morphology (size and color pattern), and behavior were recorded. Ecological and physical data of the habitat, e.g., type of stream, pond or mountain slope, water depth, water and air temperatures, were recorded. Data were analyzed using SigmaStat version 2.0.

RESULTS

Distribution

The distribution of Himalayan newts, *Tylototriton verrucosus*, obtained by reviewing previous published literature (both scientific and non-scientific), verified museum specimens, and field surveys is shown in Figure 1. Because of no previous data suggesting the distribution of these species in other areas were found, the surveys were conducted only in the north and northeast of Thailand and thus it can be concluded that the Himalayan newts are found in the north and the northeast of Thailand (ca. 16-19 °N), but we have not confirmed their albeit likely restriction to this range within Thailand. The majority of populations were found at high altitude towards the top of mountains at an elevation of at least 1,000 m above sea level. Assuming this to be a key environmental determinant of habitat, then outside the surveyed area only parts of the central- to south- western parts of Thailand would potentially provide suitable habitat anyway, excepting the possibly limiting caveat of increasing temperatures at the same altitude further towards the south of Thailand.

From the verified specimens in museums and previously published literatures, the Himalayan newts were found only in four provinces, namely Mae Hong Son (Nabhitabhata et al., 2000; Nabhitabhata and Chan-ard, 2005), Chiang Mai (Smith, 1924; Taylor, 1962; Suvatti, 1965; Beaver, 1982; Wongratana, 1984; Matsui et al., 1996; Nabhitabhata et al., 2000; Nutphund, 2001; Nabhitabhata and Chan-ard, 2005), Nan (Nabhitabhata and Chan-ard, 2005) and Loei (Wongratana, 1984; Chan-ard et al., 1999; Nabhitabhata et al., 2000; Nutphund, 2001; Nabhitabhata and Chan-ard, 2005) (Fig. 1A). Of the 14 survey locations, we encountered newts

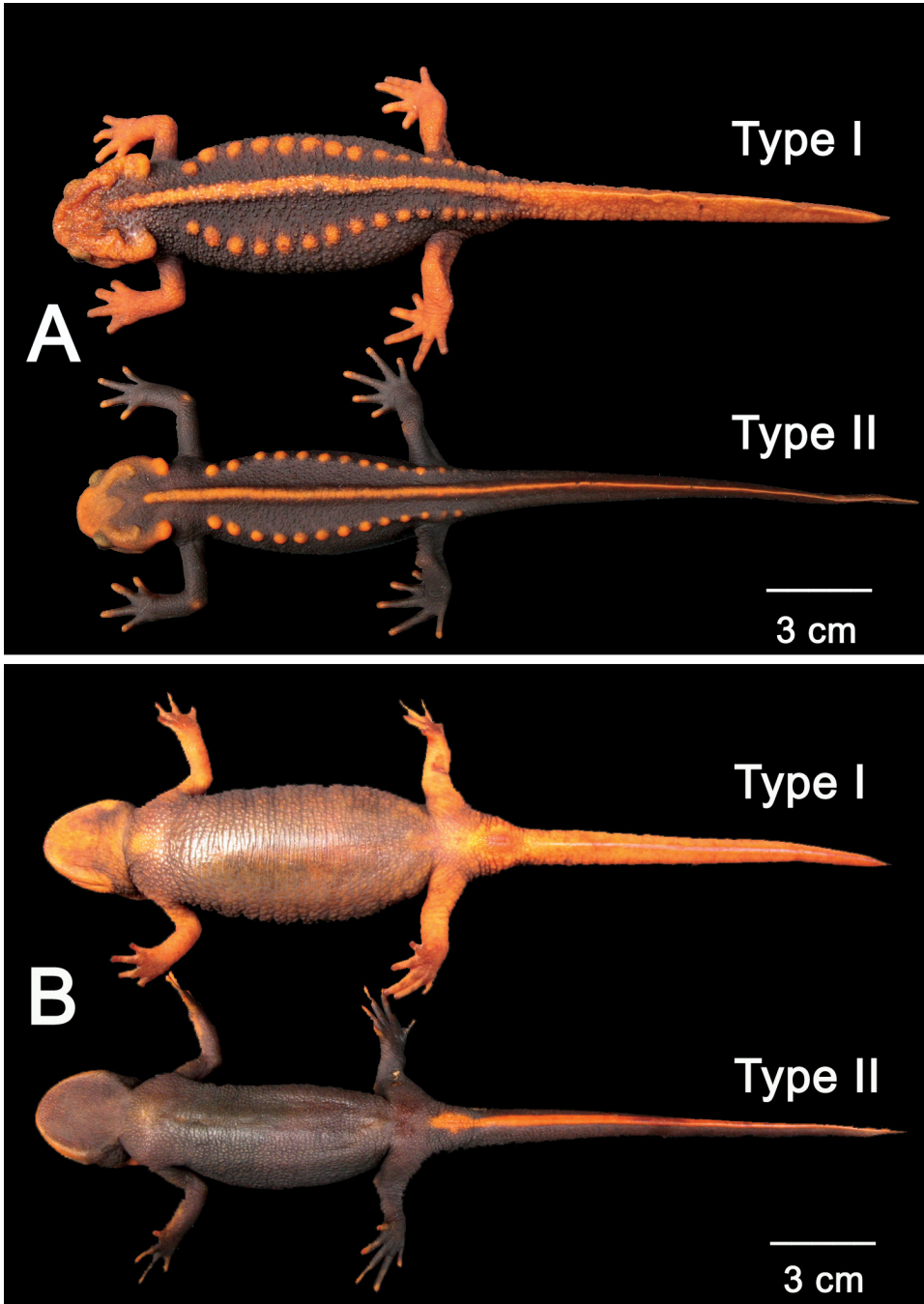


FIGURE 2. **A.** Dorsal view and **B.** ventral view of Type I (yellow to orange body coloration) and Type II (dull body coloration) females of *Tylototriton verrucosus*.

in 11 locations (Table 1). Among those 11 locations, Chiang Rai and Phitsanulok are provinces with no prior record.

Color Pattern

In our surveys two types of color pattern were observed: yellow to orange body coloration and dull body coloration (light brown) (Fig. 2). Interestingly, these two types were geographically separated. The yellow to orange body newts were found only in the northern part of Thailand: Doi Ang Khang, Namtok Mae Surin National Park (NP), Khun Chae NP, Phuping Rajanives, Doi Suthep, Doi Pui and Doi Inthanon NP, while the dull body coloration were found only in samples from the northeastern part of Thailand: Phu Suan Sai NP, Phu Luang Wildlife Sanctuary (WS) and Phu Hin Rong Kla NP (Table 1, Fig. 1B).

Female newts with yellow to orange body coloration were noticeably bigger compared to those with dull body coloration. In general, female newts have a significantly larger and more robust size than males but their size distributions are overlapping and not discrete. For instance, at Phuping Rajanives, Chiang Mai Province, average weight of 19 females was 20.3 ± 5.7 g (range 9.7-30.8 g) and for 20 males was 10.0 ± 1.3 g (range 8.1-12.6 g) ($p < 0.001$; Mann-Whitney Rank Sum Test), whilst the average snout-vent length of 19 females was 77.8 ± 10.0 mm (range 57.2-88.3 mm) and for 20 males was 63.9 ± 6.1 mm (range 60.2-88.6 mm) ($p < 0.001$; Mann-Whitney Rank Sum Test).

Habitat Uses and Foraging Behaviors

Our observations of habitats do not differ significantly from the published data.

Himalayan newts from the north of Thailand use the same habitats as those in the northeast. They were usually found in ponds or slow-moving streams, with an average depth of 38.2 ± 21.6 cm (range 9-120 cm). In most instances, the bottoms were covered with small pieces of debris. The average water temperature and air temperature was 19.1 ± 2.4 °C (range 13.4-21.7 °C), and 19.4 ± 3.9 °C (range 9.5-26.0 °C), respectively. The averaged altitude was $1,384 \pm 147$ m (range 1,119-1,584 m). In all areas, small water insects co-inhabited with the newt.

We observed the feeding behavior of larvae and adults maintained in our laboratory. The larvae foraged mainly on small crustaceans such as water fleas (*Moina macrocopa*) and showed cannibalistic behaviours among larval siblings of different sizes. Adult newts can consume small invertebrates and vertebrates such as bloodworms (*Chironomus* sp.), mealworms (*Tenebrio molitor*) and crickets (*Acheta* sp.) in keeping with preliminary data on their diet as rather non-specific generalists (Devi, 2005).

Newts were found in both clear and muddy waters. In all cases where we found newts, we did not find any fish which may suggest that perhaps fish are predators of eggs and larvae.

Breeding Behaviors

In Thailand, Himalayan newts show seasonal breeding, in May to July, the beginning of the rainy season in Thailand (Wongratana, 1984). During the breeding season the cloacal openings of females are mainly circular while those of males are oval. The clutch size of two females in captivity boxes at one field site were 15 and

20 eggs, respectively. Fertilized eggs are enclosed in transparent jelly envelopes. In nature, fertilized eggs on wet grass or plants overhanging the water surface or near small streams or ponds were found in May, 2004, at Phu Hin Rong Kra NP, Phitsanulok Province and in May, 2006, at Phu Suan Sai NP, Loei Province. Juveniles were found from August to December at Chiang Mai Province.

DISCUSSION

During our field surveys, *T. verrucosus* was found at 11 locations in Thailand, of which eight represent new locality distribution records. In previous publications, this species has been reported from within only four provinces of Thailand: Mae Hong Son, Chiang Mai, Nan and Loei (Table 2). Our field surveys add two new provinces: Chiang Rai and Phitsanulok. We did not find newts at Phu Reua NP, Loei Province, and at Nam Nao NP, Phetchabun Province. Interestingly, nor did we find them at Doi Phuka, Nan Province where they had been previously reported (Nabhitabhata and Chan-ard, 2005). However, we cannot formally exclude their current existence from these localities, and thus a distribution loss of some concern as, for example, perhaps our search did not cover appropriate habitats at those localities. However, our ability to find them elsewhere makes it tempting to speculate that they show at least a reduced current prevalence at those localities and thus merits a more thorough survey. As reported by Wongratana (1984), we found newts at Phu Luang WS which was the lowest latitude (17° 16' N) reported in the

literature. Our discovery of the newts at Phu Hin Rong Kra NP, Phitsanulok Province (16° 59' N) is, however, slightly farther to the south and thus extends its known distribution in Thailand slightly southwards. Regardless, here we confirm that this species currently is distributed in both northern and northeastern Thailand but, however, reveals morphological differences.

The Himalayan newts from the northern mountainous areas differ from those of the northeastern mountainous areas in their color pattern and in the size of females. All samples examined from the north are of an orange or yellow coloration and have large females (designated as Type I) whilst those in the northeast are all of dull coloration (light brown) and females are smaller (designated as Type II). Males of these two groups do not differ in size, only in colour as outlined.

This colour and size polymorphism has not, to the best of our knowledge, been reported before and so the distribution of Type II outside of northeastern Thailand is unclear but perhaps likely to be restricted within this region. The Type I pattern is the typical colouration for this species in Myanmar, Nepal and northern India, in keeping with its location in northern Thailand. Within Thailand, Wongratana (1984) mentioned the dull coloration of the one population he sampled, at Phu Luang, which may resemble the Type II colour of this study, but Taylor (1962) did not analyze the coloration of the Thailand populations. In contrast, Matsui et al. (1996) presented a photograph of a single specimen from northern Thailand similar in coloration to our Type I, and the two newts of Thailand illustrated by Nutphund (2001) also resemble our Type I.

TABLE 2. Locations and number of newts reported from published old literatures.

Region	No.	Province	Location	References
North	1	Chiang Mai	Doi Ang Khang	Wongratana (1984), Nabhitabhata et al. (2000), Nabhitabhata and Chan-ard (2005)
	2	Chiang Mai	Doi Chiang Dao	Smith (1924), Taylor (1962), Wongratana (1984), Nabhitabhata et al. (2000), Nabhitabhata and Chan-ard (2005)
	3	Chiang Mai	Doi Pui	Matsui et al. (1996)
	4	Chiang Mai	Doi Suthep-Pui	Suvatti (1965), Beaver (1982), Wongratana (1984), Nabhitabhata et al. (2000), Nabhitabhata and Chan-ard (2005)
	5	Chiang Mai	Doi Inthanon	Taylor (1962), Wongratana (1984), Nabhitabhata et al. (2000), Nutphund (2001), Nabhitabhata and Chan-ard (2005)
	6	Nan	Doi Phu Ka	Nabhitabhata and Chan-ard (2005)
	7	Mae Hong Son	Namtok Mae Surin NP	Nabhitabhata et al. (2000), Nabhitabhata and Chan-ard (2005)
Northeast	8	Loei	Phu Luang WS	Wongratana (1984), Chan-ard et al. (1999), Nabhitabhata et al. (2000), Nutphund (2001), Nabhitabhata and Chan-ard (2005)

NP = National Park; WS = Wildlife Sanctuary

ACKNOWLEDGEMENTS

We thank M. Chutmongkonkul, T. Chianunporn, A. Pansook, K. Nitiroj, K. Katawutpoonphan and Huay Hong Krai Royal Development Study Center staffs for help in the field, S. Malaivijitnond, N. Tandavanitj and N. Kitana for improvement of a draft version of this manuscript. This work was supported by the TRF/BIOTEC Special Program for Biodiversity Research and Training grant (T_249005 to P. Pomchote and R_148009 to W. Khonsue) and 90 years Chulalongkorn University grant, Ratchadaphiseksomphot Endowment Fund.

LITERATURE CITED

- Beaver, O. 1982. Occurrence of a salamander on Doi Suthep. *Journal of the Science Society of Thailand*, 36: 398-400. (in Thai)
- Chan-ard, T. 2003. A photographic guide to amphibians in Thailand, Darnsutha Press, Bangkok, 176 pp.
- Chan-ard, T., Grossmann, W., Gumprecht, A. and Schulz K.D. 1999. Amphibians and reptiles of Peninsular Malaysia and Thailand, Bushmasters Publication, Wuersele, 240 pp.
- Devi, N.T. 2005. The food of the Himalayan Newt (*Tylotriton verrucosus* Anderson): A preliminary study. *Journal of Bombay Natural History Society*, 102:166-168.
- Frost, D.R., Grant, T., Faivovich, J., Bain, R.H., Haas, A., Haddad, C.F.B., de Sa, R.O., Channing, A., Wilkinson, M., Donnellan, S.C., Raxworthy, C.J., Campbell, J.A., Blotto, B.L., Moler, P., Drewes, R.C., Nussbaum, R.A., Lynch, J.D., Green, D.M. and Wheeler, W.C.

2006. The amphibian tree of life. *Bulletin of the American Museum of Natural History*, 297: 1-370.
- Matsui, M., Nabhitabhata, J., Chan-ard, T. and Thirakhupt, K. 1996. Amphibian fauna of Thailand observed in 1994 and 1995. In: Matsui, M. (Ed.). *Evolutionary studies of small animals living in Asian tropics 1994-1995*, Graduate School of Human and Environment Studies, Kyoto University, 28-63 pp.
- Nabhitabhata, J. and Chan-ard, T. 2005. *Thailand red data: mammals, reptiles and amphibians*, Office of Natural Resources and Environmental Policy and Planning, Bangkok, 158 pp.
- Nabhitabhata, J., Chan-ard, T. and Chuaynkern, Y. 2000. *Checklist of amphibians and reptiles in Thailand*, Office of Environmental Policy and Planning, Bangkok, 152 pp.
- Nutphund, W. 2001. *Amphibians of Thailand*, Amarin Printing and Publishing Public Co., Ltd., Bangkok, 320 pp. (in Thai)
- Smith, M.A. 1924. The tadpole of *Tylotriton verrucosus* Anderson. *Records of the Indian Museum*, 26: 309-312.
- Stuart, B. and Papenfuss, T.J. 2002. A new salamander of the genus *Paramesotriton* (Caudata: Salamandridae) from Laos. *Journal of Herpetology*, 36: 145-148.
- Suvatti, C. 1965. A survey on salamander at Chiang Mai. Faculty of Fisheries, Kasetsart University, Bangkok, 2 pp. (in Thai)
- Taylor, E.H. 1962. The amphibian fauna of Thailand. *The University of Kansas Science Bulletin*, 43(8): 265-599.
- Wongratana, T. 1984. Range extension of crocodile salamander, *Tylotriton verrucosus* Phu Luang, Thailand. *Natural History Bulletin of the Siam Society*, 32: 107-110.
- Zhao, E., Hu, Q., Jiang, Y. and Yang, Y. 1988. *Studies on Chinese salamanders*. Society for the Study of Amphibians and Reptiles, Ohio, 67 pp.

Received: 26 November 2007

Accepted : 15 March 2008