DISSERTATION

MORPHOLOGICAL CHARACTERS FOR IDENTIFICATION OF ANURAN TADPOLES IN KHAO LUANG NATIONAL PARK, KHLONG NAKHA AND HALA-BALA WILDLIFE SANCTUARY

PRATHEEP MEEWATTANA

GRADUATE SCHOOL, KASETSART UNIVERSITY
2005

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THESIS

MORPHOLOGICAL CHARACTERS FOR IDENTIFICATION OF ANURAN TADPOLES IN KHAO LUANG NATIONAL PARK, KHLONG NAKHA AND HALA-BALA WILDLIFE SANCTUARY

PRATHEEP MEEWATTANA

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All found tadpoles were 51 species, 22 genera in 5 families at Khlong Nakha Wildlife Sanctuary, Khao Luang National Park and Hala-Bala Wildlife Sanctuary during January 2003 – January 2004. The survey was conducted every 2 months and lasted 15 – 20 days per survey. In each area, tadpoles were collected 28 species, 17 genera in 5 families at Khlong Nakha Wildlife Sanctuary; 27 species, 12 genera in 5 families at Khao Laung National Park; and 32 species, 17 genera in 5 families at Hala-Bala Wildlife Sanctuary. There were 4 genera of 6 species which can not be identifiable to species level, i. e. *Leptobrachium* sp.1, *L.* sp.2, *Amolops* sp. 1, *A.* sp.2, *Huia* sp. and *Limnonectes* sp.. Seasonally, Tadpoles 45 species were found in dry period, 23 tadpoles' species in wet period and 17 tadpoles species in both dry and wet period.

The microhabitats were separated into lotic and lentic systems. There were altogether 13 microhabitats in which 10 microhabitats in lotic system and 3 microhabitats in lentic system.

The mouthpart characters could be divided into 4 types, i. e. dorsal mouth type, ventral mouth type, anteroventral mouth type and terminal mouth type. In each tadpole's mouth type showed different feeding behavior and living in different microhabitats. Therefore, the buccal cavity of tadpoles in each genera and each mouthpart characteristic also were different. The buccal cavity together with external morphology, mouthpart and behavior could

Student's signature

Thesis Advisor's signature

27 / 05 / 2005

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Finally, I am cordially grateful for the encouragement of my parent, who not only assisted in numerous general ways, but also contributed substantial expenditure to cover my study casts.

Lastly, I would like to add that any would be errors, which may appear are solely mine.

Pratheep Meewattana
May 2005

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INTRODUCTION

An amphibian vertebrate is an animal living in water and on land. It is also the first animal group that moved to live on land 350 millions year ago, in the Upper Carboniferous Period (Young, 1981). They are abundant in the tropical region.

The extant world amphibian in the group anura has more than 4,600 species (Pough, 1998), about three quarters of these species have tadpole for some period during their development and there are known tadpole descriptions for about a third of those (McDiarmid and Altig, 1999). Thus, the studying about those anuran tadpoles is rather important for understanding them, increasingly especially life clcle (Figure 1), behavior and also their living. In Thailand, 106-110 species have been found (Nabhitabhata, 2000). However, more are likely to be found, if serious study is conducted. Although, there is other research that concerns amphibians, amphibians are difficult to study because the animals are active at night, have small bodies and their body colours blend well with the surroundings. Thus, it is very difficult to see them. Moreover, people do not find them appealing and this makes it a serious and important disincentive for study. The study of tadpole is not difficult, same amphibian's adult. Tadpoles live in water freely like fish. Each type may differ in their colour, size, shape and living habit because they live in different environmental conditions. Because of these reasons, they are different in body characters, especially the internal oral parts which are different in each type (Wassersug, 1988). The study of the differences of internal and external morphologies and the diverse environments in which they live provide us with better knowledge of their lives and habitats. These data can be utilized as basic data for further study, and even management planning of amphibians and other related animal groups.

Khlong Nakha is one of appropriated area for living and distributing species of this animal group, however there were not found the study of diversity of tadpole in Khlong Kakha. The study of the diversity of tadpole would help us to gain basic knowledge such as how many tadpoles' species in the area. Moreover, the study would enhance the knowledge on ecological situation and their behavior. On the other hand, Khao Luang had been selected to study for many researches on the diversity of amphibian's adulthood. But the increasing study would be supported an information for the distribution and species' identification. Because some study only for adulthood could not be selected all adults sample in the area of Khao Luang. In case of Hala-Bala, it closes to the border between Thailand and Malaysia, and this area also had been found the study on diversity of adult's species as Khao Luang. As well as, Hala-Bala has biggest forest. Hence, that the study only on the adulthood could not cover in every area and some species could not be found in the survey. On the contrary, the study on tadpole could be enhanced the capability for species'

identification. Furthermore, the study of tadpoles could be enabling the understanding on their living in each ecological situation of adulthood.
The discovered tadpoles in each microhabitat could be helped us to describe the characteristics of ecology around them.

OBJECTIVES

1.To study species richness of anuran tadpoles in lotic and lentic water systems at Khlong Kumpuan basin in Khlong Nakha Wildlife Sanctuary, Ranong province, Khlong Thadee basin in Khao Luang National Park, Nakhon Si Thammarat province and Khlong Ia-garding basin in Hala-Bala (only Bala) Wildlife Sanctuary, Narathiwat province.

2. To examine the features of their external morphology.

3. To study the details of buccal cavity characteristics.

4. To conduct detailed description and identification of key characteristics as features of each genus.

5. To study the ecological requirements of each anuran tadpoles species.

LITERATURE REVIEWS

There are 4,600 species of frog in the world (Pough, 1998), about three quarters of these species have tadpoles for some period during their development, and there are known tadpole's descriptions for about a third of those (McDiarmid and Altig, 1999). The study that concerns anuran tadpoles (Figure 1) was started when the herpetologist discovered fossils of tadpole in Utah (Estes, 1978; Paicheler, 1978; Spinar, 1980; Wassersug and Wake, 1995). There are many researchers who have studied external and internal morphology, as follows; External morphology, such as Amphibia of Borneo (Inger, 1966). Larval Diversity and Development in the Singapore Amphibians Anura (Leong, 1999). In Thailand such as Descriptions of Five Tadpole from Siam (Smith, 1916), On Tadpole from Siam (Smith, 1917), Descriptions of some tadpole from Thailand (Heyer, 1971), and Study on Mouthpartss Structures in Relation toFeeding Behavior of Some Tadpole species (Chanthip, 2000). For Internal Morphology (buccal cavity), such as Larvae of Southeast Asia species of *Leptobrachium* and *Leptobrachella* (Inger, 1983), Tadpoles of the forested regions of Borneo (Inger, 1984), and A survey of internal oral features of *Leptodactyloid* larvae (Wassersug, 1988).

Understanding morphology, especially the oral disc, is crucial to comprehending the feeding ecology of tadpoles and therefore is likely to be the foremost factor in interpreting most, perhaps all, aspects of their biology. Variations in the timing of morphological change in tadpoles have strongly influenced the evolutionary history of frogs and certainly are central to species definition and diagnoses. Therefore, it is necessary to describe the basic morphological patterns of tadpole's diversity and interpreting them in the light casted by their physical and biological environments (McDiarmid and Altig, 1999, 1999). Most tadpole's descriptions are based on aspects of coloration, shape of body, fin and tail-musculatures and positions of the spiracle, eyes and vent. The complex oral apparatus and buccal pharyngeal structures of tadpole are diverse on both micro and macro morphological scales (Gollman, 1991 and 1995).

Staging is the recognition of certain morphological characters during the whole development and is divided into 46 stages (Gosner, 1960) (Appendix Figure 1) of Nieuwkoop and Faber (1967; *Xenopus laevis*: 60 stages, fertilization to metamorphic completion), Shumway (1940; *Rana sylvatica*: 25 stages, from the fertilization to opercular closure) and Taylor and Kollros (1946; *Rana pipiens*: 25 stages, hind limb bud appearance to metamorphic).

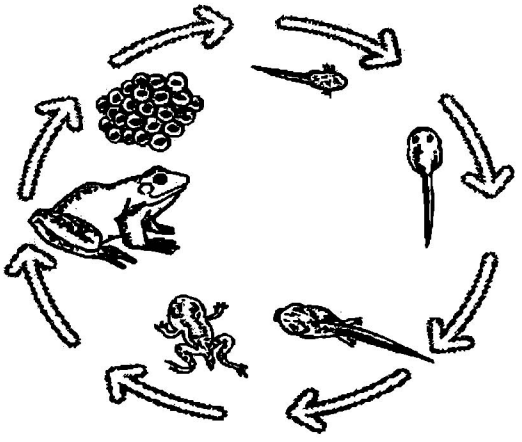


Figure 1 Life Cycle of Amphibians.
Source : Life cycle, 2001

Morphological Characters

Morphology characters of anuran tadpoles are different in each species. However, in each species the external and internal buccal cavity can be used in the classification. Morphological features that are used for identification are as follows;

1. External Morphology

Body Plan; when observed superficially they look like small fish (Figure 2). But when they are viewed from the left side, the difference can be seen because they have a spiracle and that distinguishes them from fish (McDiarmid and Altig, 1999).

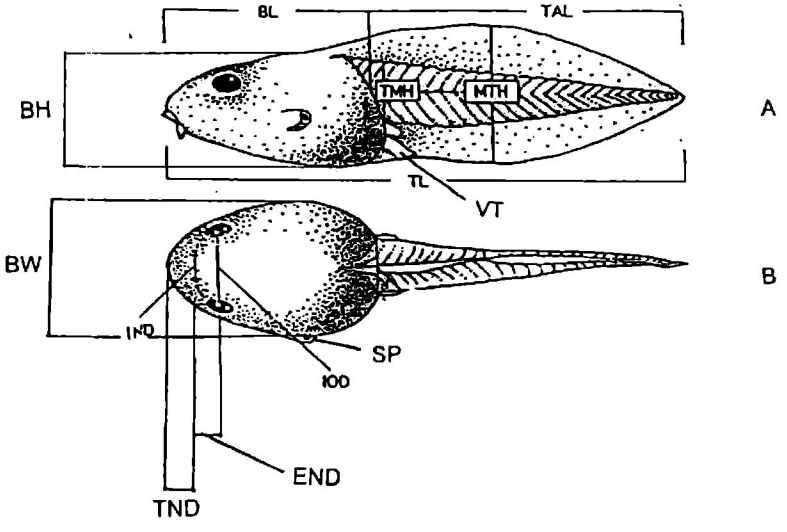


Figure 2 The Body of Tadpole.
Source: McDiarmid and Altig (1999)

Primary features and measurements of a tadpole body. (A) Lateral view. (B) Dorsal view. Abbreviations;

BL – body length = tip of mouthparts of body to end of body (Smith, 1917; Inger, 1966; Heyer, 1971; Wassersug, 1981; Altig, 1998; Leong and Chou, 1999 and Mcdiarmid and Altig, 1999).

BH – body Elevation = belly to back(Smith, 1917).

BW – body weight = left to right side (Smith, 1917).

C – colour (Inger, 1966 and Wassersug et al., 1981).

EP – eyes position (Smith, 1917; Inger, 1966; Heyer, 1971; Wassersug et al., 1981; Altig, 1998; Leong and Chou, 1999 and Mcdiarmid and Altig, 1999).

END – eyes–nostil distance (Inger, 1966 and Wassersug et al., 1981).

IND – internarial distance = measured between centers of narial apertures (Smith, 1917; Inger, 1966; Heyer, 1971; Wassersug et al., 1981; Altig, 1998; Leong, 1999 and Mcdiarmid and Altig, 1999).

IOD – interorbital distance = measured between centers of pupils (Smith, 1917; Inger, 1966; Heyer, 1971; Wassersug et al., 1981; Altig, 1998; Leong, 1999 and Mcdiarmid and Altig, 1999).

MTH – maximum tail Elevation = upper to lower of median tail (Smith, 1917; Inger, 1966; Heyer, 1971; Wassersug et al., 1981; Altig, 1998; Leong, 1999 and Mcdiarmid and Altig, 1999).

SP – spiracle = a hole to drain water out of body (Smith, 1917; Inger, 1966; Heyer, 1971; Wassersug et al., 1981; Altig, 1998; Leong and Chou, 1999 and Mcdiarmid and Altig, 1999).

TND – tip of mouth – nostil distance (Inger, 1966 and Wassersug et al,, 1981).

TAL – tail length = end of body to tip tail (Altig, 1998 and Mcdiarmid and Altig, 1999).

TL – total length = head and body (Smith, 1917; Inger, 1966; Heyer, 1971; Wassersug et al., 1981; Altig, 1998; Leong and Chou, 1999 and Mcdiarmid and Altig, 1999).

TMH – tail muscle Elevation = upper to lower of tail muscle on end of body (Inger, 1966; Altig, 1998 and Mcdiarmid and Altig, 1999).

VT – vent tube (Smith, 1917; Inger, 1966; Heyer, 1971; Wassersug et al., 1981; Altig, 1998; Leong and Chou, 1999 and Mcdiarmid and Altig, 1999).

Mouthparts (Figure 3, oral disc, labium tooth and jaw); tadpole of certain species may be difficult to distinguish externally. The mouthparts have characteristics that are useful for distinguishing between similar species (Altig, 1998).

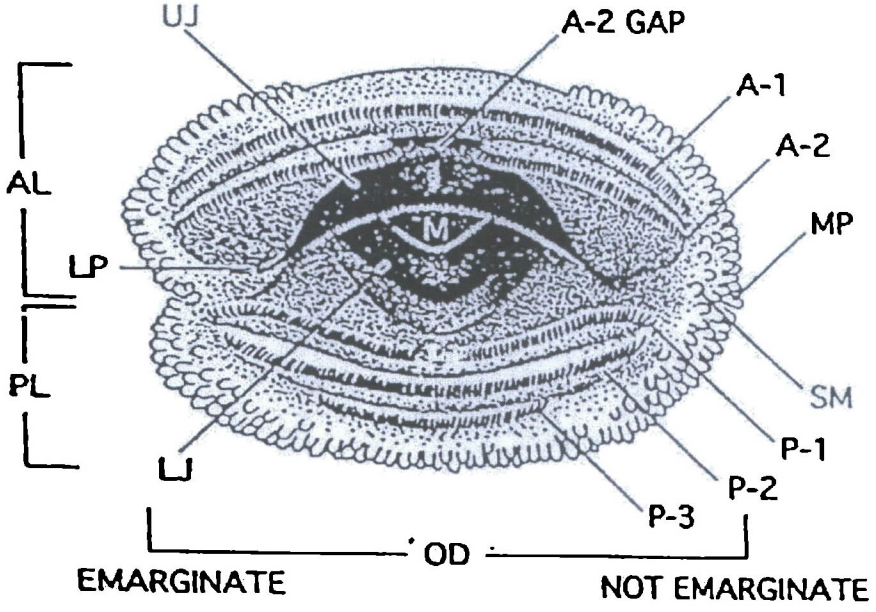


Figure 3 Mouthparts (Oral apparatus) of Anuran tadpoles.
Source: Dubois (1995)

Oral apparatus of tadpole showing emarginate (left side) and not emarginate (right side) conditions of the oral disc. The abbreviations for descriptive terminology of oral apparatus are as follows;

AL- anterior (upper) labium (Wassersug et al., 1981; Inger, 1984; Dubois, 1985; Altig, 1998 and McDiarmid and Altig, 1999).

A-1 and **A-2** - first and second anterior (upper) tooth rows (Smith, 1917; Inger, 1966; Heyer, 1971; Wassersug et al., 1981; Altig, 1998; Leong and Chou, 1999; McDiarmid and Altig, 1999).

A-2- GAP - medial gap second anterior tooth rows (Wassersug et al., 1981; Inger, 1984; Dubois, 1985; Altig, 1998, McDiarmid and Altig, 1999).

LJ - lower jaw (Wassersug et al., 1981; Inger, 1984; Dubois, 1985; Altig, 1998 and McDiarmid and Altig, 1999).

LP - lateral process of upper jaw sheath.

M - mouth (Dubois, 1995).g

MP - marginal papillae (Wassersug et al., 1981; Inger, 1984; Dubois, 1985; Altig, 1998 and McDiarmid and Altig, 1999).

OD - oral disc (Wassersug et al., 1981; Inger, 1984; Dubois, 1985; Altig, 1998 and McDiarmid and Altig, 1999).

PL - posterior (lower) labium (Wassersug et al., 1981; Inger, 1984; Dubois, 1985; Altig, 1998 and McDiarmid and Altig, 1999).

P-1, P-2 and **P-3** - first, second and third posterior (lower) tooth row (Smith, 1917; Inger, 1966; Heyer, 1971; Wassersug et al., 1981; Altig, 1998; Leong and Chou, 1999; McDiarmid and Altig, 1999).

SM - submarginal papillae (Wassersug et al., 1981; Inger, 1984; Dubois, 1985; Altig, 1998 and McDiarmid and Altig, 1999).

UJ - upper jaw sheath (Wassersug et al., 1981; Inger, 1984; Dubois,1985; Altig, 1998 and McDiarmid and Altig, 1999).

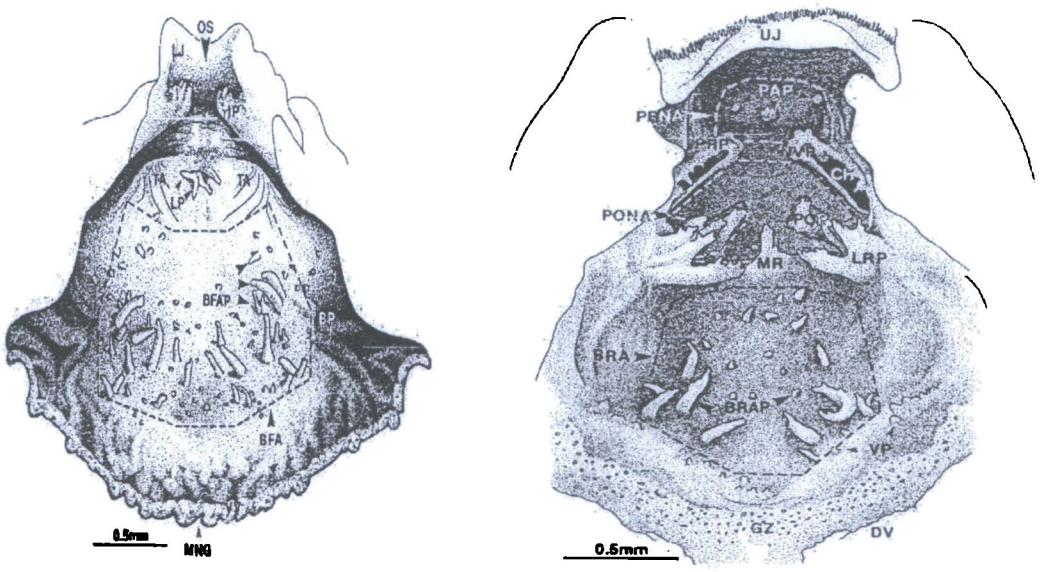
Figure 3, Shows the 2 keratodont rows on anterior labium (A-1 continuous ; A-2 discontinuous lateral), 3 keratodont rows on posterior labium (P-1 discontinuous, divided; P-2, P-3 continuous), Keratodont Formula (KF) or Labial Tooth Row Formula (LTRF) and a list of the various formulae which have been proposed to describe the number and structure of keratodont rows of anuran tadpoles, with examples of fig 3.

Boulenger, 1891; 2/3
Boulenger, 1895; 1/1 1 / 1 1/2
Annandale, 1908; 1/1+1//1+1/2
Boulenger, 1918; 1/1+1/1+1/2
Annandale and Ryo, 1918; 1 : 1+1/1+1 : 2
Rao, 1922; 1 1/1 2
Van Kampen, 1923; $1^1/1^2 1$
Okada, 1925; 1 : 1+1/2 : 1+1
Liu, 1990; I : I-I / II : I-I
Inger, 1966; I : I+I / I+I : I
Altig, 1970; 2(2) / 3(1)
Matsui, 1975; I : I+I / I+I : II
Heyer, 1990; 2(2) / 3(1)
Dubois, 1995; 2(2) / 3(1

For example of LTRF are 1/1+1/1+1/2 (Boulenger, 1895) and I:I+I/I+I:II (Inger, 1966). Both LTRF can describe as follows: 1/1+1 and I:I+I are upper tooth with 2 rows, 1 or I are the first row, 1+1 or I+I are left and right rows of the second row because median with gap: 1+1/2 and I+I:II are lower tooth with 3 rows; 1+1 or I+I are left and right rows of lower tooth and median with gap; 2 or II are the second and third rows and they are complete. For 2(2)/3(1) (Dubois, 1995) is 2(2) is upper tooth with 2 rows, 2 is the number of tooth row but (2) is the second row with gap; 3(1) is lower tooth with 3 rows, 3 is the number of tooth row but (1) is the first row with gap. In this study, Dubois's LTRF have been used for description LTRF.

2. Internal morphology (Buccal cavity)

The buccal cavity is the dominant character shown inside the oral cavity (figure 4), some kinds of tadpole are similar in external morphology but their buccal cavity feature is different and the characteristic in the buccal cavity varies enabling a procedure of tadpole classification (Wassersug et al., 1981). The characteristics that are used for study are as follows;



A **B**

Figure 4 Buccal cavity structure of Anuran tadpoles (**A**= Buccal floor **B**= Buccal roof). Source: McDiarmid and Altig (1999)

A: The floor of the buccalphryngeal (buccal cavity); *Bufo bufo*, Terminology follows Wassersug (1976; 1980): **BFA**= buccal floor arena, **BFAP**= buccal floor arena papillae; buccal floor arena (Inger, 1984), **BP**= buccal pocket; lateral papillae of buccal floor arena (Inger, 1984), **IP**= infralabial papillae, **LJ**= lower jow, **LP**= lingual papillae; tongue and tongue papillae (Inger, 1984), **MNG**= medial notch above glottis; ventral velum (Inger, 1984), **OS**= mouth, **TA**= tongue anlage.

B: The roof of the buccal cavity; *Bufo bufo*, Terminology follows Wassersug (1976a; 1980): **BRA**= buccal roof arena, **BRAP**= buccal roof arena papillae; buccal roof arena (Inger, 1984), **CH**= Choanae, **DV**= dorsal velum, **GZ**= grandular zone, **LRP**= lateral ridge papillae, **MR**= medial ridge, **NVP**= narial valve projection, **PAP**= prenarial arena postulations; prenarial ridge (Inger, 1984), **POP**= postnarial papillae, **PONA**= postnarial arena; postnarial papillae (Inger, 1984), **PRP**= prenarial papillae, **PRNA**= prenarial arena, **UJ**= upper jaw, **VP**= prevelar papillae.

3. Synoptic Description of Key to Families, Subfamilies and Genera

Character abbreviations used in the compilation are CO = Composition (Family/ Subfamily; number of genera/number of species, genus: number of species); **GR** = Geo-graphic Range; **EMG** = EcoMorphological Guild; **LTRF** = Labial Tooth Row Formula; **OA** = Oral Apparatus (typical oral disc with labial teeth and jaw sheaths regardless of configuration: position descriptor); **MP**= Marginal Papillae (distribution: arrangement); **SUP**= Submarginal Papillae; **DEM**= Disc Emargination; **NA**= Nares; **VT**= Vent Tube; **EP**= Eyes Position; **SP**= Spiracle; **UJ**= Upper jaw sheath (width notation descriptor of shape of serrated edge); **LJ**= Lower Jaw Sheath (width notation descriptor of shape of serrated edge); **DF**= Dorsal fin (general

Elevation descriptor, anterior site of origin, tip descriptor); **BS**= Body Shape (dorsal view / lateral view); **CP**= Colour and Pattern; **TL**= Total Length / Stage; **NO**= Notes; **CI**= Citation(s).

Family Bufonidae

CO: 33/381. GR: widespread except Australia. EMG: exotroph: lentic: benthic; lotic: benthic; suctorial, gastromyzophorous, endotroph. LTRF: 2/3, 2(2)/3, 2(2)/3(1), 2(2)/2. OA: typical: anteroventral, rarely ventral and suctorial. MP: wide dorsal and ventral gaps, complete uni-and biserial, wide dorsal gap only. DEM: lateral, absent. NA: often large, often not round and with medial papillae, sometimes small and rounded, closer to eye than snout or reverse. VT: medial, dextral. EP: dorsal. SP: sinistral. UJ: usually narrow and broadly arched. LJ: usually narrow and broadly arched V-shaped. DF: low, originates near or posterior to dorsal tail-body junction, tip round to slightly pointed. BS: oval to round / depressed. CP: Typically uniformly black; tail muscle sometimes bicolored or banded. TL: 15-40/36.

Ansonia: CO: 19. GR: India-Borneo-Philippines. EMG: exotroph: lotic clasping, suctorial, gastromyzophorous. LTRF: 2/3. OA: typical : ventral. MP: small, with medium to wide dorsal gap, complete: uniserial. SUP: row(S) distal to P-3, few laterally. DEM: lateral, absent. NA: small, neares eyes than snout. VT: medial. EP: dorsal. SP: sinistral. UJ: narrow to medium, divided, absent. LJ: narrow, very open V-shaped. DF: low, originates on tail muscle or near dorsal tail-body junction, tip bluntly pointed. BS: oval / depressed. CP: uniformly dark, with middorsal stripe. TL: 18-35/36. NO: large variations in oral morphology within genus ; anterolateral terminus of abdorminal sucker of A 'sucker' of Inger (1992) has finger like projection. CI: Inger (1966, 1985 and 1992).

Bufo: CO: 217. GR: widespread. EMG: exotroph: lentic: benthic; lotic: benthic, suctorial, gastromyzophorous. LTRF: 2(2)/3(1), 2(2)/3, 2/3, 2(2)/2(1). OA: typical: anteroventral. MP: wide dorsal and ventral gaps, complete: uniserial. SUP: few laterally, absent. DEM: lateral, absent. NA: large and usually not round, often with medial papilla. VT: medial, dextral. EP: dorsal. SP: sinistral. UJ: narrow, smooth arc, angled laterally. LJ: narrow, open V-shaped. DF: low, originates at dorsal tail-body junction, tip rounded. BS: oval-round/depressed. CP: typically uniformly black, tail muscle sometimes bicoloured or banded. TL: 15-35/36. NO: small size is common; morphologically conservative and species characteristics poorly documented; no consistently recognized morphological differences among numerous species groups except in *debilis* group; Crump (1989) reported facultative endotrophy in *B. periglenes*. CI: Altig (1970); Berry (1972); McDiarmid and Altig (1990); Zweifel (1970).

Family Hylidae

CO: 41/743. GR: Holarctic-Neotropic-Australopapua. EMG: exotroph: lentic: several guilds; lotic: several guilds; endotroph. LTRF: many variations between 0/0 and 17/21 OA: typical: anteroventral, ventral, terminal. MP: dorsal gap, complete,

dorsal and ventral gaps: variable, often bi – or multiserial. SUP: highly variable, DEM: absent, lateral. NA: round, variable in size, closer to snout than eye or reverse, often rimmed and countersunk. VT: dextral, medial. EP: lateral, dorsal. SP: sinistral, low on left side, ventral. LJ: highly variable. DF: highly variable. BS: oval to oblong/depressed, equidimensional and compressed. CP: highly variable. TL: 20-60/36. NO: marginal papillae always smaller and more densely arranged than ranids, the most commonly confused taxa; few taxa with 1-3 anterior rows with medial gaps distal to nonbroken rows.

Hyla: CO: 289. GR: North, Central and South America-Eurasia. EMG: exotroph: lotic: arboreal, benthic, adherent, clasping, suctorial; lentic, benthic, nektonic, arboreal. LTRF: many variations between 0/0 and 17/21; 2/3 most common. OA: typical: terminal, anteroventral, ventral; reduced to various degrees. MP: dorsal gap, dorsal and ventral gaps: uni-, bi-, and multiserial. SUP: few too many laterally, distinct rows above upper and below lower tooth rows, absent. DEM: absent. NA: various positions. VT: dextral, medial. EP: dorsal, lateral. SP: sinistral. UJ: many variations. LJ: many variations. DF: very low to very high, originates anterior to, near (most common), or posterior to dorsal tail-body junction, tip pointed to round. BS: oval to oblong/depressed, compressed or equidimensional. CP: variable. TL: 20-60/36. NO: a number of species groups have distinctive morphologies. CI: Caldwell (1974); Duellman (1970, 1978); Duellman and Altig (1978); Duellman and Fouquette Jr. (1968); Duellman and Trueb (1989); Peixoto and Da Cruz (1983); Savage (1980).

Family Megophryidae

CO: 9/79. GR: northern India-China-Philippines. EMG: exotroph: lotic: clasping, neustonic, benthic; endotroph. LTRF: 0/0 to 7/7. OA: typical: anteroventral, ventral; umbelliform; oral disc bi-triangular. MP: narrow dorsal gap, complete, absent: uniserial. SUP: scattered near mouth, few laterally, some arranged radially to mouth. DEM: absent, dorsal and ventral. NA: equidistant between eye and snout, nearer eye than snout or reverse. VT: dextral, medial. EP: dorsal, lateral. SP: sinistral but well below longitudinal axis. UJ: absent, medium to wide, small medial convexity or not. LJ: absent, medium to wide, U- or V-shaped. DF: low, originates near or posterior to dorsal tail-body junction, tip rounded to pointed. BS: oval to elongate/depressed. CP: muted mottling to unicolored. TL: 25-75/36.

Leptobrachium: CO: 10. GR: Indonesia-China-Philippines. EMG: exotroph: lotic: benthic. LTRF: 3(1-3)/4(1-3) to 7(2-6)/6(1-5). OA: typical: anteroventral to ventral. MP: complete: uniserial. SUP: few laterally. DEM: absent. NA: equidistant between eye and snout, 1-3 medial projections. VT: dextral. EP: dorsal. SP: sinistral but well below longitudinal axis. UJ: wide, smooth arc. LJ: wide, wide V-shaped. DF: low, originates near dorsal tail-body junction, tip pointed to rounded. BS: oval to oblong/depressed. CP: uniformly dark. TL: 30-50/36. NO: LTRF very variable, integumentary glands sometimes present, submarginal papillae commonly have labial teeth. CI: Berry (1972); Inger (1983, 1985).

Leptolalax: CO: 7. GR: Burma-China-Borneo. EMG: exotroph: lotic: suctorial, clasping. LTRF: 5(2-5)/3(1-2). OA: typical: ventral. MP: narrow dorsal gap or complete: uniserial. SUP: scattered above and below mouth, probably rudimentary tooth ridges. DEM: dorsal and ventral. NA: nearer snout than eye. VT: dextral EP: dorsal. SP: sinistral but well below longitudinal axis. UJ: wide, smooth arc. LJ: wide, open U-shaped. DF: low, particularly in first fourth, originates distal to dorsal tail-body junction, tip rounded. BS: oblong/very depressed. CP: uniformly brown. TL: 25-50/36. NO: integumentary glands dorsolaterally. CI: Inger (1983, 1985).

Megophrys: CO: 25. GR: Southeast Asia-China-Philippines-Greater Sundas. EMG: exotroph: lotic: neustonic; endotroph. LTRF: 0/0. OA: umbelliform: bi-triangular. MP: slight crenulations to none. SUP: scattered throughout oral disc, some arranged radially to mouth. DEM: absent. NA: nearer snout than eye. VT: medial. EP: lateral. SP: sinistral but well below longitudinal axis. UJ: absent, minor keratinization. LJ: minor keratinization. DF: low, originates near or posterior to distal tail-body junction, tip pointed. BS: oblong/depressed. CP: belly striped in some. TL: 30-50/36. CI: Inger (1985); C.-C. Liu and Hu (1961); Ye and Fei (1996).

Ophryophryne: CO: 3. GR: Vietnam-China. Tadpole unknown.

Family Microhylidae

CO: 65/327. GR: North and South America, Africa, India-Korea-Austropapuan region. EMG: exotroph: lentic: suspension feeder, psammonic; endotroph. LTRF: 0/0. OA: keratinized structures absent (except in *Otophryne* and *Scaphiophryne*); any resemblance to an oral disc absent (except in umbelliform *Microhyla*, *Nelsonophryne*, *Otophryne* and *Scaphiophryne*) oral apparatus usually involves semicircular to straight-edged oral flaps pendant over terminal mouth, few species with umbelliform oral disc. MP: not applicable except in *Nelsonophryne* and some endotrophs. SUP: not applicable except perhaps in *Nelsonophryne*. DEM: not applicable. NA: usually absent until metamorphosis but positioned nearer snout than eye. VT: medial, dextral. EP: lateral, dorsal. SP: midventral on chest, abdomen or near vent, appears sinistral in different configurations in *Otophryne* and *Stereocyclops*. UJ: usually absent but *Scaphiophryne* has unpigmented jaw sheaths, *Otophryne* has hypertrophied serrations without a basal sheath. LJ: as upper jaw. DF: low, originates near dorsal tail-body junction, sometimes with flagellum. BS: round to oval/depressed. CP: dorsum uniform, sometimes with sagittal line, venter sometimes mottled or striped. TL: 15-35/36.

Subfamily Microhylinae

CO: 29/106. GR: North and South America and Southeast Asia.

Kalophrynus: CO: 10. GR: southern China-Java-Philippines. EMG: endotroph.

Kaloula: CO: 10. GR: Korea-Sri Lanka. EMG: exotroph: lentic: suspension feeder. LTRF: 0/0. OA: straight-edged upper lip without oral flaps above terminal mouth. MP: not applicable. SUP: not applicable. DEM: not applicable. NA: absent. VT: medial. EP: lateral. SP: midventral near vent. UJ: absent. LJ: absent. DF: low, originates near dorsal tail-body junction, tip pointed. BS: rounded/depressed. CP: uniform, tail striped, terminal part of tail may be unpigmented. TL: 25-30/36. CI: Kirtisinghe (1958); C.-C. Liu (1950).

Microhyla: CO: 24. GR: Sri Lanka-Japan-China-Southeast Asia. EMG: exotroph: lentic: suspension feeder. LTRF: 0/0. OA: small to large semicircular oral flaps with smooth edges pendant over terminal mouth, umbelliform taxa have oral disc with radially arranged submarginal papillae, and formed almost entirely of lower labium. MP: not applicable. SUP: not applicable. DEM: not applicable. NA: absent. VT: medial. EP: lateral. SP: midventral on belly or near vent. UJ: absent. LJ: absent. DF: low, originates near dorsal tail-body junction, tip pointed with or without a flagellum. BS: round to oval/depressed. CP: dark, belly sometimes mottled or banded, tail striped. TL: 20-30/36. CI: Chou and Lin (1997); Heyer (1971); Inger (1985); Inger and Frogner (1979).

Glyphoglossus: CO: 1. GR: Burma-Thailand. EMG: exotroph: lentic: suspension feeder. LTRF: 0/0. OA: straight-edged upper lip without oral flaps above terminal mouth. MP: not applicable. SUP: not applicable. DEM: not applicable. NA: absent. VT: medial. EP: lateral. SP: midventral below gut. UJ: absent. LJ: absent. DF: low, originates near dorsal tail-body junction, tip pointed. BS: oval/depressed. CP: pale brown, translucent, distal part of tail dark. TL: 40/36. NO: M.A. Smith (1917) reports data on the nares as if they were present, hang in midwater at a 45° angle. CI: M.A. Smith (1917).

Subfamily Dyscophinae

CO: 2/9. GR: Madagascar and Southeast Asia.

Calluella: CO: 6. GR: Southeast Asia. EMG: exotroph: lentic: suspension feeder. LTRF: 0/0. OA: straight-edged upper lip without medial notch above terminal mouth. MP: absent. SUP: absent. DEM: not applicable. NA: absent until metamorphosis. VT: medial. EP: lateral. SP: midventral below gut. UJ: absent. LJ: absent. DF: low, originates near dorsal tail-body junction, tip pointed. BS: oval/depressed. CP: pale brown, translucent, distal part of tail dark. TL: 24/31. NO: ventral fin with lobe near body, hangs in mid-water at a 45° angle. CI: C.-C. Liu and Hu (1961); M.A. Smith (1917).

Family Ranidae

CO: 45/635. GR: widespread. EMG: exotroph: lentic: several guilds; lotic: several guilds; endotroph. LTRF: many variations between 0/0 and 9/8, 2/3 and n/3 most common. OA: typical: anteroventral, ventral to almost terminal, oral disc reduced and LTRF absent. MP: wide dorsal gap, dorsal and ventral gaps: uni- and

biserial. SUP: absent few laterally. DEM: lateral absent NA: nearer eye than snout or reverse. VT: dextral, medial. EP: dorsal, lateral. SP: sinistral. UJ: narrow to wide, smooth arc, medial convexity. LJ: narrow to wide, U- to V-shaped. DF: low, originates near dorsal tail-body junctions, very low, originates on tail muscle, tip pointed to round. BS: oval/depressed. CP: mostly muted tones of mottling. TL: 30/100/36.

Subfamily Raninae

CO: 32/541. GR: widespread.

Amolops: CO: 24. GR: northern India-China-Southeast Asia-Indonesia. EMG: exotroph: lotic: gastromyzophorous. LTRF: 4-8/3-4, usually with three complete distal rows on upper labium and a medial gap in first lower row. OA: typical: suctorial. MP: wide dorsal gap. SUP: absent. DEM: lateral. NA: closer to eye than snout. VT: medial. EP: dorsal. SP: sinistral. UJ: medium, wide U-shaped. LJ: medium, wide U-shaped. DF: low, originates near or posterior to dorsal tail-body junction, tip rounded. BS: oval/depressed. CP: muted mottling. TL: 50-70/36. NO: postorbital and posteroventral integumentary glands, some species with keratinized spinules in the skin. CI: Inger (1985); Inger and Gritis (1983).

Chaparana: CO: 6. GR: India-China. EMG: exotroph: lotic: clasping. LTRF: 8(3-8)/3. OA: typical: ventral. MP: wide dorsal gap: uniserial. SUP: few ventrolaterally and in a row distal to P-3. DEM: absent. NA: -. VT: dextral. EP: dorsal. SP: sinistral. UJ: medium, wide smooth arc. LJ: wide, V-shaped. DF: low, originates near dorsal tail-body junction. BS: oval/depressed. CP: uniformly dark. TL: -. CI: C.-C. Liu and Hu (1961).

Hoplobatrachus: CO: 5. GR: Angola-Ethiopia-southern Asia-China. EMG: exotroph: lentic: carnivore: lotic: carnivore. LTRF: 4(3-4)/4(1-2), 5(3-5)/5(1). OA: typical: anteroventral. MP: complete: uniserial. SUP: absent. DEM: absent. NA: nearer eye than snout. VT: dextral. EP: dorsal. SP: sinistral. UJ: wide, prominently medially incised. LJ: wide, prominently medially incised. DF: low, originates near dorsal tail-body junction. BS: oval/depressed. CP: uniformly brown. TL: 43/30. NO: M.A. Smith (1917) discussed variations and nonconcordance among sources that suggest other species are involved. CI: Annandale and Rao (1918); Lamotte and Zuber-Vogeli (1954); M.A. Smith (1917).

Huia : CO: 4, GR: Angola-Ethiopia-southern Asia-Chaina. EMG: exotroph: lentic: carnivore; LTRF; 4(3-4)/4(1/2), 5(3-5)/5(1): OA: typical" anteroventral. MP: complete: uniserial. SUP: absent. DEM: absent. NA: nerer eye than snout. VT: dextral. EP: dorsal. SP: sinistral. UJ: wide, prominently medially incised. LJ: wide, prominently medially incised. DF: low, originates near dorsal tail-body junction. BS: oval/depressed. CP: uniformly brown. TL: 43/30. NO: M.A. Smith (1917) discussed variations and nonconcordance among sources that suggest other species are involved. CI: Annandale and Rao (1918); Lamotte and Zuber-Vogeli (1954a); M.A. Smith (1912).

Limnonectes: CO: 62. GR: China-Southeast Asia-Philippines. EMG: exotroph: lotic: benthic; lentic; benthic. LTRF: 1/3(1), 1/4(1), 2(2)/3[1]. OA: typical: anteroventral. MP: wide dorsal gap: papillae often with elongate basal areas, narrow ventral gap sometimes present. SUP: few laterally. DEM: absent. NA: nearer snout than eye or reverse. VT: dextral. EP: dorsal. SP: sinistral. UJ: narrow to medium, smooth arc or slight medial convexity. LJ: narrow to medium, open U-shaped. DF: low, originates near dorsal tail-body junction, tip rounded to pointed. BS: oval/depressed. CP: variable, uniform to prominently spotted/mottled. TL: 25-40/36. CI: Inger (1954, 1966, 1985).

Occidozyga: CO: 2. GR: Southeast Asia-Java. EMG: exotroph: lentic: carnivore. LTRF: 0/0. OA: oral disc and papillae reduced to fleshy rim, jaw sheaths recessed. MP: dorsal gap in fleshy, nonpapillate rim, small rounded flap middorsally. SUP: absent. DEM: absent. NA: equidistant between eyes and snout. VT: medial. EP: dorsal. SP: sinistral. UJ: -. LJ: distinctly U-shaped deeply semilunar in shape. DF: anterior portion prominently high drops abruptly with remainder low, tip pointed. BS: oval/depressed. CP: black stripe through eye, tail variegated. TL: 30-50/36. CI: Inger (1985); M.A. Smith 1916b.

Paa: CO: 26. GR: India-Southeast Asia-China. EMG: exotroph: lotic: clasping. LTRF: 4(2-4)/3(1), 7(3-7)/3(1). OA: typical: anteroventral. MP: medium dorsal gap: uniserial. SUP: laterally and below P-3. DEM: absent. NA: nearer snout than eye. VT: dextral. EP: dorsal. SP: sinistral. UJ: wide, smooth arc. LJ: wide, smooth arc, open U-shaped. DF: low originates near dorsal tail-body junction, tip round. BS: oval/depressed. CP: body uniformly dark, tail lighter with flecking. TL: 55/36. CI: Annandale (1912) C.-C. Liu and Hu (1961).

Rana: CO: 224. GR: widespread. EMG: exotroph: lentic: benthic; lotic: benthic, clasping, gastromyzophorous; endotroph. LTRF: many variations between 1/2 and 9/8, 2/3 is common in North America, n/3 common elsewhere. OA: typical: anteroventral, ventral. MP: dorsal gap: usually uniserial, more rarely a narrow ventral gap, ventral papillae may be elongate. SUP: few laterally, absent. DEM: lateral, absent. NA: nearer eye than snout or reverse. VT: dextral. EP: dorsal. SP: sinistral. UJ: narrow to wide, smooth arc, medial part of edge straight. LJ: narrow to wide, narrow V-open U-shaped. DF: low originates near dorsal tail-body junction, tip pointed to round. BS: oval/depressed. CP: variable. TL: 30-100/36. NO: a number of species groups have distinctive morphologies. CI: Boulenger (1892); Hillis (1982); Hillis and Frost (1985); Hillis and De Sa (1988); Lanza (1983); Scott and Jennings (1985); A.H. Wright and Wright (1949); Zweifel (1958).

Taylorana.: CO: 2. GR: India-Vietnam-Java. EMG: endotroph.

Family Rhacophoridae

CO: 12/292. GR: Africa-India-southeastern Asia. EMG: exotroph: lentic: benthic, arboreal, nektonic; lotic: benthic, clasping, suctorial; endotroph. LTRF: many variations between 1/0 and 8/3; n/3 most common. OA: typical: anteroventral

or terminal. MP: wide dorsal gap, sometimes narrow ventral gap or complete: uni-, bi-, and multiserial. SUP: absent, laterally or below P-3, row(s) centripetal to marginal papillae. DEM: lateral, absent. NA: nearer snout than eye or reverse. VT: dextral, medial. EP: dorsal, lateral. SP: sinistral. UJ: variable including wide, medial margin straight or smooth are coarsely serrated or not, absent. LJ: medium to wide, U- to V-shaped, coarsely serrated or not, sometimes small medial convexity. DF: low to moderately high, originates near dorsal tail-body junction, tip rounded to pointed. BS: round oblong or oval/depressed. CP: variable. TL: 25-90/36.

Subfamily Rhacophorinae

CO: 9/220. GR: Africa-Madagascar-Seychelle Islands-India-southeastern Asia.

Chirixalus: CO: 8. GR: Southeast Asia. EMG: exotroph: lentic: arboreal. LTRF: 5(2-5)/3, 4(2-4)/3(1), 2/2. OA: typical: terminal or anteroventral. MP: wide dorsal gap: multi- or uniserial midventrally, narrow ventral gap. SUP: absent. DEM: lateral, absent. NA: nearer snout than eye. VT: dextral. EP: dorsal. SP: sinistral. UJ: medium, massive construction, smooth arc. LJ: medium, V-shaped. DF: low, originates at dorsal tail-body junction, tip slightly rounded. BS: oval/depressed. CP: slightly speckled on tail, uniformly dark, distal part of tail dark. TL: 30/41. NO: *C. eiffingeri oophagous*. CI: Bourret (1942); Heyer (1971); Kam et al. (1996); Kuramoto and Wang (1987); Utsunomiya and Utsunomiya (1983).

Nyctixalus: CO: 5. GR: Greater Sundas-Philippines. EMG: exotroph: lentic: arboreal. LTRF: 5(2-5)/3, 5(3-5)/3. OA: typical: anteroventral. MP: wide dorsal gap: biserial. SUP: absent. DEM: lateral. NA: equidistant between eye and snout, small medial projection. VT: medial. EP: dorsal. SP: sinistral. UJ: medial convexity, coarsely serrate. LJ: medium, V-shaped, coarsely serrated. DF: low, originates near dorsal tail-body junction, tip rounded. BS: oval/depressed. TL: 43/26. CP: uniformly purplish brown. CI: Alcala and Brown (1982); Inger (1966, 1985).

Philautus: CO: 87. GR: India-China-Philippines. EMG: exotroph: lentic: arboreal; endotroph. LTRF: 1/0. OA: typical: terminal. MP: complete: biserial. SUP: -. DEM: lateral. NA: tiny nearer snout than eye. VT: medial. EP: dorsal. SP: sinistral. UJ: wide without serrations. LJ: wide, coarsely serrate. DF: low, originates near dorsal tail-body junction, tip rounded. BS: oval/depressed, widest near plane of eyes, snout truncate. CP: uniformly pale brown. TL: 29/37. CI: Wassersug et al. (1981).

Polypedates: CO: 19. GR: India-China-Japan-southeastern Asia-Philippines. EMG: exotroph: lentic: benthic. LTRF: 4(2-4)/3[1], 5(2-5)/3[1]. OA: typical: anteroventral. MP: wide dorsal gap: biserial, narrow ventral gap. SUP: few laterally, throughout extent of marginal papillae, absent. DEM: lateral. NA: nearer snout than eye. VT: dextral. EP: dorsal, lateral. SP: sinistral. UJ: medium, high smooth arc, medial convexity. LJ: medium open V-shaped. DF: moderately high, originates near dorsal tail-body junction, tip pointed. BS: oval/depressed. CP: variable. TL: 25-

45/36. NO: Inger (1966) shows tail sheath in *P.macrotis* and *P. otilophus*. CI: Inger (1985).

Rhacophorus: CO: 51. GR: India-China-Celebes-Islands. EMG: exotroph: lentic: benthic, nektonic. LTRF: 4(2-3)/3(1), 5(2-5)/3[1]. OA: typical: anteroventral. MP: wide dorsal gap: biserial, sometimes small ventral gap. SUP: absent, few laterally. DEM: lateral. NA: nearer snout than eye. VT: dextral. EP: dorsal. SP: sinistral. UJ: medium to wide, smooth arc or small medial convexity. LJ: medium to wide, V-shaped. DF: low to medium, originates near dorsal tail-body junction, tip pointed. BS: oval/depressed. CP: usually unicolored, often pale. TL: 35-45/36. CI: Inger (1966, 1985).

Theloderma: CO: 9. GR: Burma-Malaysia. EMG: exotroph: lentic: arboreal. LTRF: 4(2-4)/4(1). OA: typical: nearly terminal. MP: wide dorsal gap: biserial. SUP: absent. DEM: lateral. NA: small, nearer snout than eye. VT: medial. EP: dorsal. SP: sinistral. UJ: medium, medial convexity, coarsely serrated. LJ: more finely serrated, open U-shaped. DF: medium erupts abruptly from near dorsal tail-body junction, tip broadly rounded. BS: round/depressed. CP: uniformly dark. TL: 28/28. CI: Wassersug et al. (1981).

Microhabitats

The microhabitats refered to Inger (1984) have the following definitions:

1. Lotic or Streams

Torrents: surface of water broken, occasionally, foaming, bed of rocks and current strong.

Riffle: surface of water in shallow waves but never foaming, bed of gravel and occasional rocks and current moderate.

Shingle area: surface of water smooth, bed of circular or oval and current weak to moderate.

Leaf drift: areas of deep accumulation of dead leaves tightly packed except at periphery and current weak.

Open pool: pondee parts of stream, current weak, bottom silt to sand and gravel.

Side pools: an embayment off a main channel, partially or completely cut off from current by sand or a gravel bar, bottom fine to coarse sand and small gravel usually covered by dead leaves and current weak or absent.

Potholes on rock banks: water-filled depression on rocky bank, bottom bed rock, though often with dead leaves, no current, potholes at varying Elevations above normal stream level.

Pools of intermittent streams: pond or pool by tie down of tree or rock moving, no current except after moderate or heavy rain.

2. Lentic or Non Stream

Rain pool: rain–filled depression of variable size and depth, bottom usually clay, often with dead leaves.

Buttress tank: cavity formed by anastomosis of two or more buttresses and Elevation above ground.

Pool or pond in community: pool or pond that have been dug or built by humans.

Other related research

In Thailand there are many studies about amphibians in many areas, but they are not adequate because they are basic studies and most of them deal mainly with adult amphibians and that they have been found 80 species altogether (Nabhitabhata, 2000) in Southern Thailand (Table 1). While the anuran tadpoles have been studied scantly, their data can support taxonomic arrangement of adults. Some works related to this study include:

Diversity of Amphibians at Hala-Bala Wildlife Sanctuary in Narathiwat Province (Table 1) had revealed 41 species in 5 families as follows, 6 species of Bufonidae, 5 species of Megophryidae,8 species of Microhylidae, 14 species of Ranidae and 9 species of Rhacophoridae (Chan-ard, 2003)

The study of wildlife diversity for the master plan management at Khlong Nakha Wildlife Sanctuary in Ranong province showed 38 species of anuran amphibians in 5 families (Table 1) and 1 specie is a new record in Thailand, that is *Caperina fusca* (Royal Forestry Department, 2001)

The study of amphibians' diversity at Khao Luang National Park in Nakhon Si Thammarat province where 36 species in 5 families (Table 1) were found (Nabhitabhata, 2003).

Table 1 Species richness of amphibians anura (adulthood) in Southern Thailand and 3 areas of this study

Species	Areas		
	Khlong Nakha	Khao Luang	Hala-Bala
1. *Leptobrachium hendricksoni*	-	-	x
2. *L. smithi*	x	x	-
3. *Leptolalax heteropus*	-	-	x
4. *L. pe;pdytoides*	-	-	-
5. *Brachytarsophrys carinense*	-	-	-
6. *Megophrys nasuta*	-	-	x
7. *Xenophrys aceras*	x	-	-
8. *X. longipes*	x	x	x
9. *Bufo asper*	-	x	x
10. *B. quadriporcatus*	-	-	x
11. *B. macrotis*	x	-	x
12. *B. melanostictus*	x	x	-
13. *B. parvus*	x	x	-
14. *Ansonia malayana*	x	x	x
15. *A. siamensis*	-	-	-
16. *Leptophryne borbonica*	-	-	x
17. *Pedostibes hosii*	-	-	x
18. *Amolops larutensis*	-	-	x
19. *Occidozyga laevis*	x	-	x
20. *O. lima*	x	x	-
21. *O. martensii*	x	x	-
22. *Fejervarya cancrivora*	-	x	-
23. *F. limnocharis*	x	x	x
24. *F. raja*	-	-	-
25. *Hoplobatrachus rugulosa*	x	x	-
26. *Ingerana tarsanae*	x	-	-
27. *I. tenasserimensis*	x	x	-
28. *Limnonectes blythii*	x	x	x
29. *L. doriae*	x	x	-
30. *L. kuhlii*	x	x	x
31. *L. laticeps*	x	-	x
32. *L. macrognathus*	x	x	-
33. *L. malesianus*	-	-	x
34. *L. paramacrodon*	-	-	-
35. *L. plicatellus*	-	-	x
36. *Rana alticola*	x	x	-
37. *R. baramica*	-	-	x
38. *R. cubitalis*	x	x	-
39. *R. glandulosa*	-	-	-
40. *R. hosii*	x	x	x
41. *R. livida*	-	-	-

Table 1 (Cont'd)

Species	Areas		
	Khlong Nakha	Khao Luang	Hala-Bala
42. *R. luctuosa*	-	x	-
43. *R. macrodactyla*	-	x	-
44. *R. miopus*	x	x	-
45. *R. nicobariensis*	-	x	-
46. *R. nigrovittata*	x	x	x
47. *R. chalconota*	x	x	-
48. *R. signata*	-	-	x
49. *R. erythraea*	x	x	x
50. *Taylorana hascheana*	x	x	x
51. *T. limborgi*	-	-	-
52. *Philautus parvulus*	-	x	-
53. *P. vermiculatus*	-	-	x
54. *Rhacophorus appendiculatus*	-	x	x
55. *R. bipunctatus*	x	x	-
56. *R. cyanopunctatus*	-	-	x
57. *R. nigropalmatus*	-	-	x
58. *R. pardalis*	-	-	x
59. *R prominanus*	-	-	x
60. *Rhacophorus robinsoni*	-	-	-
61. *Polypedates colletti*	-	-	-
62. *P. leucomystax*	x	x	x
63. *P. macrotis*	-	x	x
64. *Nyctixalus pictus*	-	-	x
65. *Theloderma horridum*	-	-	-
66. *Chaperina fusca*	x	-	-
67. *Calluella guttulata*	x	-	-
68. *Phrynella pulchra*	-	-	-
69. *Kaloula baleata*	-	-	-
70. *K. mediolineata*	-	-	-
71. *K. pulchra*	-	x	x
72. *Kalophrynus pleurostigma*	x	-	-
73. *Microhyla annectens*	-	-	-
74. *M. berdmorei*	x	-	x
75. *M. borneensis*	-	-	x
76. *M. butleri*	x	-	x
77. *M. heymonsi*	x	-	x
78. *M. pulchra*	x	x	x
79. *M. ornata*	x	x	x
80. *M. inornata*	x	x	x

Remark: x= Present

1. External morphology studies

Smith (1916a) studied the coloration, body length and thickness of tail and other external morphological features in 5 species of anuran tadpoles in Bangkok and Chanthaburi Province, such as *Microhyla ornate*, *M. heymonsi* and *Kaloula pulchra*.

Smith (1916b) studied the comparative mouthparts and external morphology of anuran tadpoles in *Occidozyga* for identification of key arrangements. This genus could be divided into 2 species, that are *Occidozyga lima* and *Occidozyga martensii*.

Smith (1917) studied the external morphology, such as coloration, thickness and length of body, tail, eye position and mouthparts in 16 species 7 genus of anuran tadpoles, such as *Rana kuhlii*, *R erythraea*, *Rhacophorus leucomystax* and *Microhyla butleri* and they could help the classification of anuran tadpoles in Thailand.

Inger (1966) studied the relationship of labium tooth row formula and body length of anuran tadpoles. He found that the mouthparts can be different when their body length changes. His conclusion is the difference of mouthparts depends on each anuran tadpole's species and the stage of their growth.

Heyer (1971) studied the external morphology, such as coloration, thickness and length of body, tail, fin, eye position, and mouthparts in 18 species 10 genuses 4 families of Thailand anuran tadpoles. Then he arranged classification of Ranidae that could be divided into *Occidozyga laevis* and *O. martensii*.

Porter (1972) studied the difference of mouthparts in several stages of anuran tadpole's growth. He found that the mouthparts are completed between 29-40 stages. These stages will have full teeth and tooth rows, while their forelegs are developing and have papillae. After stage 40 their mouth part would be reduced, while the forelegs emerge from their body.

Wassersug (1988) studied the external morphology and buccal cavity of anuran tadpoles in *Theroderma stellatum* and *Philautus* and then used the data to classify and identify the Rhacophoridae particularly for egg laying in tree holes. Two genera were found in Chanthaburi Province.

Leong and Chou (1999) studied both the external morphology and the mouthparts in anuran tadpoles in Singapore where he found 22 species altogether. Then he arranged a key for making a database of them.

Inthara (2000) studied the mouthparts of anuran tadpoles on feeding behavior and carrying their mouth parts to key arrangements. These keys could be divided for some anuran tadpoles.

Noikotr (2001) studied the diversity of mature frogs and their tadpoles in Kichakut National Park in Chanthaburi Province. This study found 27 species of frog and their tadpoles all of them belonging to 29 species in adults and 20 species in tadpole. The mouthparts and external morphology of anuran tadpoles were used for identification as a key.

Taksintum (2003) studied the diversity of mature frogs and their tadpole in Khlong- Sang Wildlife Sanctuary in Surat Thani Privince. This study found 39 species of frogs and their tadpole that belong to 18 genera 5 families in 1 order. *Chaperina fasca* and *Rhacophorus pardalis* were firstly recorded for frog species in Thailand. Then carrying the mouthparts and external morphology of anuran tadpoles to the identification key.

2. Internal morphology studies

Wassersug (1976) studied the buccal cavity and the development of some anuran tadpoles. This study considered the shape, size, numbers and positions of papillae in the buccal cavity. Finally he concluded that these characters are difficult to identify in similar species but are easily identified in different species.

Inger (1983) studied the buccal cavity and external morphology of anuran tadpoles in *Leptobrachiumm* and *Leptobrachella* and used their different characters to identify species.

Inger (1985) studied the buccal cavity, type of tooth and beaks in anuran tadpoles in Borneo. This study found 66 species in 5 families and the description follows as in Wassersug (1946).

Wassersug (1988) studied the buccal cavity of anuran tadpoles in the family Leptodactyloids in South America. This study found 43 species altogether. All of them were used in the identification key and classification in their mature stage.

MATERIALS AND METHODS

Materials

1. Collecting the Specimens

1.1 Collecting specimens of tadpole was carried out throughout the research areas in two prevalent seasons of the year i.e. the dry season and the rainy season. Collecting periods lasted about 15 – 20 days between 9.00 am – 22.00 pm each month.

1.2 Tadpole surveys were conducted by walking both in the daytime (8:00 AM.-05:00 PM.) and nighttime (8:00-11:00 PM. by flashlight) in non-flowing water(Lentic) and flowing water(Lotic) habitats at survey sites of 10, 100, 300, 500 m and more from Mean Sea Level (MSL), each selected level will be surveyed for a distance of 500 m.

1.3 A record (notebook and take photos) was made of the following ecological conditions of water parameters and conditions that tadpole were found in such as; (a) Lotic system – flowing water: eg. forest streams, torrents, leaf drifts, shingle areas, riffles, open pools, side pools, potholes on rock bank pools of intermittent streams; (b) Lentic systems – non-flowing water: eg. rain pools, ponds, log cavities and buttress tanks; the temperature of water for surface dwellers, midwater dwellers, or bottom dwellers, and the temperature of the environment at 1 m above water surface was detected by thermometer. The periods could be divided as follows; morning period (8:00-10:00 AM), late morning period (10:00-12:00 AM), afternoon period (1:00-3:00 PM), late-afternoon period (3:00-5:00 PM) and nighttime (8:00-11:00 PM). The altimeter evaluated height above Mean Sea Level (MSL); the dimension of microhabitats was measured by measurement cassette.

1.4 Collection of 1-30 tadpole was done by using scoop fine-meshes, size 3"x3" and 12"x12" of each species were put in jars, diameter 6x6 cm and air pumps were put into jars for rearing. Then those tadpoles were taken out to continue rearing to adulthood in an aquarium.

2. Specimens Preparation

2.1 The tadpole specimens were divided into two groups

2.1.1 The first group was reared until the subarticular tubercles were formed, and the cloacal tail-piece was present at the anuran stages 37^{th}-40^{th} because the morphological structure have been completely attained (Gosner, 1960 and Porter, 1972).

2.1.2. Another group was reared until adult and separated into type to identify the species.

3. Data Analysis

3.1. Tadpole at stages 35-40 (fixed in 20-40% formalin) were separated into 2 groups.

3.1.1 A study and measurement of the external morphology by verneer caliper was done to determine body length, body Elevation, body width, body shape, eye position, eye–nostil distance inter- narial distance, interorbital distance, maximum tail Elevation, spiracle, tip of mouth – nostil distance, tail length, total length, tail muscle Elevation, tail muscle weight, vent tube, and mouthparts, including papillae, labial tooth row formula (LTRF), beaks, and also the position of the mouth by stereoscope (detailed in Appendix Table 1).

3.1.2 A study of the buccal cavity was done by scanning with an electron microscope (SEM) to identify (a) shape, position and number of buccal floor arena papillae (buccal floor arena), buccal pocket (lateral papillae of buccal floor arena), medial notch about glottis (ventral velum), lingual papillae (tongue and tongue papillae), (b) shape, position and number of buccal roof arena papillae (buccal root arena), lateral ridge papillae, medial ridge, prenarial arena postulations (prenarial ridge), postnarial arena (postnarial papillae), prenarial papillae.

3.1.3 Obtained data from above two studies, coupled with the results of the actual rearing of tadpole to adulthood, will be utilized for constructing the identification keys based on the larval characters.

Places and Duration

1. The Study Areas

It was necessary to investigate secondary data for suitable habitats of amphibians by using average temperature and rainfall for determining the selection of study areas. According to the discovery of suitable secondary data in Southern of Thailand, it was found that these areas are most suitable for amphibian's habitation. Regarding the statistics of average rainfall and temperature (Meteorological Department, 2002), the mean annual rainfall is 2,219.35 mm (year 1961 – 1990) and the mean annual temperature is 27.90°C (year 1951 – 2000). The statistic of mean annual temperature (year 1951 – 2000) is 27.15°C in Ranong Province, 26.47°C for Nakhon Si Thammarat Province and 27.15°C for Narathiwat Province. The statistic of mean annual rainfall (year 1961 – 1990) is 4,119.3 mm in Ranong Province, 2,383.2 mm for Nakhon Si Thammarat Province and 2,560.2 mm for Narathiwat Province. According to the secoundary data, the study of a representative study site found that these areas have not had any study of Anuran tadpoles and also these areas are suitable for amphibian's habitation. Furthermore, species diversity of this animal group in Southern Thailand has found 80 species and that is 64% of all the species in Thailand (Nabhitabhata, 2000), but the study cannot be conducted in Southern Thailand, thus the determination of the representative study sites (Figure 5) is as follows:

1. Khlong Kampuan basin in Khlong Nakha Wildlife Sanctuary, Ranong Province is a representative study site of Western South.

2. Khlong Tha Dee basin in Khao Luang National Park, Nakhon Si Thammarat Province is a representative study site of Eastern South.

3. Khlong Ia-garding basin in Hala-Bala (only Bala) Wildlife Sanctuary, Narathiwat Province is a representative study site of the Lower Southern Malayan peninsula.

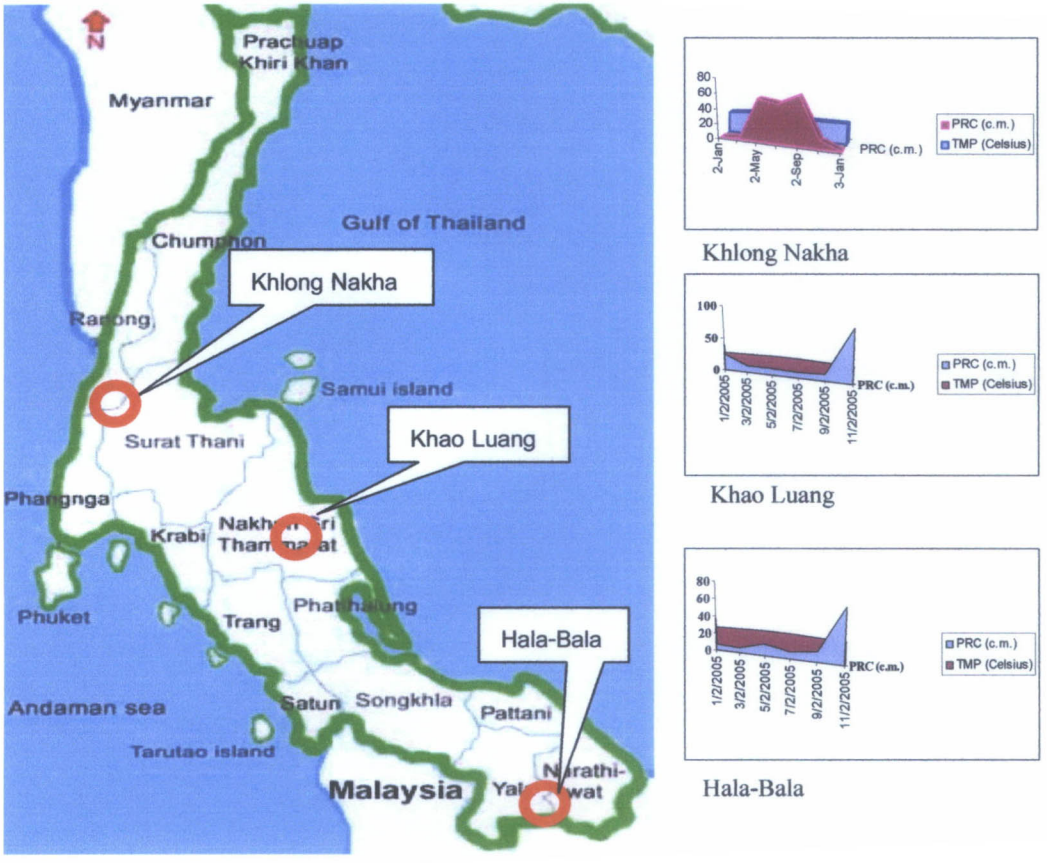


Figure 5. Map of study areas and climate and precipitation of Khlong Nakha, Khao Luang and Hala-Bala.

Source: Department of Highway (2003) and Meteorological Department (2002)

Khlong Nakha Wildlife Sanctuary

Most areas are high mountain complexes (Figure 6), there are few plains. Most of the region has more than 26 % slopes. The mean sea level (MSL) is about 300-500 m and the highest mountain is Lankhateik. It is 1,395 m from MSL. Because this area contains many mountains it is the source of many canals, such as Khlong Nakha, Khlong Kumpuang and Khlong Bangmaan. These canals always have water. The weather of Khlong Nakha Wildlife Sanctuary receives the Southwest monsoon, thus raining has almost the whole year. The rainy season runs from April to November then it is the summer season.

Most forest in the area is evergreen forest but mixed deciduous forest and grassland can be found as well. These forests are suitable for wildlife because there are many plants that animals can eat. Examples of wildlife in Khlong Nakha wildlife Sanctuary are *Cervus unicolor*, *Panthera tigris*, *Megalaima haemasephala*, *Plyas korros*, *Megophrys longipes* and *Rana nigrovittata* (Royal Forestry Department, 2003).

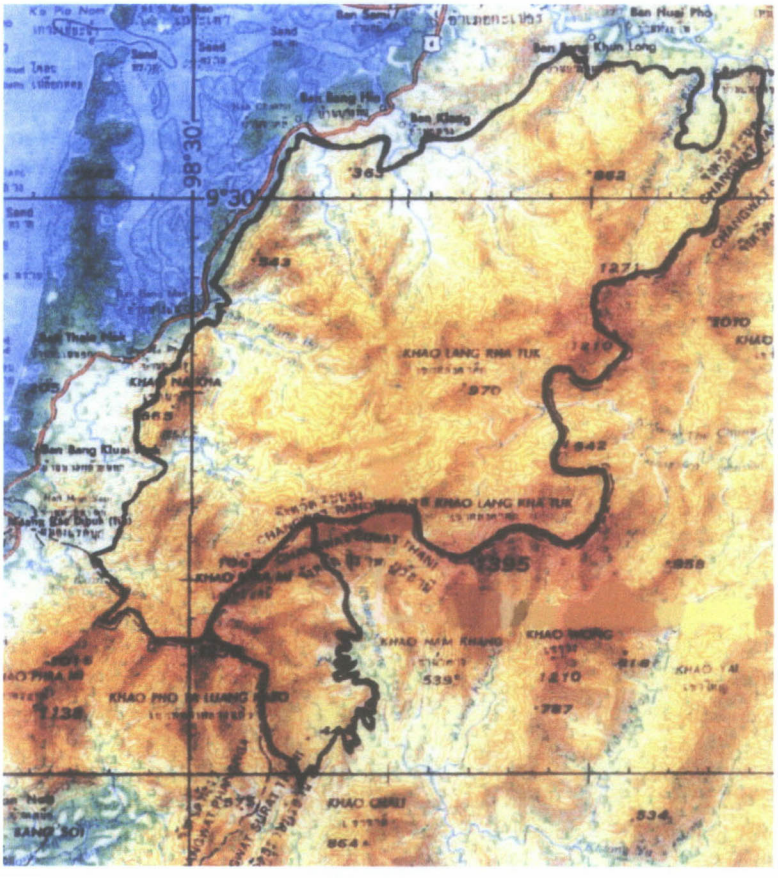


Figure 6. Map of Khlong Nakha Wildlife Sanctuary.
Source: Royal Forestry Department (2003)

Khao Luang National Park

The total area of Khao Luang National Park is 567 km^2 (Figure 7) and it covers the center of Nakhon Si Thammarat valley that is surrounded by high mountains which lie across from the North to the South. In some areas some plains can be found in valleys. At the top of these mountains is Khao Luang and it is above mean sea level (MSL). Khao Luang National Park gets both of eastern and western monsoons, so it gets rain nearly the whole year and the weather is rather cold. The mean rainfall is 3,500 – 4,000 mm in a year. The lowest temperature is about 15–17 °C in December and the highest is about 28–30 °C in April.

Khao Luang National Park contains evergreen forest and more than 327 species of wildlife can be found in Khao Luang National Park , for example *Tapirus indicus*, *Semnopithecus obscurus*, *Gallus gallus*, *Bufo asper* and *Varanus calvator* (Royal Forestry Department, 2003).

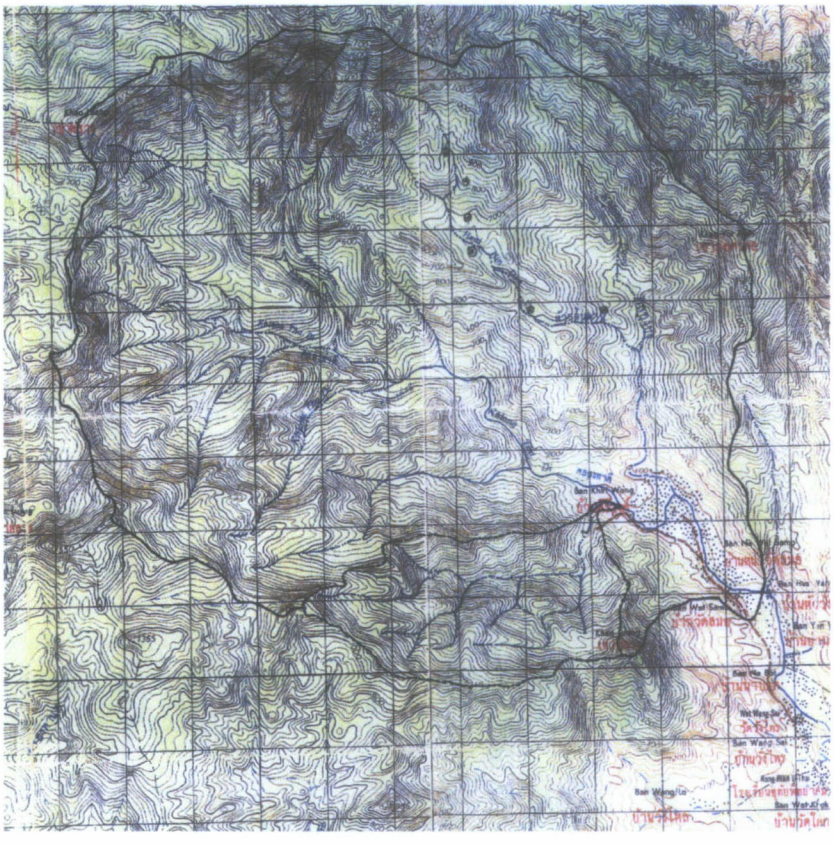


Figure 7. Map of Khao Luang National Park.
Source: Royal Forestry Department (2003)

Hala-Bala Wildlife Sanctuary

Hala-Bala Wildlife Sanctuary contains a high mountain complex (Figure 8). This area is about 100 m from mean sea level and the highest mountain is 1,466 m. The weather is stable and there is a suitable humidity for animals and plants. Hala-Bala Wildlife Sanctuary is the biggest tropical rain forest in Thailand. It has more than 2,000 mm average precipitation per year and the average monthly and daily temperature is 27.6°C.

There is only one type of forest in this area, which is moisture evergreen forest. There are 414 species of wildlife found which can be divided into 217 species 114 genera 38 families of birds, 144 species 84 genera 38 families of mammals, 30 species 24 genera 9 families of reptiles and 23 species 15 genera 9 families of amphibians (Royal Forestry Department, 2003).

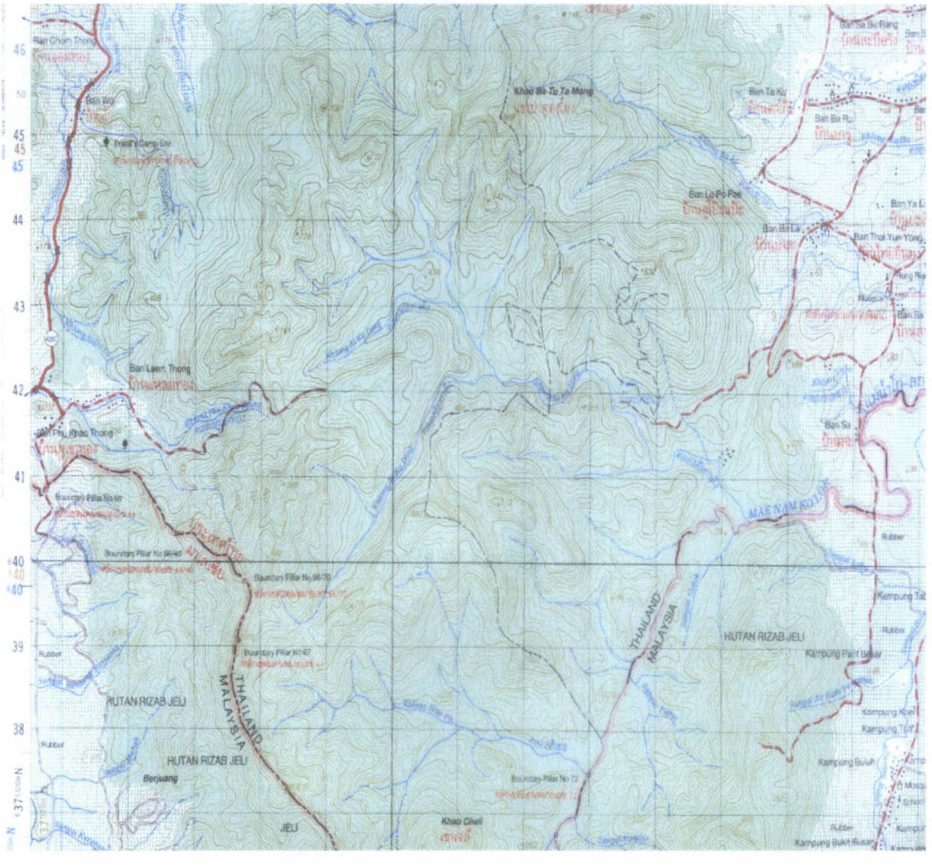


Figure 8. Map of Hala-Bala Wildlife Sanctuary.
Source: Royal Forestry Department (2003)

1.2 The Study Duration

The research had been carried out between January 2003 – January 2004 and rearing between 2003-2005.

RESULTS AND DISCUSSION

Species Richness

In this study, 51 Species 22 Genera in 5 Families of Anuran tadpoles have been found from 3 areas: Khlong Nakha Wildlife Sanctuary, Ranong Province at which 28 species 17 genera in 5 families were found. From Khao Luang National Park, Nakhon Si Thammarat Province 27 species 12 genera in 5 families were found and at Hala-Bala (only Bala) Wildlife Sanctuary, Narathiwat Province 32 species 17 genera in 5 families were found, the detail shown in Table 2, Figure 9, 10 and 10A. The description of data of those tadpoles is as follows;

Table 2 All species in each areas

Family / Genus / Species	Areas[1]
Family Megophryidae	
Genus *Brachytarsophrys*	
1. *Brachytarsophrys carinense*	2
Genus *Megophrys*	
2. *Megophrys nasuta*	3
Genus *Xenophrys*	
3. *Xegophrys longipes*	1
4. *Xenophrys aceras*	1,2
Genus *Leptobrachium*	
5. *Leptobrachium* sp.1 (White-eyes)	2
6. *Leptobrachium* sp.2 (Red and Yellow-eyes)	1,2
7. *Leptobrachium hendricksoni*	3
Genus *Leptolalax*	
8. *Leptolalax heteropus*	3
Family Bufonidae	
Genus *Ansonia*	
9. *Ansonia malayana*	1,3
Genus *Bufo*	
10. *Bufo asper*	1,2,3
11. *Bufo quadriporcatus*	3
12. *Bufo parvus*	1,2
13. *Bufo melanostictus*	1,2,3
14. *Bufo macrotis*	1,2
Genus *Pedostibes*	
15. *Pedostibes hosii*	3

Table 2 (Cont'd)

Family / Genus / Species	Areas[1]
Family Ranidae	
Genus *Amolop*	
16. *Amolops larutensis*	3
17. *Amolops* sp.1	1
18. *Amolops* sp.2	3
Genus *Huia*	
19. *Huia* sp.	1
Genus *Ferjervarya*	
20. *Ferjervarya limnocharis*	1,2,3
Genus *Limnonectes*	
21. *Limnonectes* sp.	3
22. *Limnonectes blythii*	1,2
23. *Limnonectes macrognathus*	2
24. *Limnonectes kuhlii*	1,2,3
Genus *Rana*	
25. *Rana alticola*	1,2
26. *Rana chalconata*	1,2,3
27. *Rana hosii*	1,2,3
28. *Rana signata*	3
29. *Rana nigrovittata*	1,2,3
30. *Rana cubitalis*	1,2
31. *Rana erythraea*	1,2,3
Genus *Taylorana*	
32. *Taylorana hascheana*	1,3
Genus *Hoplobatrachus*	
33. *Hoplobatrachus rugulosus*	1,2
Genus *Occidozyga*	
34. *Occidozyga lima*	2
35. *Occidozyga martensii*	1,2
Family Rhacophoridae	
Genus *Rhacophorus*	
36. *Rhacophorus pardalis*	3
37. *Rhacophorus nigropalmatus*	3
38. *Rhacophorus reinwardtii*	3
39. *Rhacophorus prominanus*	3
40. *Rhacophorus bipunctatus*	1
Genus *Polypedates*	
41. *Polypedates leucomystax*	1,2,3
42. *Polypedates macrotis*	3

Table 2 (Cont'd)

Family / Genus / Species	Areas[1]
Genus *Nyctixalus*	
43. *Nyctixalus pictus*	3
Family Microhylidae	
Genus *Microhyla*	
44. *Microhyla ornata*	1,2,3
45. *Microhyla borneensis*	3
46. *Microhyla heymonsi*	1,2,3
47. *Microhyla berdmorei*	2
48. *Microhyla butleri*	2,3
49. *Microhyla inornata*	3
Genus *Kaloula*	
50. *Kaloula pulchra*	1,2,3
Genus *Chaperina*	
51. *Chaperina fusca*	1

[1] 1: Khlong Nakha Wildlife Sanctuary
2: Khao Luang National Park
3: Hala-Bala (only Bala)Wildlife Sanctuary

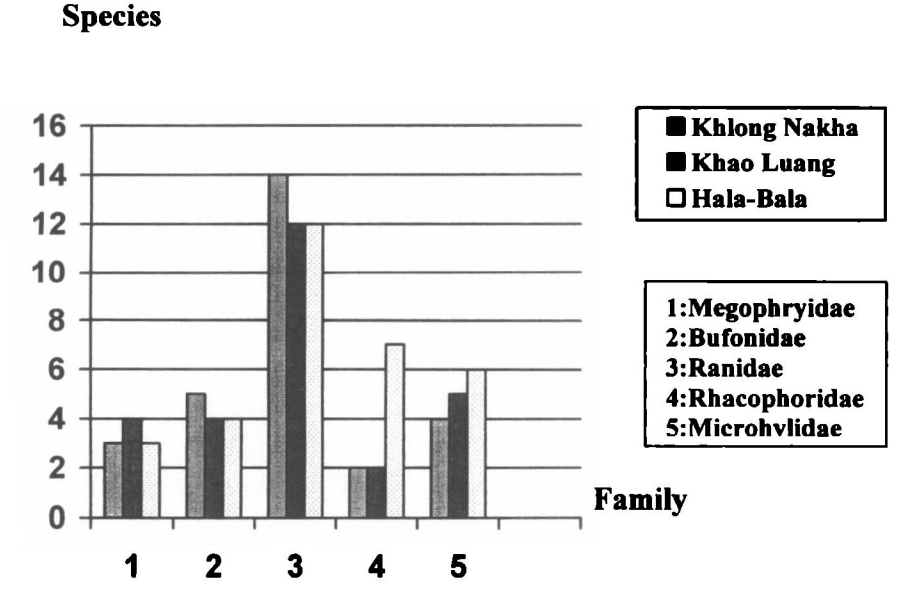
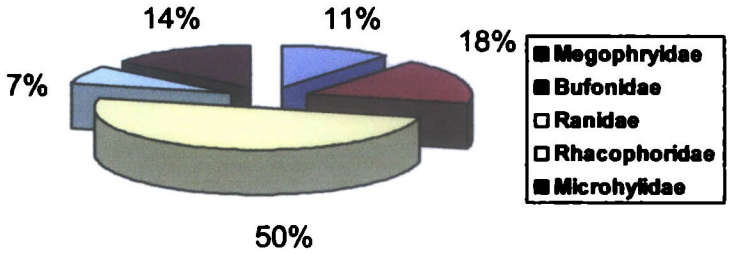
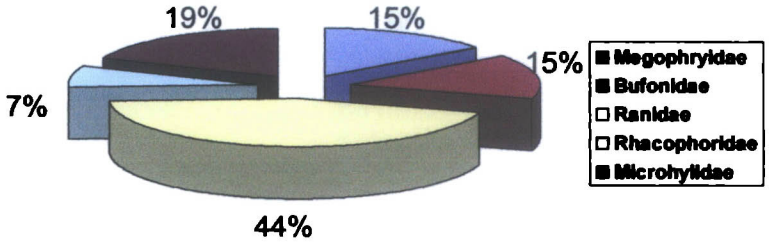


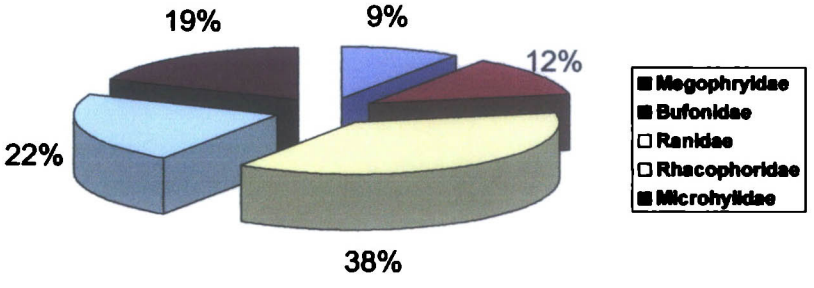
Figure 9 Species richness of anuran tadpoles in each area.



Khlong Nakha Wildlife Sanctuary



Khao Luang National Park



Hala-Bala (only Bala) Wildlife Sanctuary

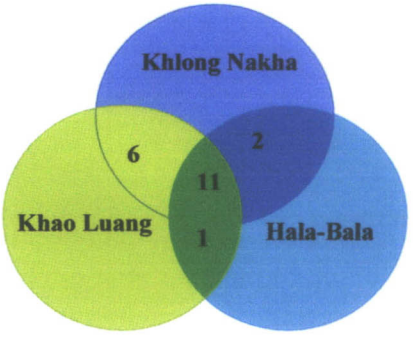


Figure 10 The percentages of species richness in each family of area and species richness of anuran tadpoles in both areas and all areas.

Morphometric Description

The descriptions of body measurements and standard deviation value are shown in Appendix Table1. The taxonomic arrangement has followed Frost (2000) and also all specimens have been collected at Thailand Natural History Museum.

Key to Families of External Morphology

1. Spiracle midventral on chest abdomen, or near vent, spiracle is near vent.....2
   Spiracle sinistral, usually present, tubular, at least as a ridge.....3
2. Oral apparatus no jaw or labial teeth..... Microhylidae
   Oral apparatus with jaw sheaths or labial teeth.....Megophryidae
   .....Bufonidae, Ranidae and Rhacophoridae (Part)
3. Oral disc dorsal, lateral lips expanded (umbelliform) or anteroventral; Body enlarge.....Megophryidae
   Oral disc anteroventral; body medial or small.....4
4. Body wall fleshy, hollow crown surrounding eyes and nares or tranverse, fleshy flap behind eyes.....Bufonidae
   Body wall belly modified into actively operating sucker.....5
5. Labial tooth row formula (LTRF) 0/0 and 9/8, 2/3 and n/3 most common.....
   .....Ranidae
   Labial tooth row formula (LTRF) 1/0 and 8/3 and n/3 most common.....
   .....Rhacophoridae

Key to Buccal Roof Carvity

1. Lip without denticle.....2
   Lip with denticle.....3
2. Nares rounded, prenarial and postnarial without ridge (Inger, 1985).....*Microhyla*
   Nares depress by rounded depressions separated (Inger, 1985).....*Chaperina*
3. Prenarial area of roof with U-shape ridge.....4
   Prenarial area of roof without U-shape ridge.....5
4. Median ridge tall, thick; lateral ridge of buccal roof area long and thick.....
   .....*Megophrys*
   Median with triangular ridge ; lateral ridge of buccal roof arena smooth
   .....*Brachytarsophrys*
5. Pranarial of roof with 2 low pustules on each side and posterior wall with a similar papillae medianly (Inger, 1985).....*Leptobrachium*
   Prenarial of roof smooth.....6
6. Buccal roof arena smith.....7
   Buccal roof arena with pustules.....8
7. Nares oblique, oval or ventral.....11
   Nares tranverse, wide gap between them about half length of one (Inger, 1985)...
   .....*Occidozyga*
8. Postnarial with ridge pustules..... 9
   Postnarial without ridge pustules.....10

9. Postnarial with ridge pustules, stick and tranverse in median; median ridge with a low triangle; lateral papillae with branches palp.....*Rana*
   Postnarial with 3 pustules on each side parallel to nares median most tallest and Pustulous (Inger, 1985).....*Pedostibes*
10. Postnarial with a branch pulp on each side; median ridge with 2 rows, as long as internarial.....*Polypedates*
    Postnarial area with groove.....12
11. Prenarial with trancerse in center, pustulous; anterior and posterior narial wall hight; anterior narial wall in corners with highest palp.....*Bufo*
    Prenarial with high wallstraight.....*Amolops*
12. Postnarial area with groove behind each naris (Inger, 1985).....*Limnonectes*
    Postnarial area with shallow groove behind naris (Inger, 1985).....*Rhacophorus*

Family Megophryidae

In Thailand, this family was divided into 6 genera or 6 groups in adult, that are *Xenophrys, Brachytarsophrys, Megophrys, Leptobrachium, Leptolalax* and *Ophryophryne*. Nevertheless, they can be divided into 3 groups from tadpoles, by mouth features. The first form is lips upword and wide funnel (umbelliform), no labial teeth rows. The second form is lips downward and enlarged oral disc, feeble rows of teeth. The last form is lips ventral, subterminal and with well developed rows of teeth. Labial tooth row formula (LTRF) is 0/0 – 7/7; beaks present in some groups, thick and U or V shape marginal papillae might be ranged around lips or having a gap somewhere reaching dental; interorbital with equal or subequal internarial; vent tube is dextral or middle of body; fins beginning at root tail, tip rounded or pointed; head - body ellipsoidal or oval, dark brown or brown sometimes having marks or small dots from head to tail.

Key to Genera of Megophryidae

1. Lips expanded, oral disc dorsal or ventral, head-body ellipsoidal.....2
   Lips not expanded, oral disc anteroventral; head-bodyoval.....*Leptobracium*
2 Oral disc dorsoterminal; marginal lips long expanded.....3
   Oral disc ventral; marginal lips expanded, rounded; median of lower lip interrupted .....*Leptolalax*
3. Lateral lips long expanded, 1.5 time of oral width.....*Brachytarsophrys*
   Lateral lips long expanded, less than 1.5 times oral width.....4
4. Lateral lips length subequal of oral width, triangular shaped.....*Xenophrys*
   Lateral lips length equal or slightly longer than oral wide, horn-like..... .....*Megophrys*

Key to Species of Megophryidae

1. Labial teeth rows non present.....2
   Labial teeth rows present 5
2. Ventral with dark spots or stripes; ventolateral of body with a white line.....
   .....*Brachytarsophrys carinense*
   Ventral and ventrolateral body without pigment.....4
3. Mouth downward, teeth expanding across width of lips; beak enlarged.....6
   Mouth downward, lips wide funnel; teeth about 2-3 rows.....*Leptolalax heterop*
4. Head-body and tail without pigment.....*Xenophrys aceras*
   Head-body and tail with dark spots or marks.....5
5. Fins cloudy, with gray or dark dots; cajdal muscle grayish.....*Xenoophrys longipes*
   Fin grayish, with light dots on marginal; caudal muscle darkish-gray.....
   .....*Megophrys nasuta*
6. Head-body and tail muscle orangish or redish-orange; fins cloudy, all body and tail with black dots.....*Leptobrachium hendricksoni*
   Head-body and tail muscle brownish to grayish; end of body with a light brown triangle(∇).....7
7. Caudal muscle with slightly dark dots; lateral inframarginal ridge with about 16-18 small denticle rows.....*Leptobrachium* sp.1(White-eyes)
   Half posterior of tail with dark spots; lateral inframarginal ridge with
   About 12-14 small denticle rows.....*Leptobrachium* sp.2(Red and Yellow-eyes)

Genus *Brachytarsophrys*

Only one species of this genus has been found in this study, that is *Brachytarsophrys carinense* but their mouthparts are similar to *Megophrys* and *Xenophrys,* especially the mouth with upward and wide funnel, lips expanded, look like a horn and longer than other genus. Teeth and beaks are absent; papillae scattering on mouth plate but not present on marginal lips.

1. *Brachytarsophrys carinense* (Boulenger,1889)

Metamorphosis of these larvae is slow and when they develop to stage 30 dorsolateral stripes appears from eyes to vent; stage 42 the body starts to be similar to that of an adult, dorsolateral with small white spots while some stripes on ventral were fading.

1.1 External morphology

Head-body ellipsoidal, about twice as long as wide; eyes lateral visible from below; interorbital twice of internarial distance; mouth to snout equals snout to eyes distance; spiracle sinistral, much closer to eye than to the end of the body; vent tube median and separated from ventral fin; caudal muscle slender; dorsal fin deeper than ventral; tail tapering gradually from center to distal; end rounded (Figure 11).

Oral disc terminal with funnel-shaped lips and lateral expended twice the width; marginal lips without papillae but inner lips with row; teeth and beak weak

Head-body dark brown; dorsal and lateral; all of ventral with black and white stripes; tail dark or dark grey sports separated; marginal fins with dark or black spots.

Total length 45-50 mm, (N=4).

1.2 Buccal carvity

Buccal roof: Prenarial area of roof with deep in median, U-shaped ridge with ends of arms almost touching beak, behind with a thin ridge; narial walls raised, anterior smooth, posterior wall with tall; median of anterior buccal roof with triangular ridge: median of buccal roof arena smooth (Figure 12).

1.3 Microhabitat

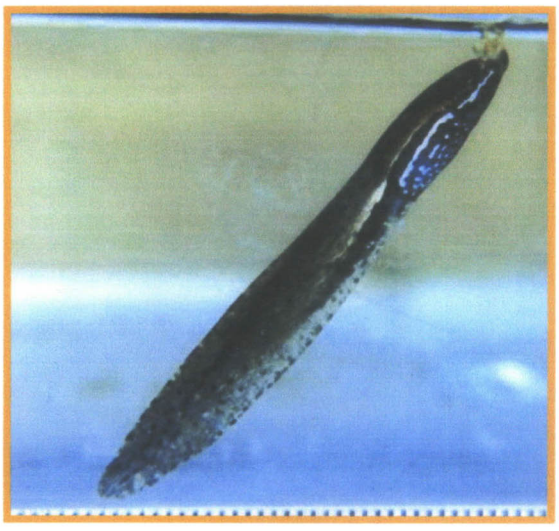
Tadpoles were found in open pools, with moderately strong currents. Habitats are usually water currents blocked by rocks, where there are accumulated dead leaves and other plants on sand or gravel at the bottom. The temperature in pools is 28° C and 1 m above the water surface (air temperature), (morning period) is 30°C. Pools are 15-25 cm deep and 785 m from Mean Sea Level (MSL).

1.4 Behavior

Tadpoles usually live at the water surface in shallow waves but never in foaming water. There is bed gravel and dead leaves or other plants from which they suck organic matter, they float on the surface using their mouth to feed and sometimes they hide under dead leaves or in rock holes. In aquarium their lips are reduced in stage 35, thus they cannot float on the surface for a long time, they attach to some materials on thesurface to help them float. Their bodies are usually tilted 45° from the ground and floating by their mouth, on the water surface. Moreover, they bend their tails to support as well. Therefore, they usually float by themselves.

1.5 Place and Duration

Khao Luang National Park in February, March and August 2003.



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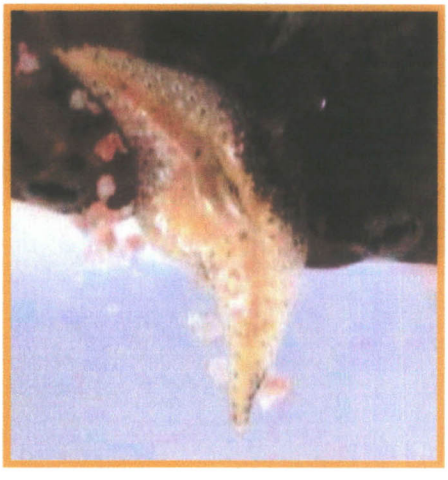


B

C

Figure 11 *Brachytarsophrys carinense*
A: Body shape of tadpole (stage 37, no. of specimen PT001)
B: Mouthparts of tadpole C: Adult

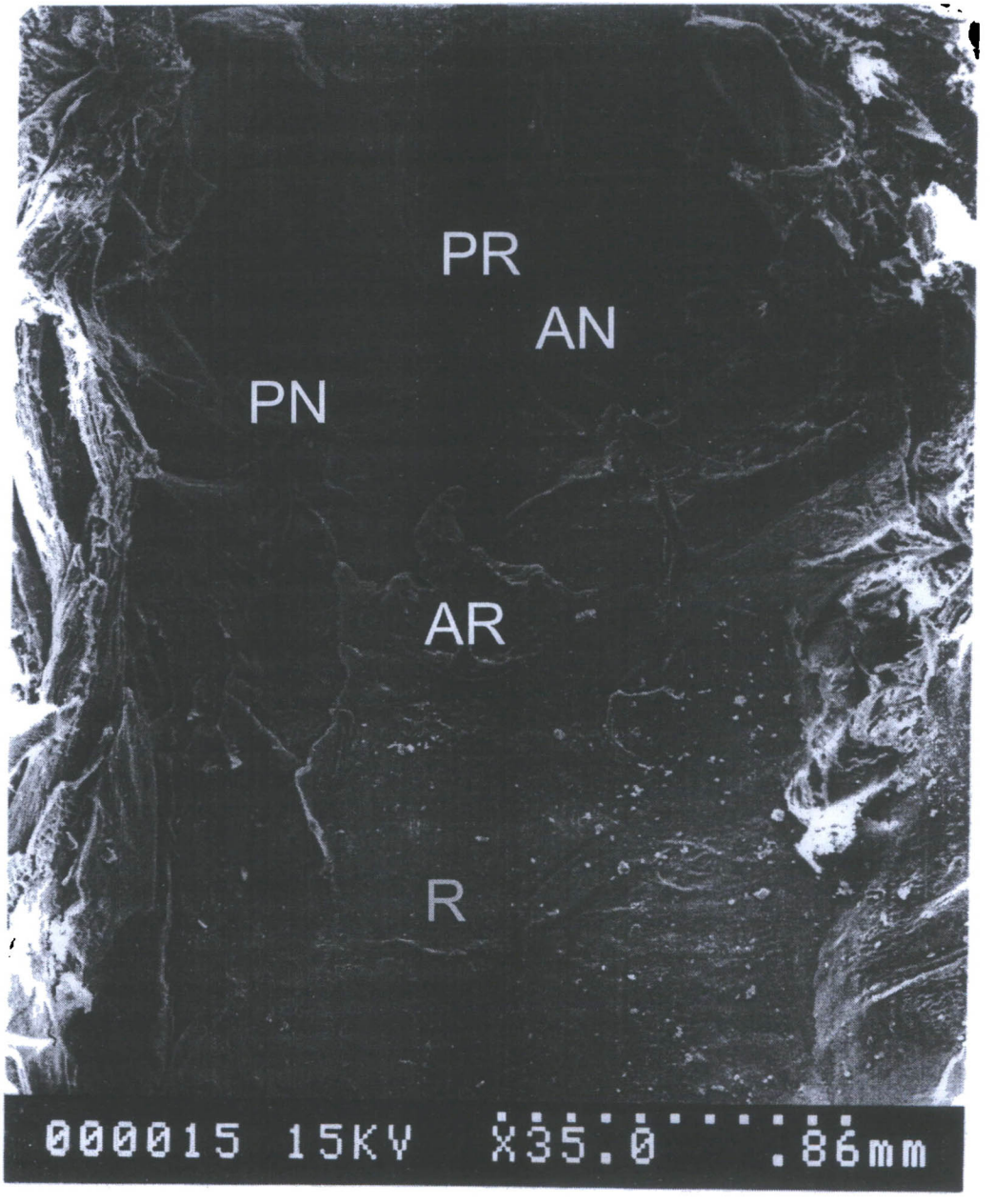


Figure 12 Buccal Roof:
PR-prenarial roof; AN-anterior narial wall; PN-posterior
AR-anterior of buccal roof; R-buccal roof arena.

Genus *Megophrys*

Tadpoles in this genus are similar to *Brachytarsophrys* and *Xenophrys*, especially their mouthes and external morphology but they are different from *Leptobrachium* and *Leptolalax*. *Megophrys* have upward lips and a wide funnel; some species lateral lips are short; beaks and teeth are absent. Moreover, habitat and behavior of *Megophrys, Xenophrys and Brachytarsophrys* are similar.

2. *Megophrys nasuta* Kuhl and Van Hasselt, 1822

The metamorphosis of this larva is similar to adults in stage 41, the body color has started fading. In stage 45 eyelids and end of narial are present in a triangular projection including the lateral brown stripe

2.1 External Morphology

Head-body ellipsoidal, is about twice as long as wide; the eyes are lateral and visible from below; internarial 2/3 time of interorbital distance; the mouth-snout is equal to the snout-eye distance; spiracle sinistral is much closer to the eye than to the root of the tail, eye to spiracle is equal or a little longer from eye to mouth; anul tube medial and free from ventral fin; caudal muscle deeper than the fins, except near the tip (Figure 13).

Oral disc terminal; lips expanded into horizontal and lateral expanded1/2-2/3 of width; lips without marginal papillae but inside lips with rows; beaks and weak teeth.

Head-body and caudal muscle darkish; fins dark brown, dorsal and ventral of margin with smalls dark grey dots; the end is dark.

Total length 34-37 mm, (N=3).

2.2 Buccal Carvity

Buccal floor: Prelingual area (Prelingual palps) of floor deep dorsoventrally, curved, horizontal, slightly raised platform on each side, platform supporting 4 flaps, anteromedial palp with curving forward and upward, a second palp, concave arising from near posteromedian edge of platform, a thick curved flap projecting forward from the anterolateral corner of the platform. Tongue enlarged indistinct, without lingual papillae. A deep transverse groove is behind the prelingual area extended by oblique lateral arms backward to just before the lateral corners of buccal, a long flange projecting mesad from the lateral wall of groove just posterior to the beginning of the lateral arms. Buccal floor arena is smooth, with a slightly curved ridge; a long shallow central groove. Ventral vetum is smooth, without papillae or filaments (Figure 14)

Buccal roof: Prenarial area of roof with deep median, U-shaped ridge with ends of U-shape almost touching beak, U-shape thin slightly oblique ridge lateral to arm of U-shape, behind of the lateral ridge with 3 small pustules in a transverse row, a smooth median knob behind U. Postnarial area with a shallow groove behind each naris. Median ridge a tall, thick structure jutting forward to median prenarial knob, a deep median recess anterior to base of median ridge. The ridge of thebuccal roof arena is long, thick sinuate ridge beginning at median corner of each naris and extending half way to dorsal velum. Dorsal velum is smooth, with V-shaped group of low pustules two-thirds of distance from median ridge to esophagus (Figure 15).

2.3 Microhabitat

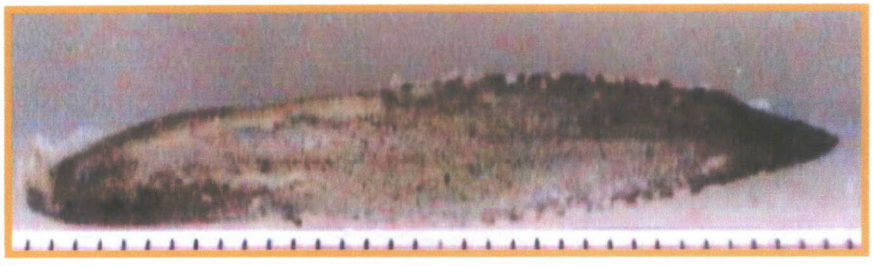
Tadpoles are found in side pools of small stream banks, where there are some small rocks and other plants to obstruct water current, there are accumulated dead leaves and other plants on a silty or sandy bottom. The temperature in the pond (morning period) is 28°C and 29°C 1 m above the water surface (air temperature). The pond is about 10-17 cm in depth and 350 m MSL.

2.4 Behavior

Their bodies usually tilt more than 45° from the ground and there is bed gravel on dead leaves or other plants in the pond. Lips normally are expanded on the surface to suck organic matter or plankton in the water to feed. Their tail is often bent so that it can support floating the body on the surface. In aquarium, larvae usually touch the body with some material while bending the tail that perhaps can support the body to float on the surface for a long time. Lips are reduced in stage 37 and stage 40 larvae usually lie down on the bottom and sometimes raised on surface. When they are disturbed, they hide under dead leaves or in rock holes on the bottom.

2.5 Place and Duratiopn

Hala-Bala Wildlife Sanctuary in February 2003.



A

B

C

Figure 13 *Megophrys nasuta*
A: Body shape of tadpole (stage 37, no of specimen PT.002)
B: Mouthparts of tadpole C: Adult

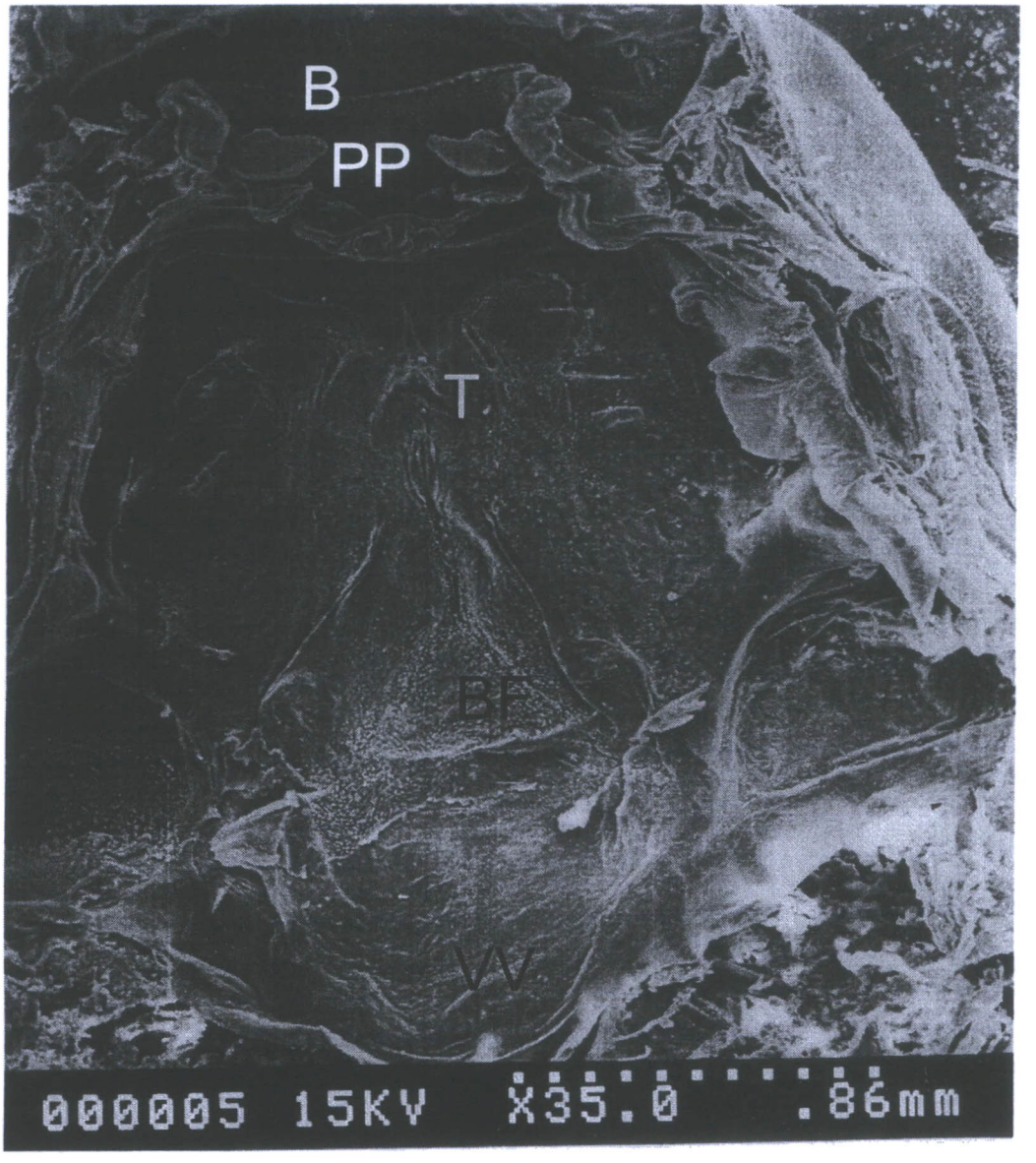


Figure 14 Buccal floor arena
B-beak; PP-prelingual palps; T-tongue; BF-buccal floor arena;
VV-ventral velum.

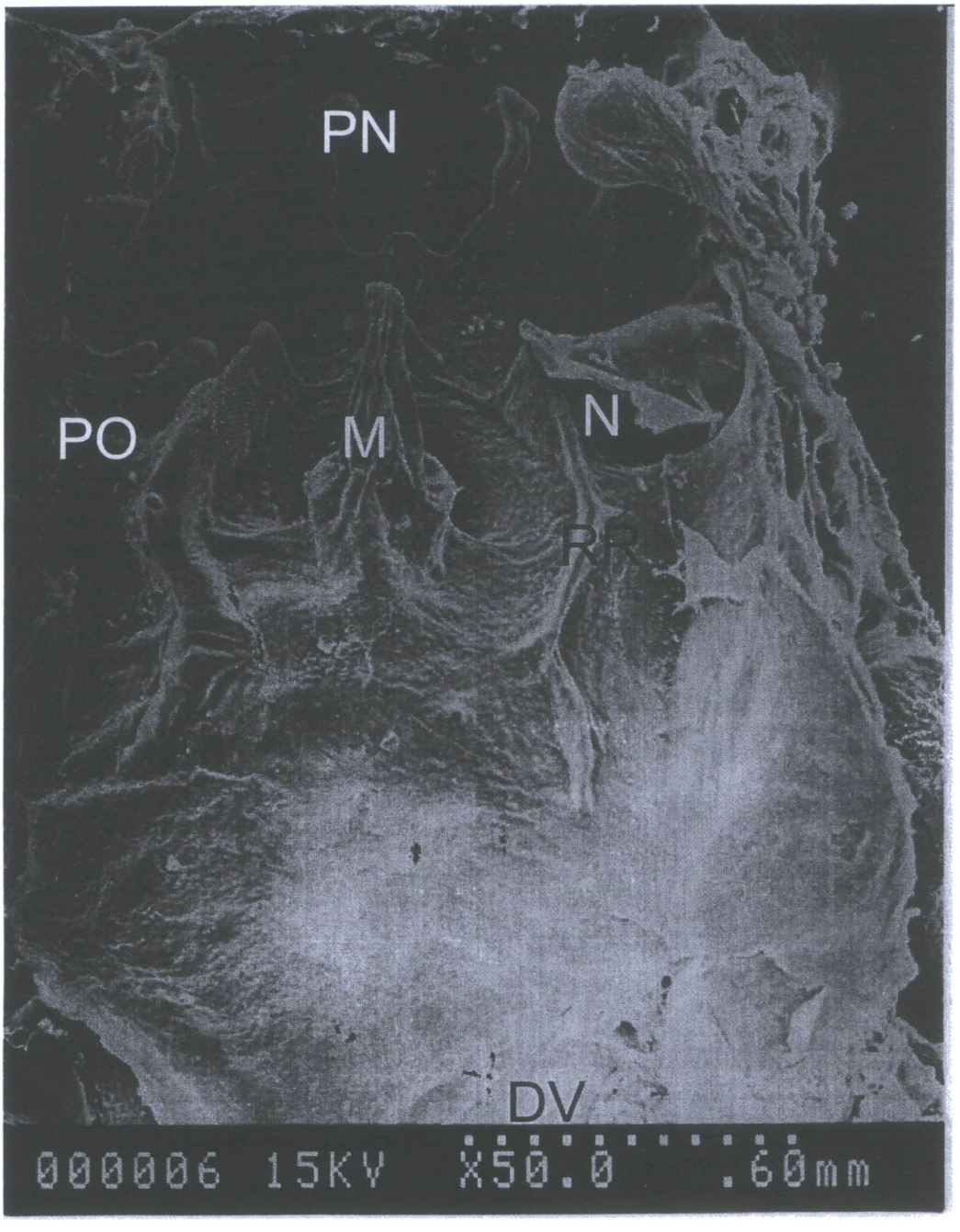


Figure 15 Buccal roof arena
PN, pranarial arena; N, narial; PO, postnarial area; M, median ridge; RR-ridge of buccal roof; DV-dorsal Velum

Genus *Xenophrys*

Xenophrys larvae resemble *Megophrys* and *Brachytarsophrys*, oral disc and body shape, but their size is distinct. *Xenophrys* are usually smaller than those genera and also the lateral lips are shorter.

3. *Xenoophrys longipes* (Boulenger, 1886)

Their metamorphosis starts in stage 39, the lateral lips are short. In stage 42 the color on the body is pale and at this stage larva is too small to rise to the surface.

3.1 External Morphology

Head-body ellipsoidal, about twice as long as width; eyes lateral visible from below; interorbital slightly longer than internarial distance; mouth-snouth twice snout-eyes distance; spiracle sinistral much nearby to eye than the root tail, spiracle-eyes slightly longer than or equal to eyes-mouth; vent tube median; caudal muscle slander; ventral fin wilder than dorsal fin; tip rounded (Figure 16).

Oral disc terminal; lateral lips equal width; papillae with inside lips; beaks and teeth weak.

Head-body and tail greyish or dark-greyish; ventral and dorsal fins transparent with dark spots on distal half; lip red-brownish.

Total length 34 mm, (N=3).

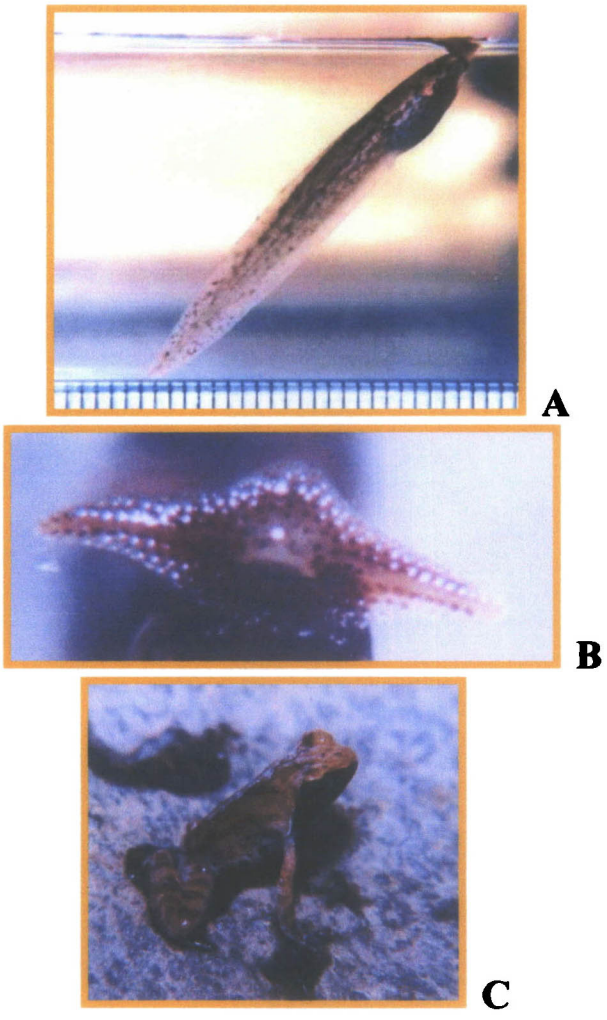


Figure 16 *Xenophrys longipes*
A: Body shape of tadpole (stage 37, no. of specimen PT.003)
B: Mouthparts of tadpole C: adult

3.2 Microhabitat

Larvae of *X. longipes* living are similar to other species but they are also found in side streams. Water is about 10-110 cm deep and the temperature is 31°C, 1 m above the surface is 32°C. Elevation is 200 m MSL.

3.3 Behavior

They are usually floatable on the surface in shallow waves but never in foaming water. The bed is gravel on several materials that block the water current, such as dead leaves or other plants and even some stones. In aquarium some larvae float on the surface using their lips, using the strain of the water surface, bended tail and tilt their body about 45° from horizontal. Some larvae attach to material to float

on the surface, they do not bend their tails but the tails are inclined more than 60° from the ground. Lateral lips are reduced in stage 38 onward.

3.4 Place and Duration

Khlong Nakha WS. in December 2003

4. *Xenophrys aceras* (Boulenger, 1903)

The metamorphosis of this larva is similar to adults in stage 42 onward, at this stage streaks occur on the back and at stage 45; dorsolateral ridge is present from tympanum to vent. At stage 46 the body color is light grey.

4.1 External Morphology

Head-body ellipsoidal, the length of body is about twice the width; eyes lateral visible from below; interorbital slightly longer than internarial; mouth-snout about snout-eyes distance; spiracle sinistral is much closer to eye than to root tail and spiracle-eyes equal or little more than eyes-mouth; anus median; extended from ventral; caudal muscle slender; ventral and dorsal fins are equal with pointed tips (Figure 17).

Oral disc terminal, cuplike, lateral lips about 1/2 or 2/3 as long as width; papillae absent on marginal lips but lower lips with; beak and teeth weak.

Head-body brownish or orange brown, tail same; without spots or streaks on the tail.

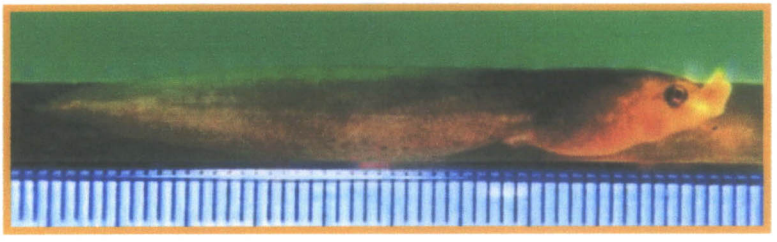
Total length 48-50 mm, (N=3).

4.2 Microhabitat

The habitat of these larvae is similar to *Brachytsophrys* and other species in this genus. The temperature (morning period) of ponds is 28°C at 1m above the surface (air temperature) is 30°C. The water is 15 cm deep and 785 m MSL at Khao Luang National Park and Khlong Nakha Wildlife Sanctuary is 18 cm deep and 200 m MSL.

4.3 Behavior

Behavior of these larvae is similar to other species in this genus but their bodies are tilted less than 45° from horizontal. They usually live together, grouping, that can help them to suck some organic matter on the surface for better food. Stage 38 lips are clear to reduce so they attach to some material to support their body for floating.



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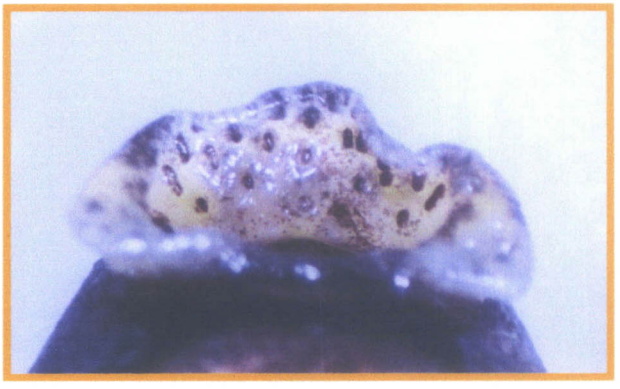

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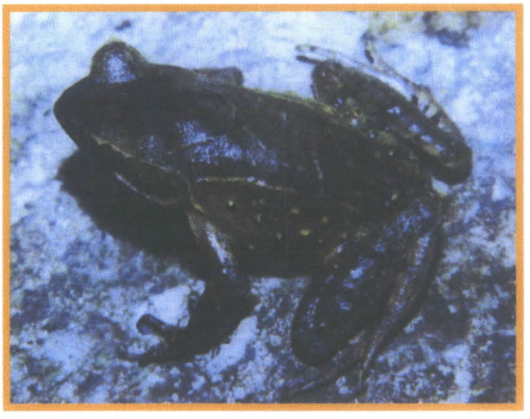


C

Figure 17 *Xenophrys aceras*
A: Body shape of tadpole (stage 37, no. of specimen PT.004)
B: Mouthparts of tadpole C: Adult

4.4 Place and Duration

Khlong Nakha WS. and Khao Luang NP. in February 2003.

Genus *Leptobrachium*

Leptobrachium is easy to distinguish from other genus in this family. They have a large body and there are lot of teeth rows, upper 3-7, lower 4-7 of rows and lateral inframarginal ridges with small denticles. Their papillae are clear; oral disc

ventral, subterminal; caudal muscle and large fins; the vent tube is big and long. Some species are unusual, all of the body has black dots.

5. *Leptobrachium* sp.1 (white-eyes) (Bourret,1937)

The metamorphosis of larvae is similar to adults in stage 45 onward, upper of marginal eyes with pale blue and grayish back.

5.1 External Morphology

Head-body oval, about 1/2 or 2/3 as long as width; eyes dorsolateral not visible from below; interorbital wider than internarial distance; mouth-snout half of snout-eyes distance; spiracle sinistral, tubular, closer to eye than to snout; anus dextral, opening at margin of ventral fin; tail muscle strong; dorsal fin deeper than ventral; fin beginning at root of tail; tip rounded (Figure 18).

Oral disc ventral, subterminal; papillae on marginal disc with a single row, upper and lower equal in size, upper with gap on median; Labial Teeth Row Formula (LTRF) 6(2-6)-9(2-9) / 5(1-4)-7(1-6) ; lateral inframarginal ridge with about 16-18 of small denticle rows in either side and starting to occur in stage 38, second of upper teeth row longer than 5-6 time of top but about half shorter than last of lower teeth row ; each of upper teeth rows with equal or subequal distance; beaks heavy, black, coarse serration

Head-body brownish or dark-brownish, tail muscle same; fins with light grey spots, some bodies with light brown or cream spots all of root tail; dorsal of root tail with a pale brown or cream, triangular mark

Total length 45-60 (N=3) mm.

5.2 Microhabitat

They were found in side pools of small stream banks where there are accumulated dead leaves and other plants on a sand or silty bottom. Water is about 15-20 cm deep, 20-40 cm wide and 60-80 cm long. The temperate of these pool (morning period) is about 28-31°C and 1 m above the surface is 29-32°C. Elevation is 800 m MSL.

5.3 Behavior

Larvae live under dead leaves or nook stone and they scrape dead leaves and other plants on stone surfaces on the bottom for food (from operations on their stomach and intestines some dead leaves were found and even sand or silt, hence perhaps they eat these things for food). Larvae do not quickly move but they live together, sometime rise to the surface and are mostly activize at night.

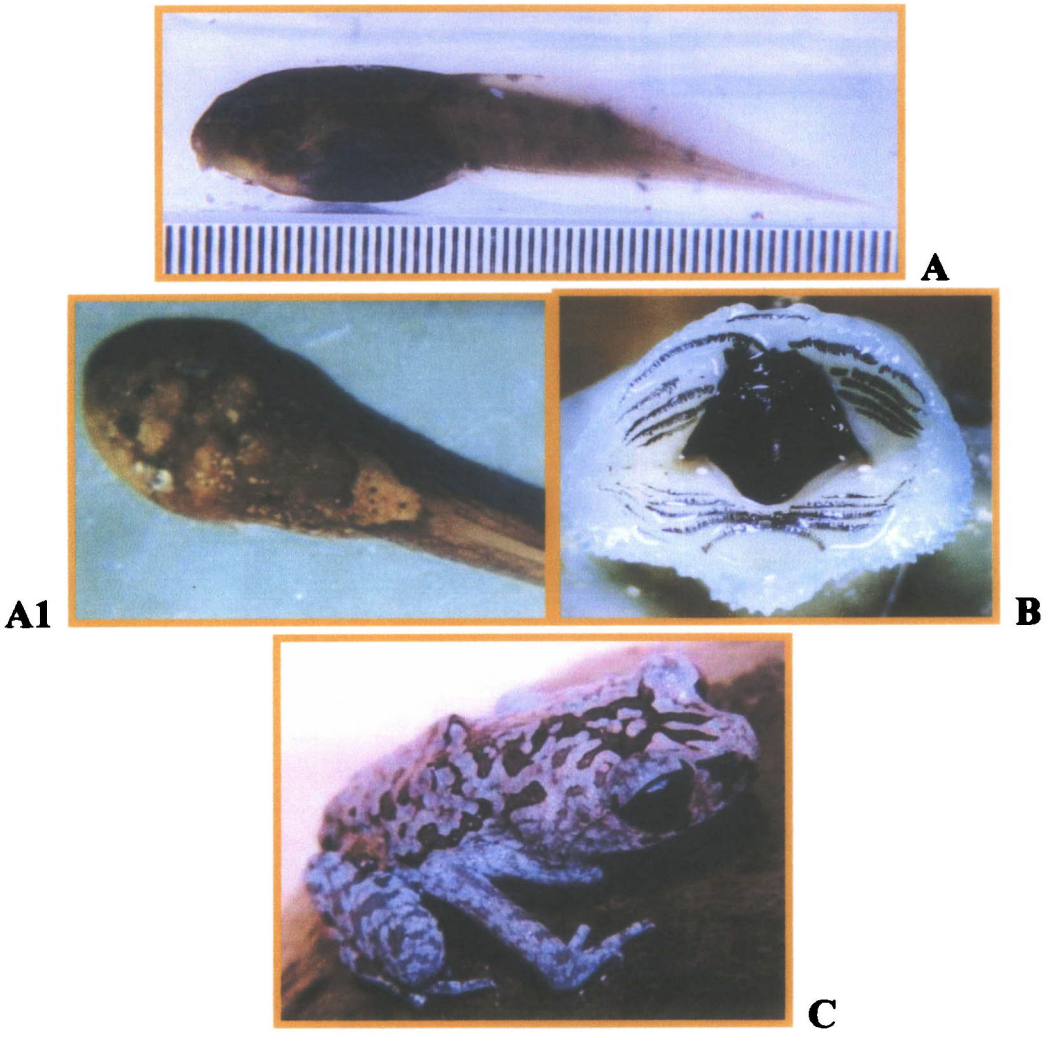


Figure 18 *Leptobrachium* sp.1 (White-eyes)
A: Body shape of tadpole (stage 36, no. of specimen PT005)
A1: Dorsal view B: Mouthparts of tadpole C: Adult

5.4 Place and Duration

Khao Luang NP. in June 2003.

6. *Leptobrachium* sp.2 (Red and Yellow-eyes) Tschudi, 1838

Their metamorphosis takes about 7-8 months to complete (in aquarium). Stage 42 upper marginal eyes any color is present, usually red or yellow. All species from Khao Luang National Park (3 individuals) found that 2 of them are yellow and the other is red on upper marginal eyes. All external morphology is similar but the color of these larvae is distinct from the larvae in Thong Phaphum National Park.

6.1 External Morphology

Head-body oval, longer than 1/2-2/3 time of width; eyes dorsolateral non visible from below; internarial half of interorbital; mouth-snout equal snout-eyes; spiracle sinistral, closer to eye than to root of tail; vent tube media, opening at root of tail; dorsal fin slightly deeper ventral; end rounded (Figure 19).

Oral disc ventral, subterminal; marginal disc with single row of papillae, which is smaller than *Leptobrachium* sp.1 (White-eyes), upper slightly smaller than lower and median gap, corner of mouth with rows; LTRF 6(1-6)-7(2-7) / 6(2-5) ; lateral inframaginal ridge with about 12-14 rows of small denticles; second of upper teeth about 5-6 times longer than the first row and equal or slightly shorter than the last of lower teeth; lower teeth without adjoining the lower beak; beaks heavy, black, coarsely serrated.

Head-body brown or grey brown,the tail is the same with light grey spots, half to end of tail; lateral body with light brown spots and a triangular mark on upper root tail. Head- body and tail of larvae at Thong-Phaphum are smaller than Khao Luang and dorsal fins have about 6-12 dark spots, small spots on ventral; root tail and lateral body with plain color.

Total length 50-80 mm, (N=3).

6.2 Buccal Carvity

Buccal floor: Prelingual area of floor with 2 pairs blanched palps on each side; tongue enlarged, 2 pairs of lingual papillae; buccal floor arena with about 30 low pustules; lateral papillae of buccal floor arena with about 30 branches palps on each side; ventral velum wide, smooth (Figure 20).

6.3 Microhabitat

Larvae are found in side pools of small stream banks, where there are accumulated dead leaves and other plants on a sand and small rock bottom. Temperate in pool (morning period) is 29°C and 1 m above the water surface (air temperature) is 30°C. The length of pools is 0.80 cm, 130 cm width and 20 cm depth. Elevation is 300 m MSL.

6.4 Behavior

All behavior of *Leptobrachium* sp.2 (red-yellow eyes) is similar to *L.* sp.1 (white-eyes).

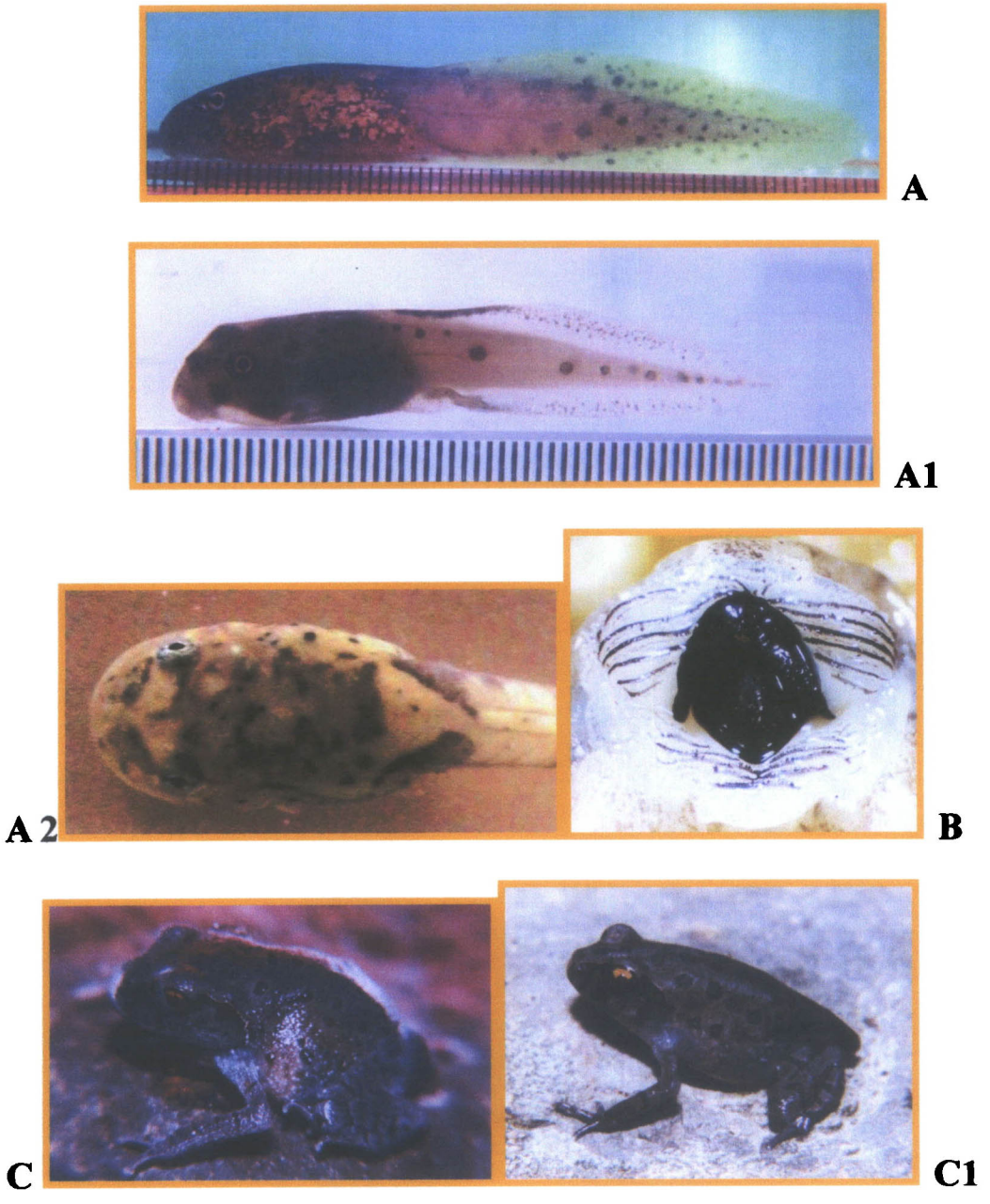


Figure 19 *Leptobrachium* sp.2 (Red and Yellow eyes)
A: Body shape of tadpole (stage 37, no. of specimen PT006)
A1: Body shape of tadpole at Thong Phaphum District (stage 37)
A2: Top View B: Mouthparts of tadpole
C: Adult of Red-eyes C1: Stage 45 of Yellow-eyes

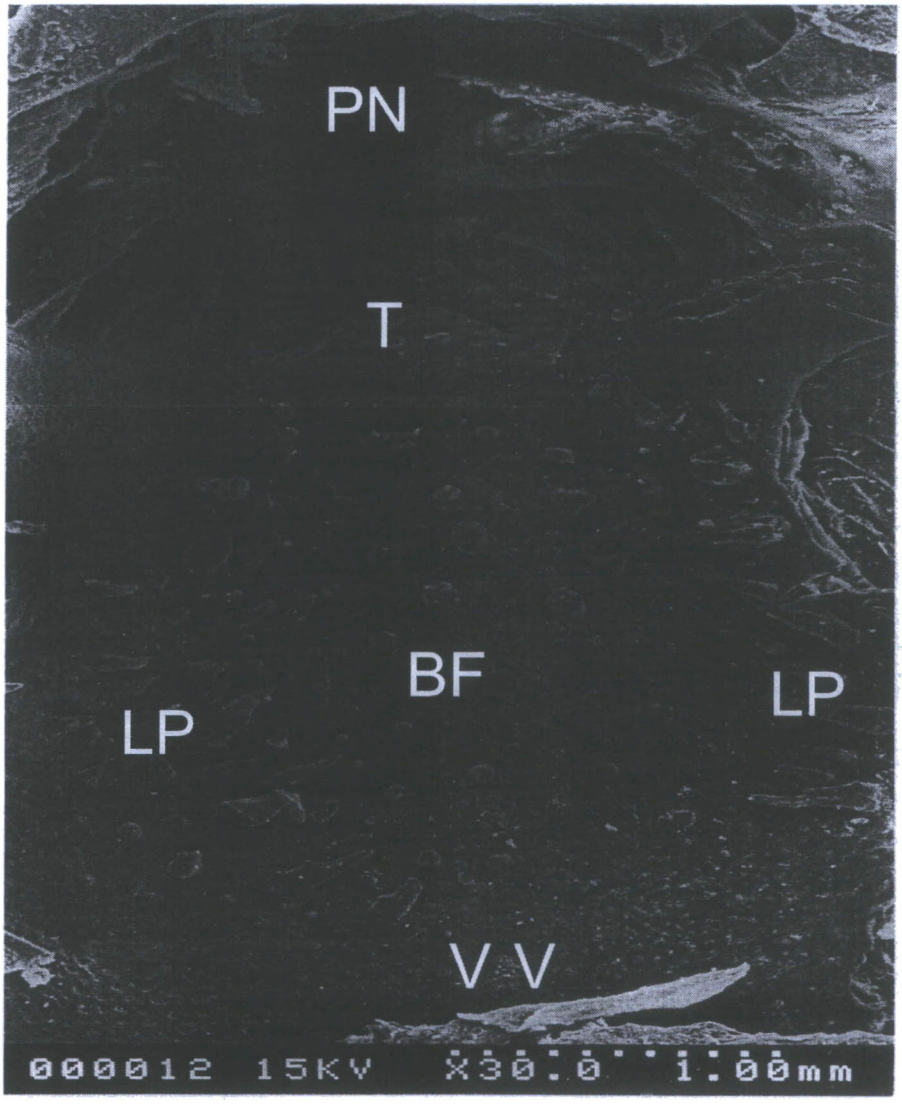


Figure 20 Buccal floor arena
PN-prenarial arena; T-tongue: BF-buccal floor arena: LP-latteral papillae; VV-ventral velum

6.5 Place and Duration

Khao Luang NP. in January, March and June 2003 but Khlong Nakha WS. in January 2004.

7. *Leptobrachium hendricksoni* Taylor, 1962

This larva is different from other species in this genus, especially their color. Stage 42 onward their color and black small dots on all of body gradually fade, stage 45 back grayish and red eyes, lateral body with scattering of small grey dots.

7.1 External Morphology

Body oval, length twice width; eyes dorsolateral, non visible from below; interorbital twice of internarial; mouth-snout equal snout-eyes; spiracle sinistral, tubular, close to eyes equal mouth; anus opening at margin of ventral fin; caudal muscle large; dorsal fin slightly deeper than or equal to ventral; fins beginning at end of body; tip rounded (Figure 21).

Oral disc ventral, subterminal; papillae with a single row on marginal disc, upper smaller than lower , upper with gap in median; LTRF 7(2-7)-8(1-7) / 7(2-7) or rarely 6(1-5) ; lateral inframarginal ridges on lower lip with more than 25 rows of small denticles; lower teeth without adjoining a lower beak; beaks with coarse serrations.

All of body is red-brown, with numerous small black dots on surface; fins transparent.

Total length 54-55 mm, (N=3).

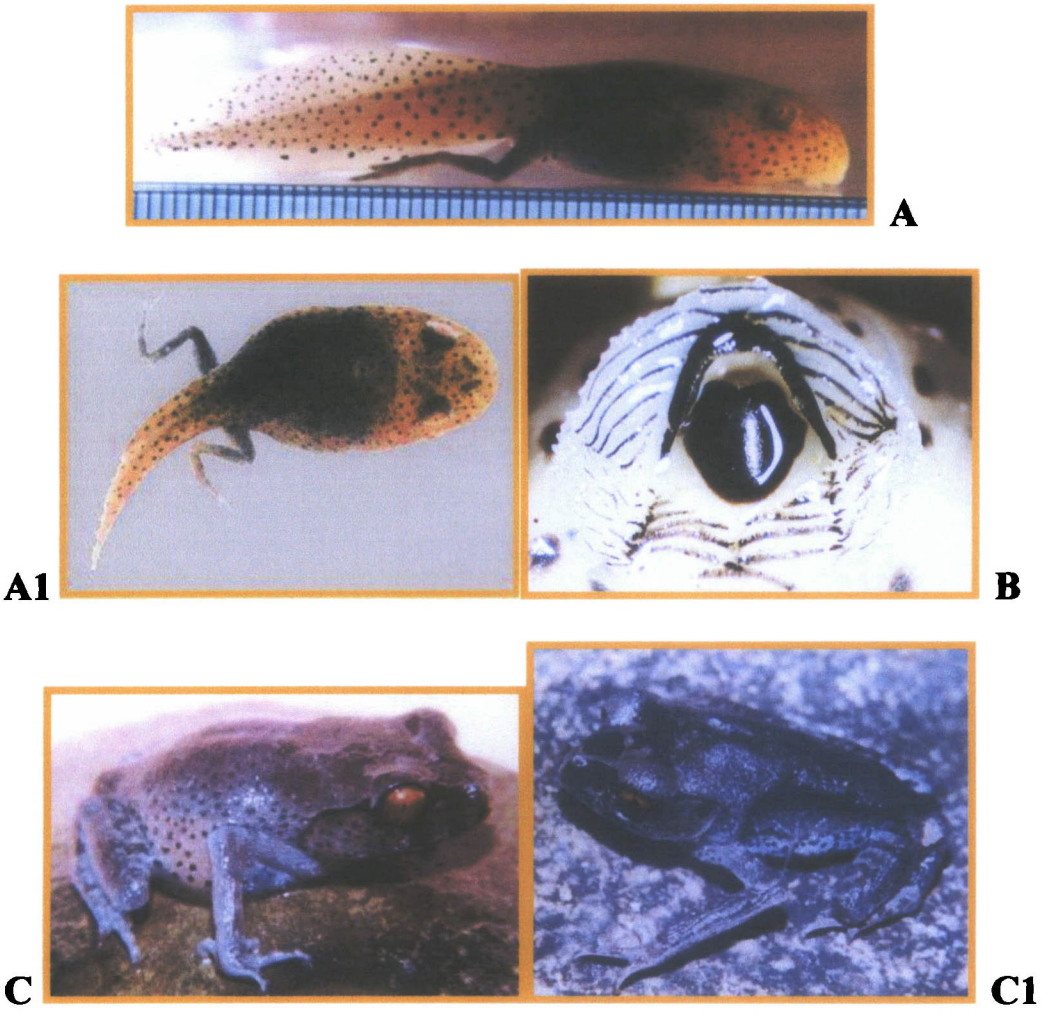


Figure 21 *Leptobrachium hendricksoni*
A: Body shape of tadpole (stage 40, no pf specimen PT007.)
A1: Dorsal View B: Mouthparts of tadpole
C: Subadult C1: Adult

7.2 Buccal carvity

Buccal floor: Prelingual area of floor smooth; tongue enlargement low, a single lingual papillae, and medial. Buccal floor arena smooth. Lateral papillae of buccal floor arena with 9 branched palps. Ventral velum wide, with spicules dorsal surface medially with about 30 pustules in an undivided group (Figure 22).

7.3 Microhabitat

These larvae are found in both side pools of small stream banks and rain pools. Side pools are about 150-200 cm width and 10-15 cm depth; the temperature (morning period), is 28°C and 1 m above the water surface (air temperature) is 29°C where there are accumulated dead leaves and other plants on sand or small rock or silty bottom. The rain pool is 100 cm width, 170 cm length and 50 cm depth; the temperature is 28°C and 1 m above the water surface (air temperature) is 29°C (morning period), the bottom is silty and with an accumulation of dead leaves and other plants on it. Elevation from is 300 m MSL.

7.4 Behavior

Every time in this study these larvae were found they were living in side pools of small stream banks, where they live under accumulated dead leaves on sand bottom at day but at night they swim on the surface and most activities appear at this time. In the rain pool their eggs are found at the edge of the pool, where there are accumulated dead leaves and other plants on a silty bottom, eggs are similar to *Rana* but they are lumpy and top of them are rafts, about 200-300 eggs, egg with dark grey and about 0.5 cm of diameter. The behavior of all larvae in rain pools is similar in side pools.

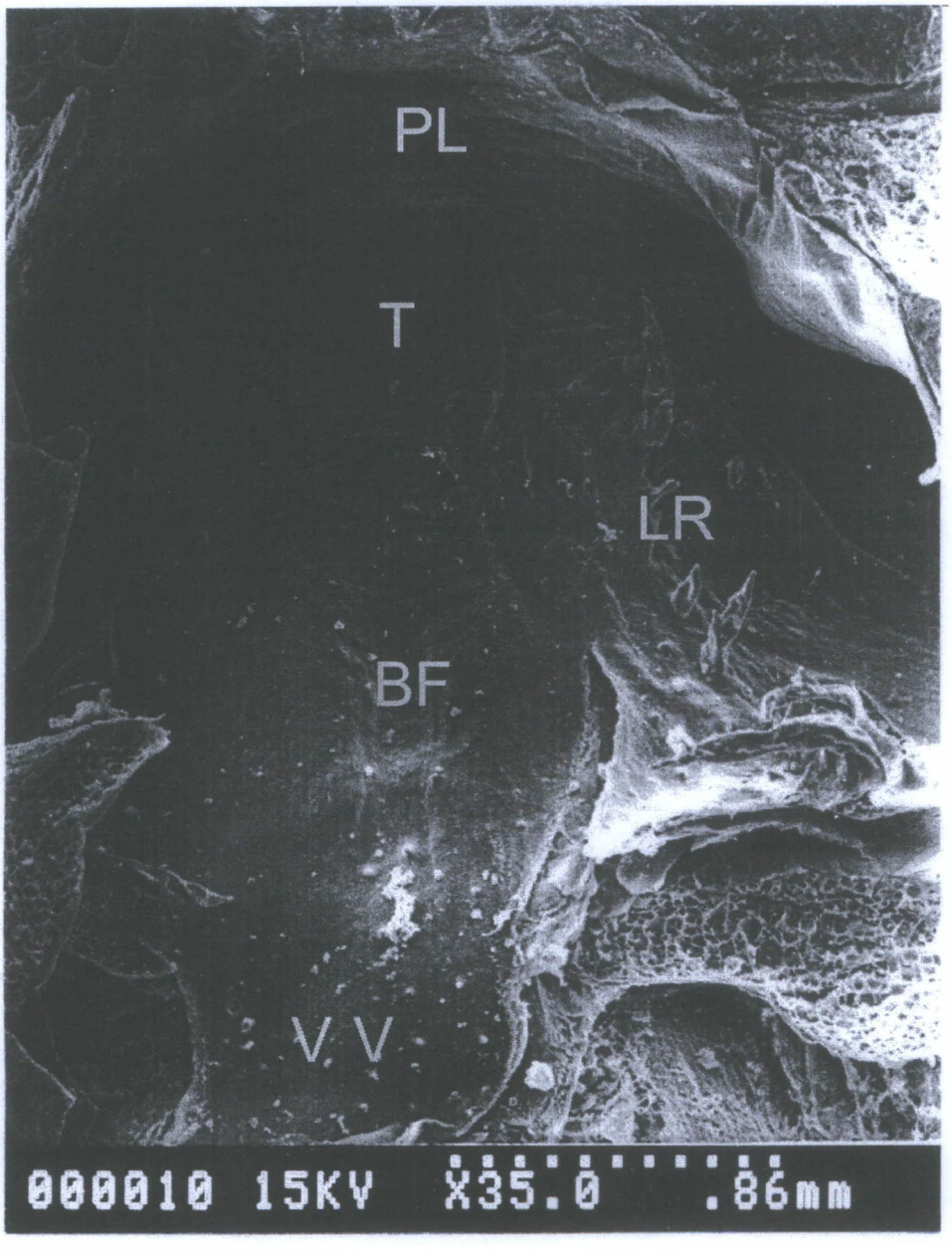


Figure 22 Buccal floor arena
PR-prelingual arena; T-tongue; LR-lateral ridge; BF-buccal floor arena; VV-ventral velum

7.5 Place and Duration

Hala-Bala WS. all to collect the data.

Genus *Leptolalax*

Only one species of *Leptolalax* is found in this study. The external morphology of it is more similar to *Megophrys* than *Leptobrachium*, especially body shape with ellipsoidal but the oral disc with ventral, funnel-shaped, lips expanded, without papillae; tail looks like a sword.

8. *Leptolalax heteropus* (Boulenger, 1900)

The metamorphosis of this larva is similar to adults in stage 46 onward, back with grey, lateral body with scattering of dark spots. In stages 45-46 they are similar to *Letolalax gracilis* in color of the body and eyes.

8.1 External Morphology

Elongated oval body, about twice as long as width; eyes dorsal not visible from below; interorbital distance slightly wider than internarial distance; mouth-snout half of snout-eyes distance; spiracle sinistral, tubular, closer to eye than to root tail; vent tube dextral, opening near edges of ventral fin; caudal muscle heavy; dorsal fin beginning at the behind of body, less than depth of ventral fin; ventral fin beginning at root tail; end rounded (Figure 23)

Oral disc ventral, about 1/3 width of head; lips expanded, cuplike, notched in center; the lower lip deeper than upper, 6 oblique rows of low papillae along outer boarder of labial teeth, entire margin of oral disc is finely serrated, LTRF 3/(2-3)/ 3(1-2); all teeth rows are short, first and third of upper teeth 7 times shorter than second row; beaks strong, black, margin serrated.

Head-body dark brown; caudal muscle same; fins with numerous brown spots or small stripe; lateral root tail with about 6-8 of dark grey arrowheads (<) marks.

Total length 54 mm, (N=1).

8.2 Microhabitat

The tadpoles were collected in side pools of small stream banks, where there are accumulated dead leaves and other plants on a sand and small rock bottom. The pool is 96 cm wide, 124 cm long and 28 cm deep. The temperate is 28°C on bottom and 1 m above the water surface (air temperature), is 29°c (morning period). Elevation is 300 m MSL.

8.3 Behavior

Larvae usually live under accumulated dead leaves or nook of stone and lips are similar suckers, holding on to something while its scrapes dead leaves or

other things in the pool to feed. In aquarium the larvae sometime rise to the surface, it moves quite quickly and most activity is at night.

8.4 Place and Duration

Hala-Bala WS. in April 2003.

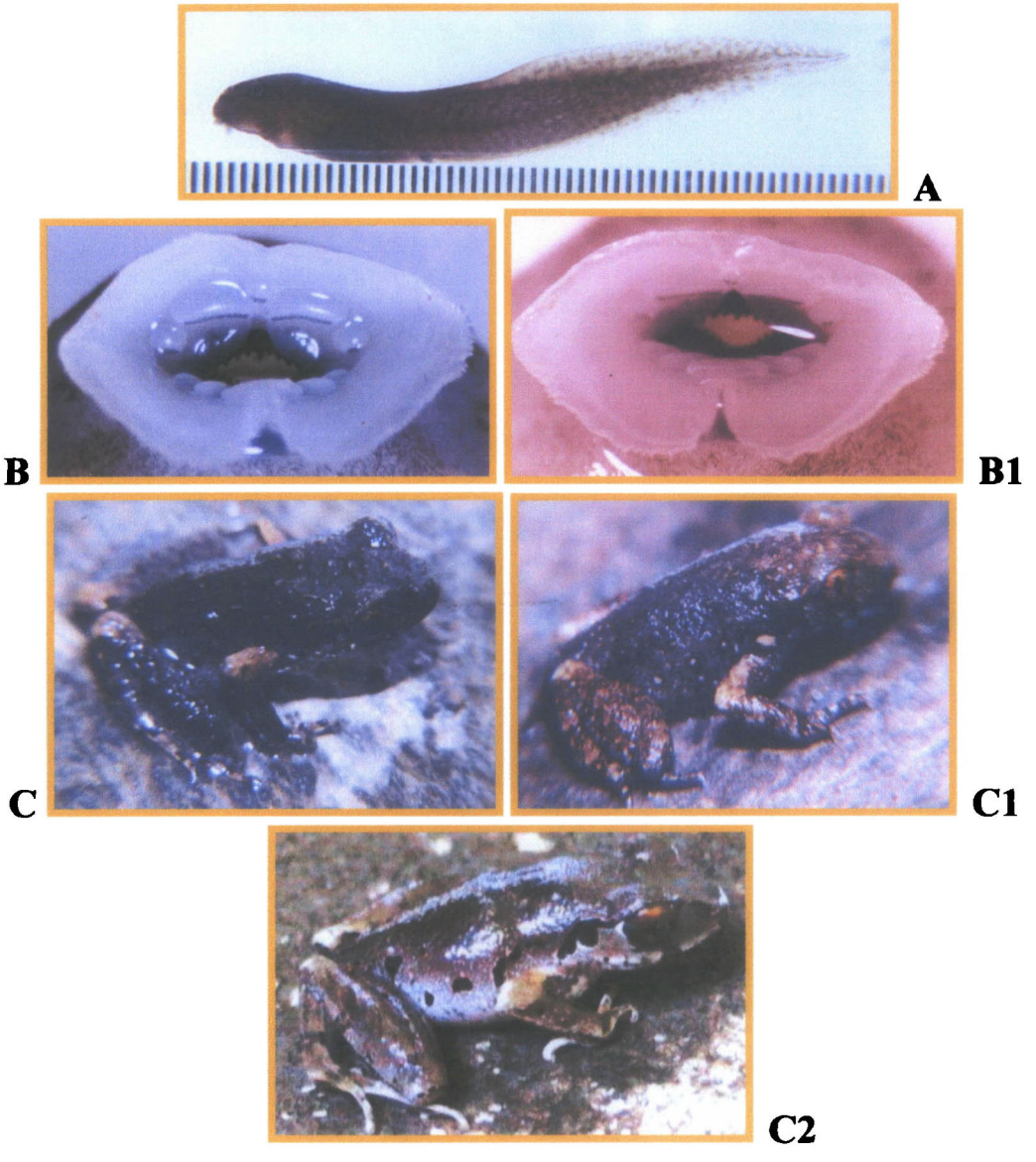


Figure 23 *Leptolalax heteropus*
A: Body shape (stage 37, no. of specimen PT008)
B: Mouthparts of *L heteropus* B1: *L. gracilis* ? from Thong Phabhum
C: Immature of *L heteropus* C1: *L. gracilis* ? from Thong Phabhum
C2: Adult of *Leptolalax heteropus*

Family Bofonidae

Anuran amphibians of this family comprise 3 genera altogether, that are *Ansonia*, *Bufo*, and *Pedostibes*. An external morphology of these tadpoles are similar, especially the plain blackish color of the body. Although they have similar external morphology their mouthparts are different. Labial tooth row formula (LTRF) are usually not distinct; no more than 2 rows on upper teeth and 3 rows on lower teeth; oral disc with 2 forms, ventral in *Ansonia* and *Bufo asper* and ventral, subterminal in most tadpoles in this family; papillae complete or with gap on lips; vent tube median; spiracle sinistral; eyes dorsal; beaks not heavy, black; head-body oval. They are very well adapted to several environments, from forest to urban, and, rain pools to strong-flowing streams.

Key to Genera of Bufonidae

1. Oral disc ventral.....*Ansonia*
   Oral disc anteroventral.....2
2. The Last of lower teeth rows with bend over in medial.....*Pedostibes*
   All lower teeth rows parallel.....*Bufo*

Key to Species of Bufonidae

1. Lips largely expanded, as wide as head; fins depth 1/3 time of caudal muscle in medial.....2
   Lips not expanded, normal; fins depth equal or subequal of caudal muscle In medial.....3
2. Upper beak with lacking, length twice of each tooth.....*Ansonia malayana*
   Upper beak connecting, M shaped.....*Bufo asper*
3. Tips of second upper teeth row close together.....4
   Tips of second upper teeth row not close together 5
4. Second upper teeth row with gap, length 1/8 time of each tooth.....*Bufo parvus*
   Second upper teeth row with gap, length half of each tooth.....*Bufo melanostictus*
5. Tips of second and third lower teeth rows with sub close.....*Pedostibes hosii*
   Tips of second and third in lower teeth rows not close.....6
6. Second and third lower teeth rows twice of first and second row's distance..... .....*Bufo macrotis*
   Second and third lower teeth rows equal or subequal of first and second rows distance.....*Bufo quadriporcatus*

Genus *Ansonia*

Only one species of this genus has been found and they are different to other species in this family, except *Bufo asper*. Their bodies are flat; small papillae on entire marginal disc; oral disc ventral and subequal head width; teeth and beaks are different with other genus; lips expanded, sucker-like. They can live on stones in heavy streams by using their mouthes that it is not a true disc like *Amolops*.

9. *Ansonia malayana* Inger, 1960

The metamorphosis of larvae is similar to adults in stage 45, stripes on ventral, strage 42 lips are reduced

9.1 External Morphology

Head-body oval, length about twice width; eyes dorsal not visible from below; interorbital distance twice of internarial; mouth-snout 3 time of snout-eyes distance; spiracle sinistral, tubular, low on side, close to eye equal to root tail; anus medial; tail margins subparallel; caudal muscle deeper than fins; tip blunt (Figure 24).

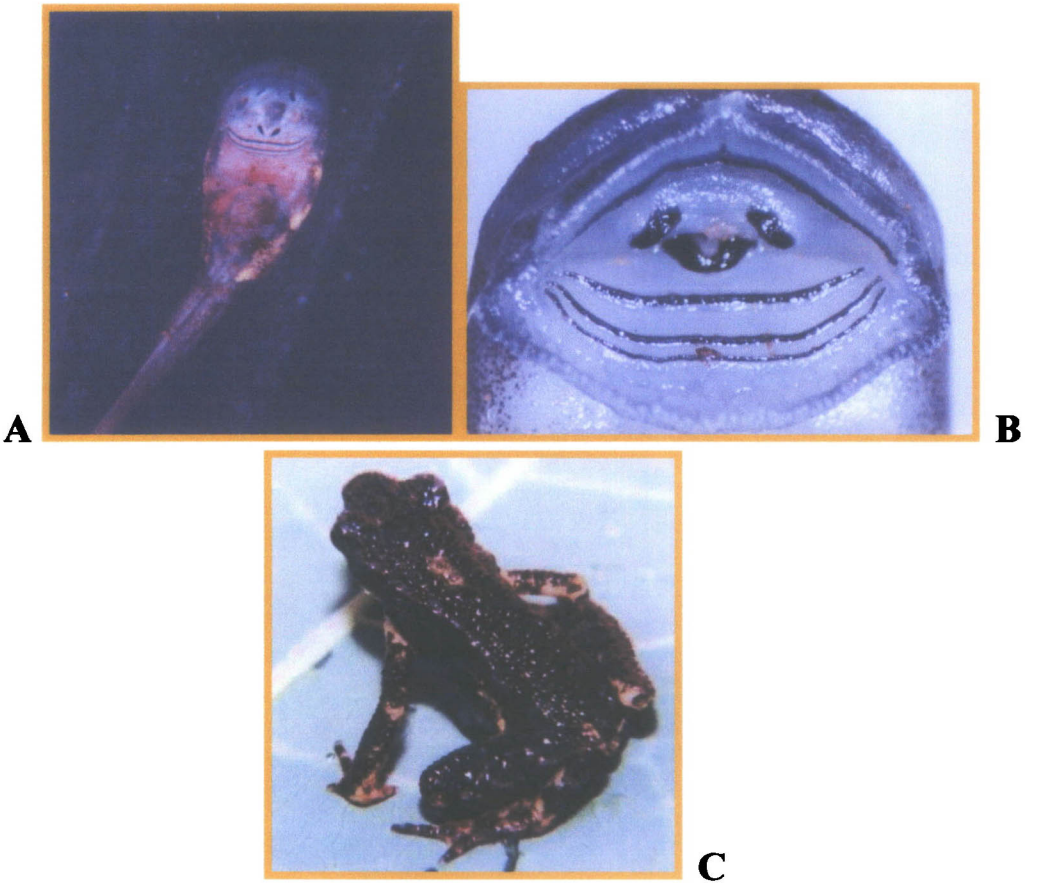


Figure 24 *Ansonia malayana*
A: Body shape of tadpole (stage 31, no. of specimen PT009)
B: Mouthparts C: Adult

Oral disc ventral, as wide as head; lips expanded, width about twice length; lower lip with a single continuous row of small papillae to upper commissural mouth; labial tooth row formula (LTRF) 2/3, the second to third row half of the first to second row in lower teeth rows distance; upper beak wide gap in median, lower beak with nearly lack in median.

Head-body and tail blackish; ventral transparent, visible entrails.

Total length 15-18 mm, (N=3).

9.2 Microhabitat

Torrents are the living place of this larva, where there are some large stones which block the current. The temperature is 28°C on surface stone and 1 m above water surface (air temperature) is 29°C (evening period). Elevation from Mean Sea Level (MSL) is 300 m.

9.3 Behavior

Larvae normally adhere to stones in heavy streams by using their sucker-like mouthes. There are many individuals living together on a stone. In a day they hideaway under or in the nook of a stone but in the night they move to an upper stone, near the water surface; most activities are done in a night so it was easy to find or catch them.

9.4 Place and Duration

Khlong Nakha and Hala-Bala WS. in February 2003

Genus *Bufo*

Tadpoles of *Bufo* have been found in assorted ecosystems because they are very adaptable. They eat everything, from plants to animals and even their carcasses. Moreover, this tadpole lives in many places, forest to urban, torrents to ponds and even some rain pools beside roads. Their external morphology is similar, black small body; fins transparent; LTRF 2/3, except *Bufo asper*

10. *Bufo asper* Gravenhorst, 1829

This larvae is very similar of *Ansonia malayana*; lips greatly expanded, sucker-like and living in strong currents but larvae of *Bufo asper* live in the pools of stream banks. Stage 40 denticle are starting to reduce, stage 42 onward their lips start reducing, while the tail also shrinks.

10.1 External Morphology

Head-body oval, slightly flatten above, length of body twice of width and 3 time of depth; eyes dorsal non visible from below; interorbital twice of internarial distance; mouth-snout twice of snout-eyes distance; spiracle sinistral, low on side, equal or slightly more to eye than to root tail; vent median, tubular; tail lanceolate, upper margin convex, lower straight; origins of fins at end of body; dorsal fin deeper than ventral; tip pointed (Figure 25).

Oral disc ventral, greatly expanded lips, sucker-like, width ¾ of head width; lips length 2/3 of width; small papillae with a single row and confined to corners of lower lip; LTRF 2/3, lower teeth in first to second rows twice of second to third rows distance, lower teeth rows subequal, upper teeth rows length to commissural mouth; beaks black, upper beak with M shape, width 3-4 times lower beak.

Total length 11-11.5 mm, (N=2).

10.2 Microhabitat

This larva is found in pools of rocky stream banks with a sand bottom. The pool is 30 cm deep. The temperature (morning period) is 28°C at the bottom and 29°C 1 m above the water surface (air temperature). Elevation is 200 m MSL.

10.3 Behavior

Larvae usually stick on rocks. They move onto rocks by shrinking and expanding their lips. Larvae do not live together, that is similar to *Ansonia* but they are easily found at night on the nook of a rock

10.4 Place and Duration

Khlong Nakha and Hala-Bala WS. in January, Khao Luang NP. in March 2003.

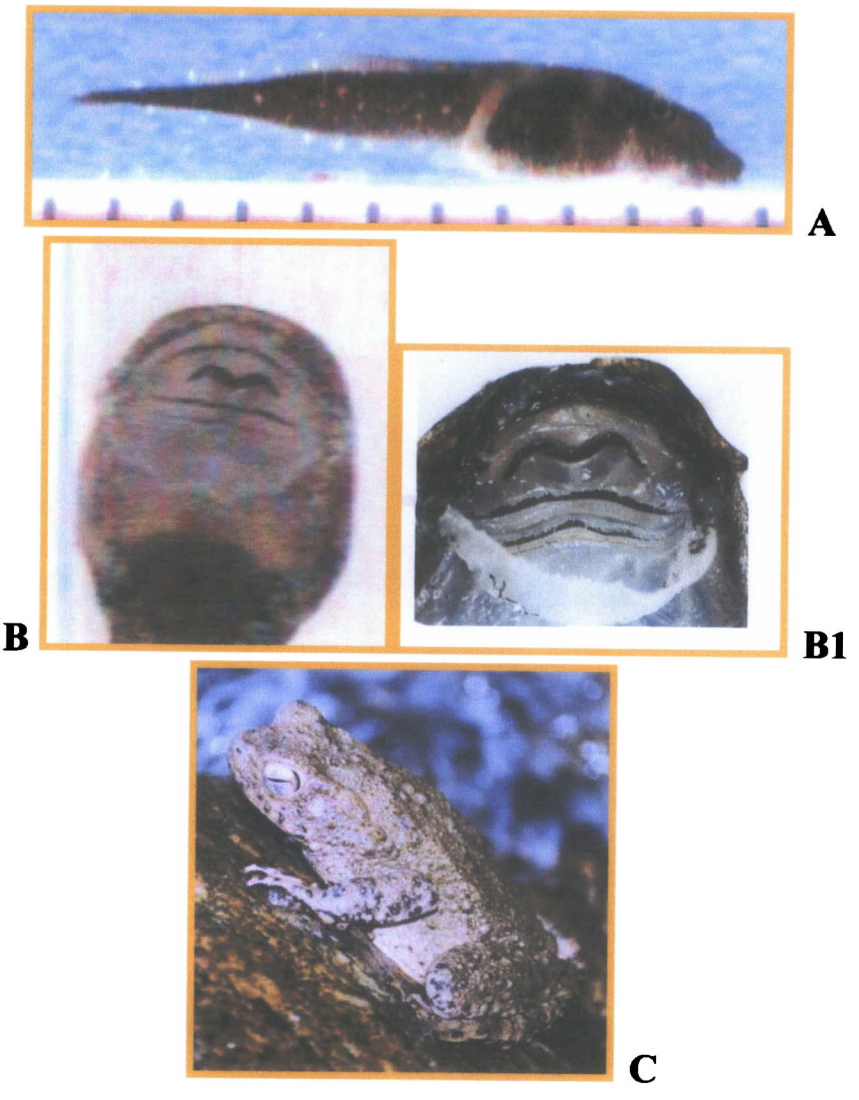


Figure 25 *Bufo asper*
A: Body shape of tadpole (stage 36, no. of specimen PT010)
B, B1: Mouthparts of tadpole C: Adult

11. *Bufo quadriporcatus* Boulenger, 1887

The metamorphoses of these larvae resemble adults in stage 37 onward. Stage 40 denticle is starting to reduce, stage 45 forward back with light brown mark then about 1-2 months the color of the body is brown, dorsolateral with some tubercle and about 3-4 months interorbital with pair of crests (parenthesis mark)

11.1 External Morphology

Head-body oval, width 2/3 time of length; eyes dorsal; internarial 2/3 of interorbital distance; mouth-snout twice snout-eyes distance; spiracle sinistral, close to eye equal to root tail; vent median; tail broadly, tail musculature weak; fins beginning at root tail, both of fins subequal in depth; tip rounded (Figure 26).

Oral disc ventral, subterminal; papillae with corner of mouth, 2 rows, zigzag; LTRF 2(2)/3, the second row of upper teeth row with gap about 1/3 of each teeth, second to third rows of lower teeth rows with 2/3 time of first to second rows distance; beaks black, both equal in depth.

Head-body black, dorsal and lateral; tail muscle same; ventral transparent, visible entrails.

Total length 19-21 mm, (N=8).

11.2 Buccal carvity

Buccal roof: Prenarial arena of roof with transverse in center, pustulous; nares oblique, oval, anterior and posterior narial wall high, anterior narial wallin corner with highest palp, half of wall distance; postnarial area with long palp, curved and almost touching in tip, dorsal marginal serrate; median ridge with triangular, marginal serrated; buccal roof arena smooth (Figure 27).

11.3 Microhabitat

Bufo quadriporcatus has been found in a variety of places and micro habitats, rain pools to side pools of stream banks. The pool is 10-15 cm deep 30-120 cm wide and 100-300 cm long. The temperature (morning period) is 29°C on bottom and 30°C 1 m above water surface (air temperature). In pools, there are accumulated dead leaves and other plants on a sand or silty bottom.

11.4 Behavior

Larvae normally live under dead leaves or other things on the bottom; they usually live together, grouping. Larvae are active at night; they swim on the surface or middle water and scrape dead leaves or other plants on the bottom for food.

11.5 Place and Duration

Hala-Bala WS. at all times to collect data.

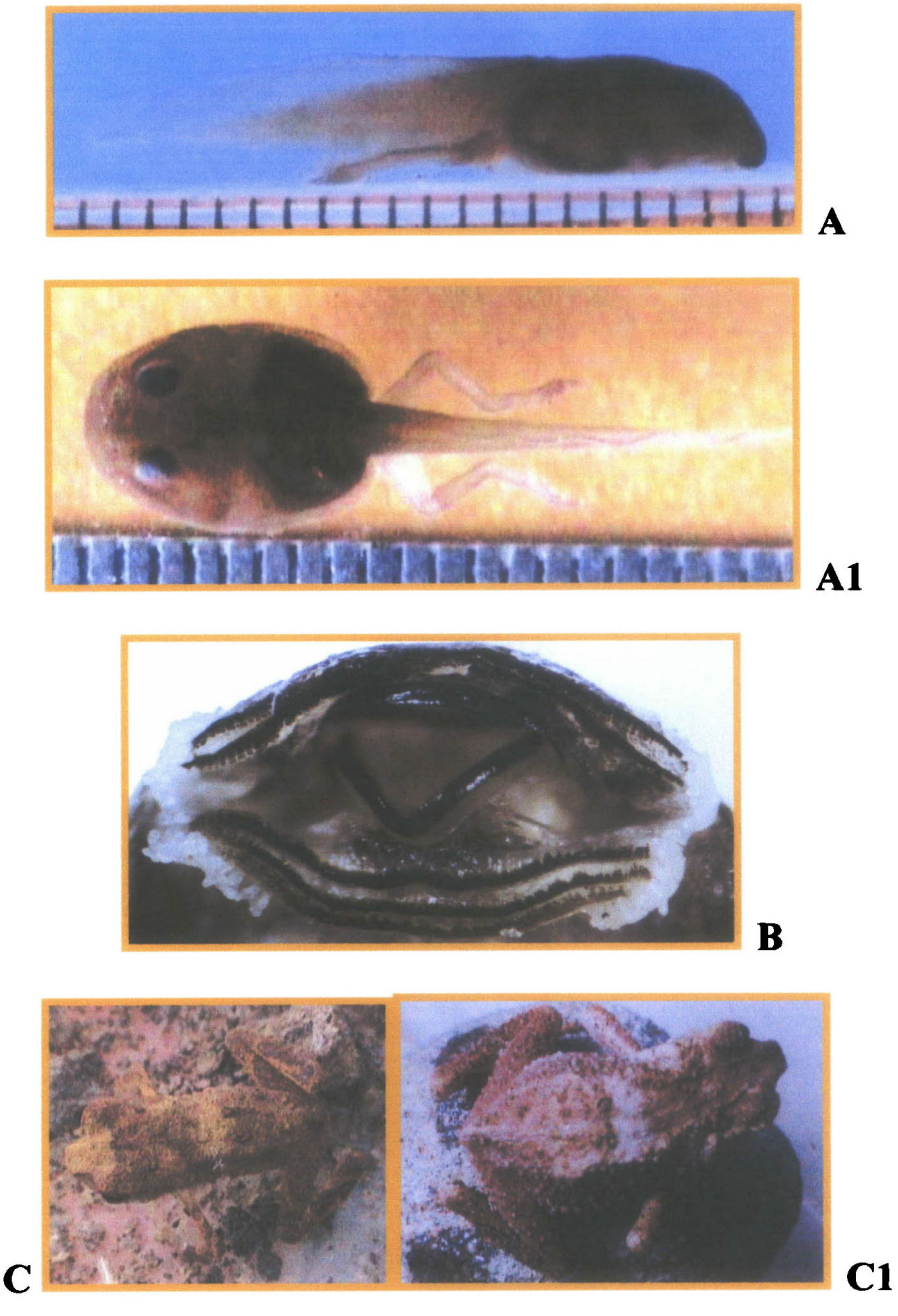


Figure 26 *Bufo quadriporcatus*
A: Body shape of tadpole (stage 40, no. of specimen PT011)
A1: Dorsal B: Mouthparts of tadpole
C: Subadult C1: Adult

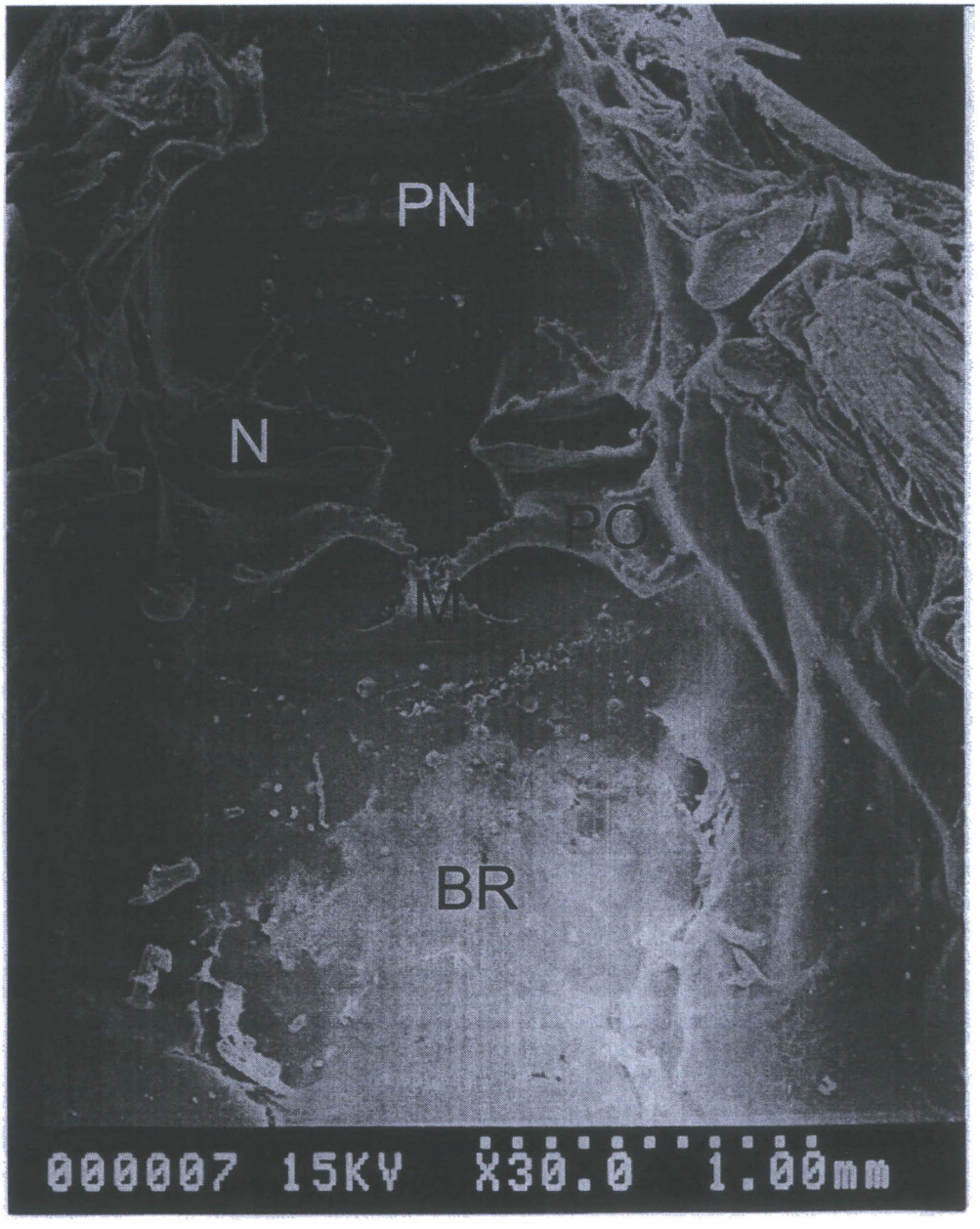


Figure 27 Buccal roof arena
PN-prenarial area; N-nares; PO-postnarial area; M-median ridge;
BR-buccal roof arena

12. *Bufo parvus* Boulenger, 1887

The metamorphosis of these larvae is fast after stage 40, a pair of crests between eyes (parenthesis mark) is present, back without light brown mark. External morphology is similar to *B. quadriporcatus*, *B. melanostictus* and *B. macrotis*.

12.1 External Morphology

Head-body oval, width 2/3 time of width; eyes dorsal not visible from below; internarial distance 2/3 of interorbital; mouth-snout equal snout-eyes distance; spiracle sinistral, close to eye equal to root tail; vent median; tail broadly, tail muscle weak; fins beginning at root tail, both subequal in depth; end rounded (Figure 28).

Oral disc ventral, subterminal; small papillae with commissure mouth, zigzag; LTRF 2(2)/3; the second row of upper teeth row with gap about 1/6 of each teeth, tips connected with end of first rows; second to third row of lower teeth rows about half of first to second rows distance; beaks black, fine serrated.

Head-body black, dorsal and lateral; ventral transparent, visible intestine with about half of body length; tail muscle blackish; fins transparent.

Total length 17-20 (N=6) mm.

12.2 Microhabitat

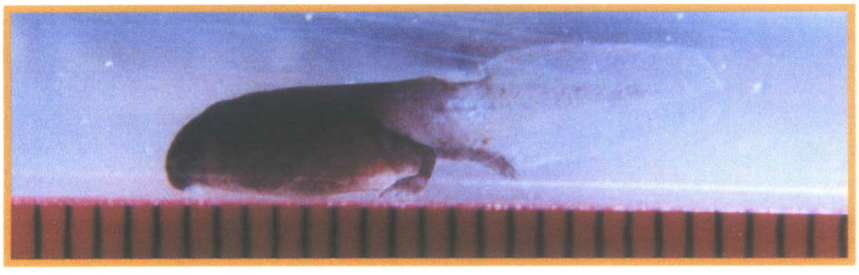
These larvae live in rain pools and side pool of stream banks; there are accumulated dead leaves and other plants on a sand or mud bottom. Pools are 30-50 cm wide, 35-80 cm long and 10-15 cm deep. The temperate is 29°C on bottom and 1 m above water surface (air temperature), is 30°C (morning period). The Elevations are 200, 500 and 700 m MSL.

12.3 Behavior

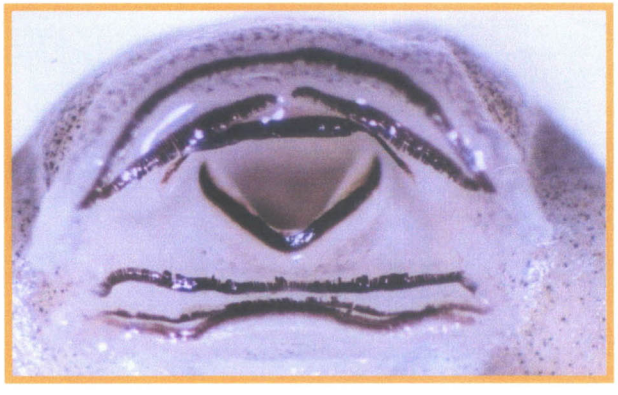
Most activities of these larvae at night when they swim in the middle or on the surface. During the day they usually hide under some accumulated dead leaves or other plants on the bottom. Larvae eat everything in the water, including plants and small animals.

12.4 Place and Duration

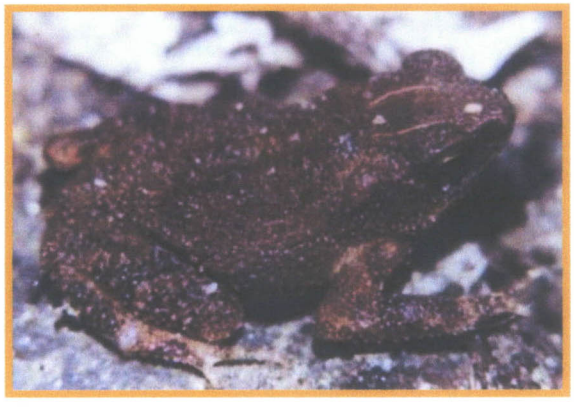
Khlong Nakha WS. in February and April, Khao Luang NP. in April and June. 2003.



A



B



C

Figure 28 *Bufo parvus*
A: Body shape of tadpole (stage 40, no. of specimen PT012)
B: Mouthparts of tadpole C: Adult

13. *Bufo melanostictus* Schneider, 1799

Larvae are quick to metamorphose. Stage 45 paratoid glands are present; body dark-greyish; small tubercles on back and lateral are present.

13.4 External Morphology

Head-body ellipsoidal, width 2/3 of length; eyes dorsal; interorbital twice the internarial distance; mouth-snout twice the snout-eyes distance; spiracle sinistral, close to eye equal or subequal to root tail; anus median, tubular; tail broadly; lower fin equal or subequal upper, fins beginning at tail; tail muscle weak, distal blunt.

Oral disc ventral, subterminal; small papillae on corner of mouth, single row; labial teeth 2(2)/3; the second row of upper teeth row with gap, width half of each teeth rows, tips of first and second rows are connected, second to third row of lower teeth rows distance about half of first to second rows; beaks black, fine serrate. Upper teeth of this larva are similar of *B. parvus*, especially second of upper teeth row, tips connected but width space and not similar, *B. melanostictus* is wider than (Figure 29).

Head-body black, dorsal and lateral; ventral transparent visible the intestine, half less than of body length; tail muscle black; fins transparent.

Total length 15-21 mm, (N=10).

13.2 Microhabitat

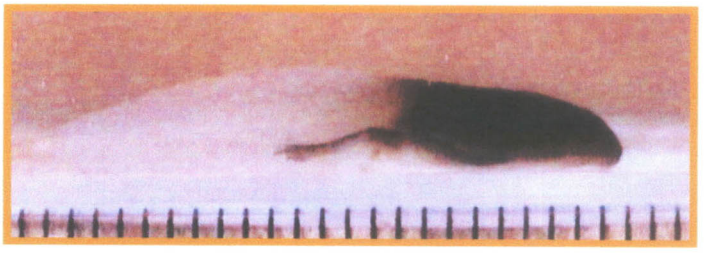
The adaptation of these larvae is good and they can live in several ecosystems, urban to forest. Larvae usually live in rain pools or ponds and even on the road side. In pools there is sand without accumulated dead leaves or other things. These pools are about 5-30 cm width, 20-30 cm length and 5-30 cm depth. The temperature is 32°C on bottom and 1 m above the water surface (air temperature), is 34°C (afternoon period). For some pools or ponds, there is more than 30 cm width and length, more than 50 cm depth and there are accumulated dead leaves or other plants on the bottom. The temperature is 31°C on the bottom and 33°C above water surface (air temperature). Elevation from MSL is 30-300 m.

13.3 Behavior

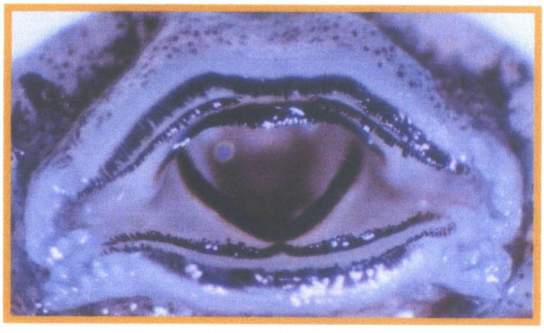
These larvae usually live on the bottom in pools at day but at night, they rise to the middle or surface and swim around the pool for food. Some larvae were found in roadside rain pools, where they often rise to the surface in the day and they eat everything in the pool, even carcasses. Their metamorphosis is very quick about 5-10 days, from egg to stage 46. They often live with *Kaloula pulchra, Microhyla heymonsi* and *Polypedates leucomystax* larvae, but *P. leucomystax* will eat other larvae, and even their own.

13.4 Place and Duration

Khlong Nakha WS., Khao Luang NP.and Hala-Bala WS. in July, September and November 2003.



A



B

C

Figure 29 *Bufo melanostictus*
A: Body shape of tadpole (stage 40, no. of specimen PT013)
B: Mouthparts of tadpole C: Adult

14. *Bufo macrotis* Boulenger, 1887

Association of this larva and their adults were present in stage 42 onward; stage 42 subarticular tubercle completed. Stage 45 lateral bodies with small pustules, behind eyes with small parotoids.

14.1 External Morphology

Head-body oval, slightly flattened below, width 2/3 time of length; eyes dorsal, not visible from below; internarial distance half of interorbital distance; mouth-snout 1/2 time of snout-eye distance; spiracle sinistral, below between eye and root of hind limb, closer to root tail than to eye; anus median; tail lanceolate; dorsal fin slightly deeper than ventral; fins deeper than caudal muscle in distal half of tail; dorsal fin beginning at end of body; tip rounded (Figure 30)

Oral disc anteroventral; papillae short, a single row confined on corners upper and lower corners of mouth; LTRF 2(2)/3; the second row of upper teeth row with gap in medial, gap length 1/7 time of each side tooth; first to second rows of upper teeth row equal first to second of lower teeth row in depth; first and second of upper teeth rows in tip with parallel; second to third rows of lower teeth rows half of first to second rows in depth; beaks balck, margin serrated.

Head-body blackish, pale below; caudal muscle darkish; both fins transparent.

Total length 20-21 mm, (N=3).

14.2 Microhabitat

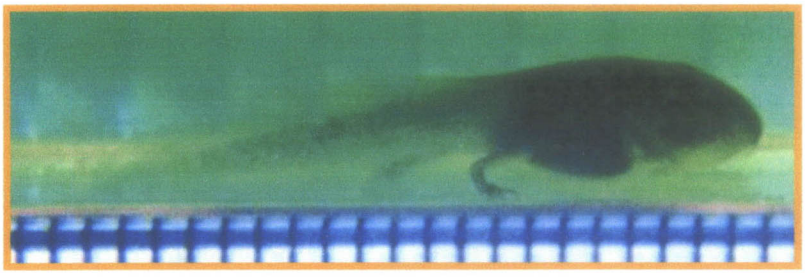
This tadpole has been found in potholes on rock banks, where there are some accumulated dead leaves on a sand bottom. The dimension of the potholes is 20 x 45 x 20 cm (wide x long x deep) and the temperature (late morning period) is 30°C on bed and 31°C 1 m above water surface (air temperature). Elevation from M.SL is 100 m.

14.3 Behavior

Larvae usually live on or under dead leaves on a sand bottom but some of them slowly move in the day time. At nighttime, they are most active, swimming around and scraping dead leaves or the smallest aquatic plants on the surface stones for food. Most larvae often rise to the water surface and return to the bed; they are easily found at this time.

14.4 Place and Duration

Khlong Nakha WS. and Khao Luang NP. in January 2003



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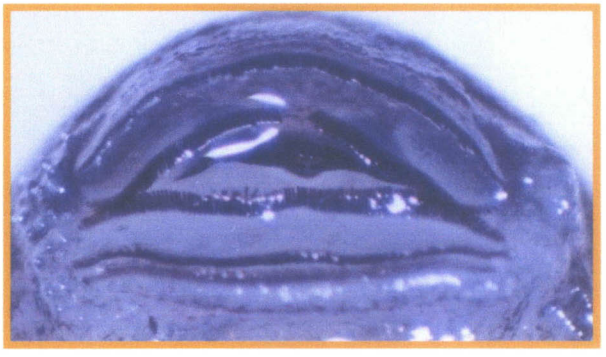


B

C

Figure 30 *Bufo macrotis*
A: Body shape of tadpole (stage 40, no. of specimen PT014)
B: Mouthparts of tadpole C: Adult

Genus *Pedostibes*

Only one species of *Pedostibes* has been found in lower Southern Thailand, that is *Pedostibes hosii*. Their external morphology is similar to that of *Bufo* but their metamorphosis is longer.

15. *Pedostibes hosii* (Boulenger, 1892)

Stage 39-40 the denticle is starting to reduce. At stage 45 a pair of paratoid grand is present, but they are different from *Bofo melanostictus,* because they don't have small tubercles on the body and plain color.

15.1 External Morphology

Head-body oval, depressed, flat below, the length is twice the width; eyes dorsal, non visible from below; internarial 2/3 of interorbital distance; mouth-snout 1.5 time of snout-eyes distance spiracle sinistral, tubular, close to eye equal or slightly more than to root tail; vent tube median; tail muscle weak; fins subequal, deeper than tail muscle; tip blunt (Figure 31).

Oral disc ventral, subterminal, papillae with corner of mouth, zigzag; LTRF 2(2)/3; the second row of upper teeth row with gap and overlapping, gap with 1/7 time of each teeth or closely, tips connected with end of first row; first and second rows of lower teeth rows with equal length, the third roe shorter than and lower curve in median; beaks black, serrated.

Head-body blackish, dorsal and lateral; ventral transparent, visible entrails; tail muscle black; fins transparent.

Total length 19-22 mm, (N=6).

15.2 Microhabitat

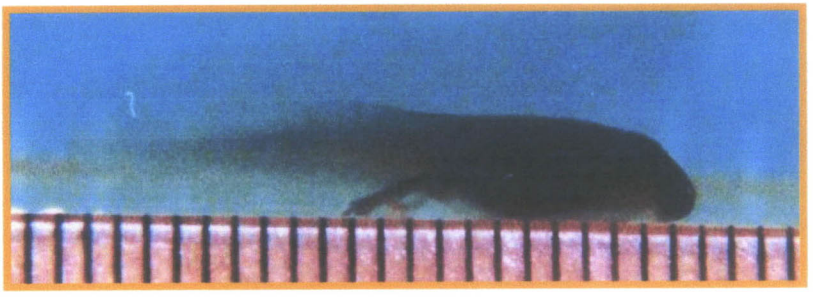
These larvae are found in the side pools of stream banks; where there are, accumulated dead leaves and other plants on a sand and silty bottom. The pool is 15 cm deep 50 cm wide and 280 cm long. The temperature is 29°C on the bed and 1 m above the water surface (air temperature) is 30°C (morning period). The Elevation from MSL is 200 m.

15.3 Behavior

In aquarium, they usually live under accumulated dead leaves or other things on the bottom but sometimes they rise to the water surface at day and night. Some of their behavior is different from other species because some larvae overturn their body to suck food on the surface. They normally live together, grouping. In stage 45 they can clamber to the top of aquarium and hold on to the wall.

15.4 Place and Duration

Hala-Bala WS. in April 2003.



A

B

D C

Figure 31 *Pedostibes hosii*
A: Body shape of tadpole (stage 40, no. of specimen PT015)
B: Mouthparts of tadpole
C: Adult
D: Eggs

Family Ranidae

Ranidae is the biggest family of Anurans Amphibian. Tadpoles of this family can adapt to live in several ecosystems, waterfalls in forest to roadside ditches. Most external morphologies are similar, such as labial teeth, labial tooth row formula (LTRF) 0/0 in *Occidozyga* to 8-9 rows in upper and lower teeth and including a sucker on the ventral, which are *Amolops* and *Huia*. Many species have an oral disc on the ventral, subterminal (anteroventral); papillae with a medial gap ; snout closer to eyes than mouth; vent dextral; eyes dorsolateral or dorsal in some species; spiracle sinistral; beaks black, serrated on the margins, U or V shaped; tail not heavy; head-body oval or ellipsoidal, assorted color; total length 30-50 mm.

Key to Genera of Ranidae

1. Oral disc terminal.....*Occidozyga*
   Oral disc ventral.....2
2. Ventral with largest abdorminal sucker; body flattened.....3
   Ventral without largest abdorminal sucker; body oval.....4
3. Lower teeth 3-5 rows; lower of corner mouth with hole.....*Amolops*
   Lower teeth more than 5 rows.....*Huia*
4. Labial teeth row present.....5
   Labial teeth row absent.....*Taylorana*
5. Second and third lower teeth rows short.....*Limnonectes*
   Second and third lower teeth rows long.....6
6. Beaks and marginal lips large.....*Hoplobatrachus*
   Beaks and marginal lips small.....7
7. Papillae on lower lips and corners mouth long; all of lower teeth rows equal in length.....*Rana*
   Papillae on lower lips and corners mouth thick; last of lower teeth rows medial and convex.....*Ferjervarya*

Key to Species of Rnidae

1. Lips with transverse rows of teeth.....2
   Lips without transverse rows of teeth.....13
2. Median of lower beak enlarge, 10 time of tooth in depth.....
   .....*Hoplobatrachus rugulosa*
   Median of lower beag small, 3 time of tooth in depth.....3
3. Lower teeth rows with more than 3 rows; body large, more than 7 cm in length....
   .....*Rana alticola*
   Lower teeth 3 rows; body less than 7 cm. in length.....4
4. Third lower teeth row half shorter than of second rows; median convex.....
   .....*Ferjervarya limnocharis*
   Third lower teeth row length equal of first and second rows.....
  5

5. Head-body and caudal muscle pale yellowish-brown; interorbital with black line, curved behind eyes.....*Rana chalconata*
   Head-body grayish.....6
6. Upper teeth row single 7
   Upper teeth rows with 2 or more 9
7. Lower teeth with 2 rows; dorsolateral body with a dark stripe from mouth to end of body; marginal fins with gray spots from root tail to tip.....*Rana erythraea*
   Lower teeth with 3 rows.....8
8. First lower teeth row lacked, length 3 times of each tooth; papillae with a single row on lower lip, pustules.....*Limnonectes blythii*
   First lower teeth row connecting, tip of second connected first row, third connected in second; papillae on lower lip with a single row, sheeted.....
   .....*Limnonectes macrognathus*
9. Upper teeth more than 2 rows.....10
   Upper teeth with 2 rows.....11
10. Upper teeth row closely upper beak; head-body and caudal muscle darkish; dorsolateral body with light line from mouth to end of body.....*Rana hosii*
    Upper teeth row not closely upper beak; head-body and tail muscle redish-brown, with light dots entired; fins transparent.....*Rana signata*
11. Papillae on commissures of mouth equal to lower lip in length.....12
    Papillae on upper commissures of mouth with 3 times lower commissures and lower lip in length; third lower teeth row half of first and second rows in length...
    .....*Limnonectes kuhlii*
12. Second upper teeth row with slightly interrupted, length 1/5 time of each tooth, long papillae on lower lip, three rows, zigzag.....*Rana cubitalis*
    Second upper teeth row with interrupted, length equal of each tooth;
    Papillae on lower lip with 2 rows, lower longer than upper row.....
    .....*Rana nigrovittata*
13. Oral disc ventral.....14
    Oral disc terminal.....15
14. Oral disc anteroventral, without abdominal sucker.....16
    Oral disc ventral, with large abdorminal sucker.....17
15. Upper fin beginning at posterior of root tail, length 1/4 of tail; oral disc mostly protruded; head-body ellipsoidal.....*Occidozyga martensii*
    Upper fin beginning at end of body; root to middle tail Elevation twice of tail muscle; Posterior mid-body with silver.....*Occidozyga lima*
16. Posterior mid-tail blackish; back with dark Y shaped; dorsolaterior with dark line from mouth to frontal eyes; interorbital with dark mark, T-like.....*Limnonectes* sp
    Tail pale brownish, without marked; tail length 3 time of head-body; upper fins beginning at Anterior mid-tail.....*Taylorana hascheana*
17. Upper beak with ∩ shaped, lower sublacking in medial; head-body with small tubercles; tip tail pointed.....*Amolops* sp.1
    Upper beak with M shaped.....18
18. Third upper teeth row slightly lacked, curved into upper beak; head-body and tail darkish, with white spots and stripes; upper fin beginning at root tail.....
    .....*Amolops laratensis*
    Third upper teeth row lacked, length 1/3 time of each tooth and straight.....19

19. Lower teeth 3 rows; first row subclosely lower beak; third upper teeth row with gap, gap length equal last row; body darkish brown.....*Amolops* sp.2
    Lower teeth 6-7 rows, first row with gap; gap length ¼ time of each tooth; lower beak to first lower teeth row length equal or subequal first to third row.....
    .....*Huia* sp.

Genus *Amolops*

Larvae in this genus are distinct from other genus. Large sactorial on ventral; labial teeth with M, V or U shaped; small papillae on commissure mouth, margins of lower lip and tip of upper lip; lower of commissure mouths with hole.

16. *Amolops larutensis* (Boulenger,1819)

Association of this larvae and their adult is similar from stage 45 onward; sucker is present on ventral; body color with brown-greyish; mouth ventral, upper disc.

16.1 External Morphology

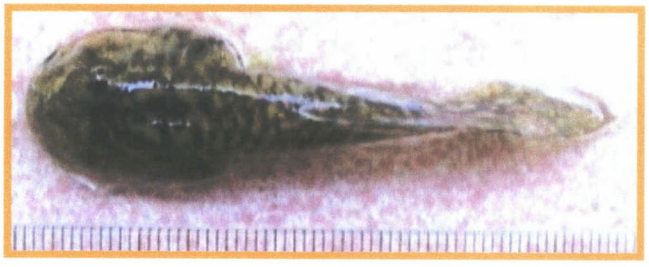
Head-body oval, length is twice the width; eyes dorsal, not visible from below; internarial distance 2/3 time of interorbital distance; mouth-snout 2/3 time of snout-eye distance; spiracle sinistral, tubular, closer to root tail than to eye; vent tube dextral, tubular, opening at root of ventral fin; tail muscle medial; dorsal fin starting at end of body; ventral fin starting at mid-tail; tip rounded (Figure 32).

Oral disc ventral, as wide as head, length 2/3 time of width; marginal of lower lip with a small single row papillae, median with gap; marginal of upper lip with gap on upper corners mouth; corners of lower lip with small hole; disc on ventral long 4/5 time of body length; labial tooth row formula (LTRF) 8(4-8)/5(1) or 9(5-9)/5(1); the first of upper teeth row with gap in median, tip curved, closely; forth to fifth of lower teeth rows distance half of first to second rows and second to third rows distance; beak black, heavy, dorsal equal ventral in depth, dorsal with M shaped, medial of upper beak concaved, length twice of gap in forth or fifth of upper teeth rows; and ventral V shaped, marginal serrated.

Head-body and tail muscle grayish to dark gray, with white marks scattered; dorsal half of body in ventral rather transparent, visible muscle under disc, ventral half is white; ventral of root tail flat and whitish.

Total length 60-70 mm, (N=9).

A



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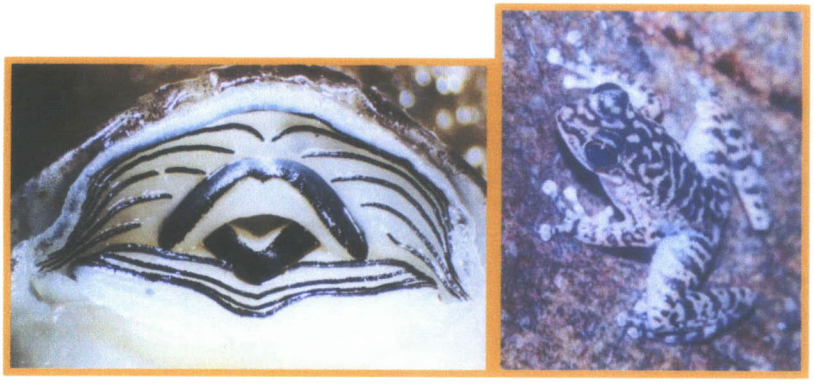


B C

Figure 32 *Amolops larutensis*
A: Body shape of tadpole (stage 37)
A1: Top view B: Mouthparts of tadpole C: Adult

16.2 Buccal carvity

Buccal floor: Prelingual area of floor smooth; tongue length as twice as width; buccal floor arena smooth; lateral papillae of buccal floor arena with about 20 pustules on each side on the base of the ventral velum, median large and long; ventral velum smooth (Figure 33).

Buccal roof: Prenarial arena of roof with 2 pairs of pustules, medially, between pustules and narial with papillae ridge, curved, marginal ridge with small

pustulous; narial vertical, lateral ridge papillae with high wall straight; buccal roof smooth; dorsal velum with more than 50 fins pustulous (Figure34).

16.3 Microhabitat

This tadpole has been encountered in strong currents in the forest, especially waterfalls, where there are many rocks, large and medial, against some current, stone surface smooth and with small aquatic plants. The water temperatures on the stone's surface where tadpoles live is 28°C, and 1 m above the water surface (air temperature), is 29°C (morning period). Elevation from mean sea level (MSL) is 200 and 400 m.

16.4 Behavior

Tadpoles commonly stick on a stone's surface in strong current by oral and disc on ventral, where they scrape some small aquatic plants on the stone's surface for food. In the day, they hide under stones but at night, 1-10 individuals are found on stone's surface. They usually move against the current, forward by moving their mouthes, up and down. Sometimes they have been found vertically stuck on the stone's surface, where their head and sometimes most of the body rises to the water surface and in an aquarium this behavior is also present. In addition, when some individuals of these tadpoles were operated on, some detritus, sand-like material, aquatic plants and moss in the stomach and intestines was found.

16.5 Place and Duration

Hala-Bala WS. all of collecting specimen.

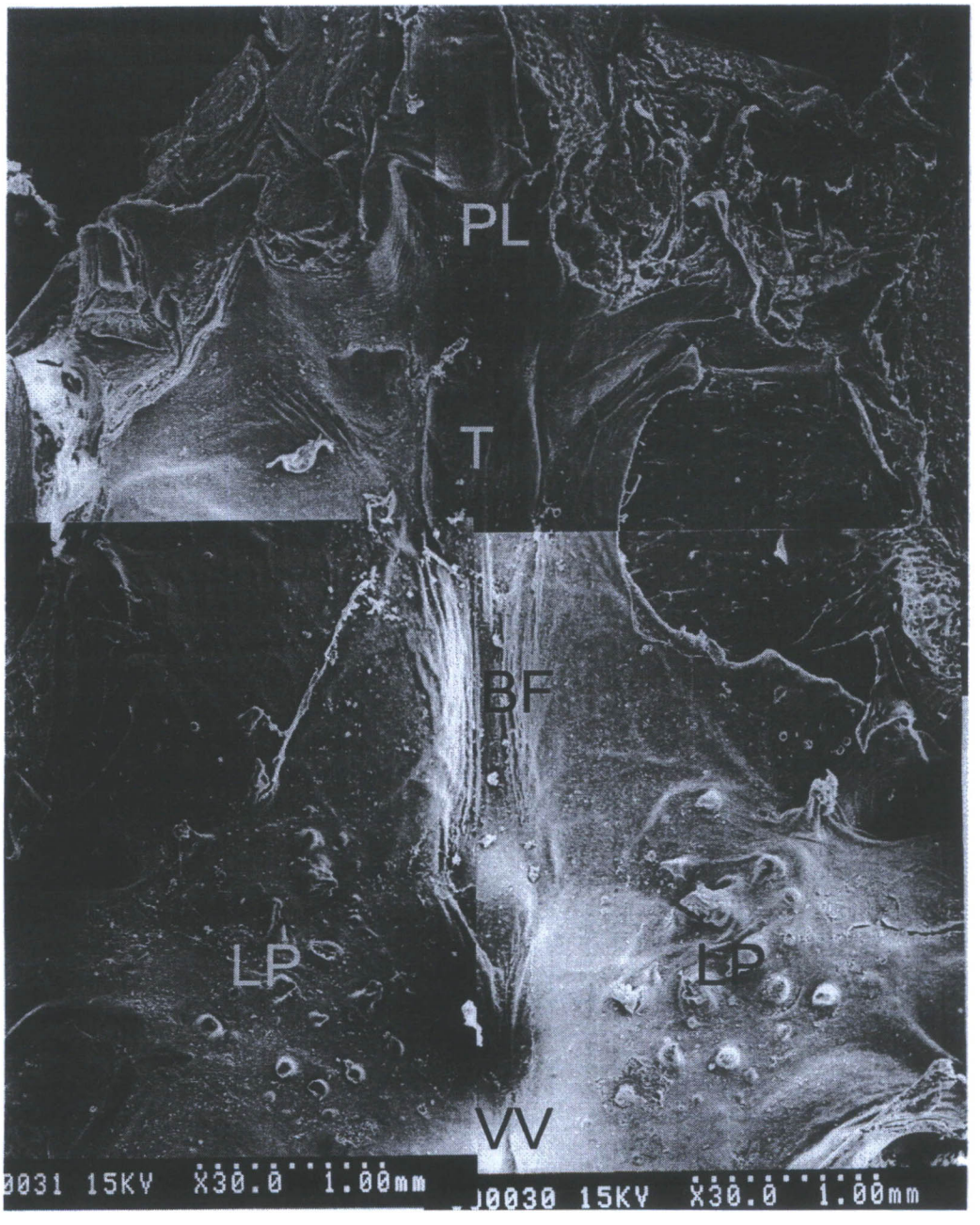


Figure 33: Buccal floor arena
PL-prelingual; T-tongue; BF-buccal floor arena; LP-lateral papillae; VV-ventral velum

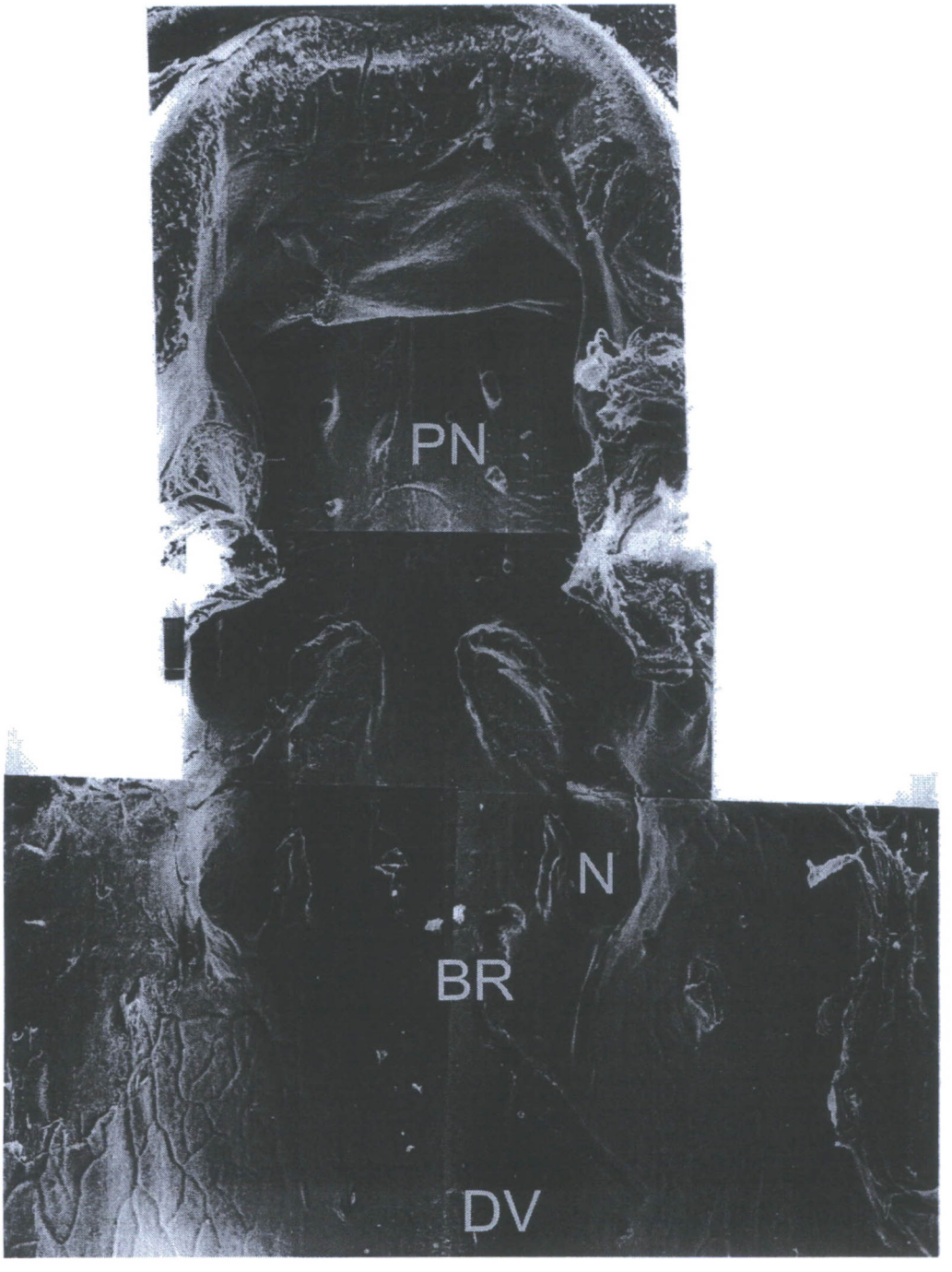


Figure 34 Buccal roof arena
PN-prenarial area; N-nares; BR-buccal roof arene; DV-dorsal velum

17. *Amolops* sp.1 Gunther,1859

Association of these tadpole and their adults was present in stage 45, body grayish, with dark spots on body; mouth ventral; disc presented lower mouth.

17.1 External Morphology

Head-body oval, length twice width; eyes dorsal, not visible from below; internarial 2/3 times interorbital distance; mouth-snout distance equal to snout-eye distance; spiracle sinistral, tubular, closer to root tail than to eye, half; vent tube dextral, tubular, opening at root of ventral fin; caudal muscle medial; root of ventral tail muscle flattened; dorsal fin starting at the end of the body; ventral fin starting at mid-tail; tip round (Figure 35).

Oral disc ventral, as wide as head, length 2/3 times width; the upper corners of the mouth with small papillae, single row; papillae on lower lip are smaller than corner mouth; lower corners mouth with hole; disc on ventral long 2/3 or less than body length; LTRF 7(4-7)/3(1); the first of upper teeth row with gap, length 1/3 times tooth length on each side; inner of second to seventh of upper teeth rows connected or close to upper beak; beaks black, heavy, upper beak M shaped, medial of upper beak concave, the length is 2/3 times or equal to the gap in the fourth upper teeth row; the lower beak is V shaped. Marginal beaks serrated

Head-body and tail gray-brown, with cream color spots on all of the body; ventral rather transparent, the muscle on sucker is visible; the end of the disc to root tail whitish; ventral of root tail with slight cream color.

Total length 45-47 mm, (N=5).

17.2 Microhabitat

This tadpole has been found on the stones in streams, moderate water current, on stone surfaces with some small aquatic plants. The average temperature (late morning period) of water on stone surfaces, where tadpoles have lived is 29°C, and 30°C 1 m above the water surface (air temperature). Elevation from MSL is 400 m.

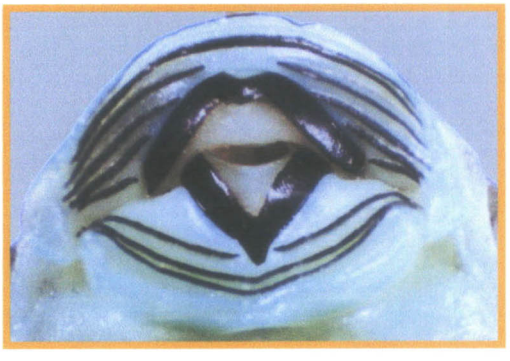
17.3 Behavior

Larvae have been found sticking on or lateral to stone surfaces, where there was moderate water current. Larvae usually scrape some small aquatic plants by moving their teeth and beaks, up and down, while the mouth is sucking some water, and some aquatic plants are pushed into the mouth. As they move by disc on ventral, especially at nighttime they are found on stone surfaces, but in the daytime they hide under stones. This tadpole does not live alone, not grouping as *A. larutensis* and also they are not sticking vertically.

17.4 Place and Duration

Khlong Nakha WS. in January 2003.

A



B

C

Figure 35 *Amolops* sp.1
A: Body shape of tadpole (stage 37, no. of specimen PT017)
B: Mouthparts of tadpole C: Adult

A A1

Figure 36 Comparative Mouthparts and Abdorminal Disc
A: *Amolops larutensis* (stage 40) A1: *Amolops* sp.1(stage 37)

18. *Amolops* sp.2

Only 2 individuals of this species were found. One tadpole, stage 41 and the other stage 46 (subadult). Larvae in stage 46 are distinct from *Amolops larutensis* and *A.* sp. larvae, whole body with small pustules. Furthermore, more than 20 individuals of *Amolops* adult have been encountered and they differ from *A. larutensis* adults but they are similar to *A.* sp.2 larvae. Hence, perhaps they are the same species.

18.1 External Morphology

Head-body oval, width 2/3 times length, with many pustules, dorsal and lateral; eyes dorsal, not visible from below; interorbital 3 times internarial distance; mouth –snout distance equals snout-eyes distance; spiracle sinistal, tubular, closer to eye than to root tail; vent tube dextral, tubular, opening at root of ventral fins; caudal muscle rather large; root tail on ventral flattened; fins starting at the end of the body; tip pointed (Figure 37).

Oral disc ventral, as wide as head, length 2/3 times width; commissures mouth and upper corners mouth with papillae, small and a single row; lower corners mouth with hole; disc as wide as body, length 4/5 of body length; LTRF 9(5/9)/5(1); first to third of upper teeth rows concave into upper beak; first of lower teeth row connect the lower beak; upper beak with ∩ shaped, medial equal upper teeth rows but

half of tips thicker than in depth; lower beak V shaped, medial half of lower teeth row in first and 1/4 times tips in depth.

Head-body brownish, tail same but, with light brown banded, scattering; ventral rather transparent, visible muscles on sucker; half-posterior white.

Total length 70 mm, (N=1).

A

B

C

Figure 37 *Amolops* sp2.
A: Body shape of tadpole (stage 40, no. of specimen PT018)
B: Top view C: Mouthparts of tadpole

18.2 Microhabitat

Their microhabitat is similar to *A. lalatensis*, that is in strong streams, where there are large stones. The temperature (morning period) of the water on stone surfaces, where tadpole live is 28°C and 29°C 1 m above the water surface (air temperature). Elevation from MSL is 200 m.

18.3 Behavior

Tadpole stick on stones in strong streams by sucker on ventral, where they scape small aquatic plants for food by mouth and moving disc. At nighttime tadpole are easily found on stone surfaces but daytime they hide under stones. Conversely, adults have been found in the daytime.

18.4 Place and Duration

Hala-Bala WS. in June 2003.

Genus *Huia*

External morphology of *Huia* is quite similar to *Amolops* in body shape, mouth and disc on ventral but teeth, beaks and especially disc are distinct. Moreover, their microhabitat of *Huia* is also different. Only one species of *Huia* has been found in this study, which is *Huia* sp.

19. *Huia* sp.

Association of larvae with adult is present in stage 39, back with pale brown, stage 43 back brownish and lateral body with gray; subarticular tubercle and well completed. At stage 45 their body is rather slender.

19.1 External morphology

Head-body oval, length twice width; eyes dorsal, not visible from below; internarial distance half of interorbital distance; mouth-snout distance equal to snout-eye; spiracle sinistral, tubular, closer to eye than to root tail; vent tube dextral, tubular opening at root of ventral fin; tail muscle moderate; dorsal fin 2/3 times caudal muscle but double the ventral in depth, medial tail; fins starting at the end of the body; tip rounded (Figure 38).

Oral disc ventral, as wide as head, length 2/3 times width; lower corners mouth with small papillae, single row; upper corners of the mouth with bigger, single row, and staggered; disc as wide and long as mouth; LTRF 5(3/5)/8(1); third of upper teeth row with gap, gap length 1/3 of each side teeth; first of lower teeth row to beak twice of first to second distance; beaks weak, black, width 2/3 of teeth in depth; upper beak with M shape, the lower is V shaped.

Head-body and tail muscle grayish; ventral transparent visible muscle of disc and gut half posterior with white-silver; dorsal fin with light brown spots or marks; ventral fin cloudy, margin with black dots; ventral of root tail to mid-tail with a white stripe and pale gray.

Total length 30-35 mm, (N=2).

19.2 Microhabitat

This tadpole has been found in the side pools of streams, where there are some stones, against the water current and some accumulated dead leaves, small rocks on a sand bottom. The side pool is 3 m width and 30 cm depth. The temperature (evening period) of water on stone surfaces, where tadpole live is 27°C and 28°C 1 m above the water surface (air temperature). Elevation from MSL is 400 m.

19.3 Behavior

Larvae had been encountered sticking on stone surfaces by their disc and mouth. 3-4 individuals have been found living together; at night, scraping some small aquatic plants on surface stone for food. Larvae move by disc, like an *Amolops*, but they do not live in strong currents.

19.4 Place and Duration

Khlong Nakha WS. in January 2003.

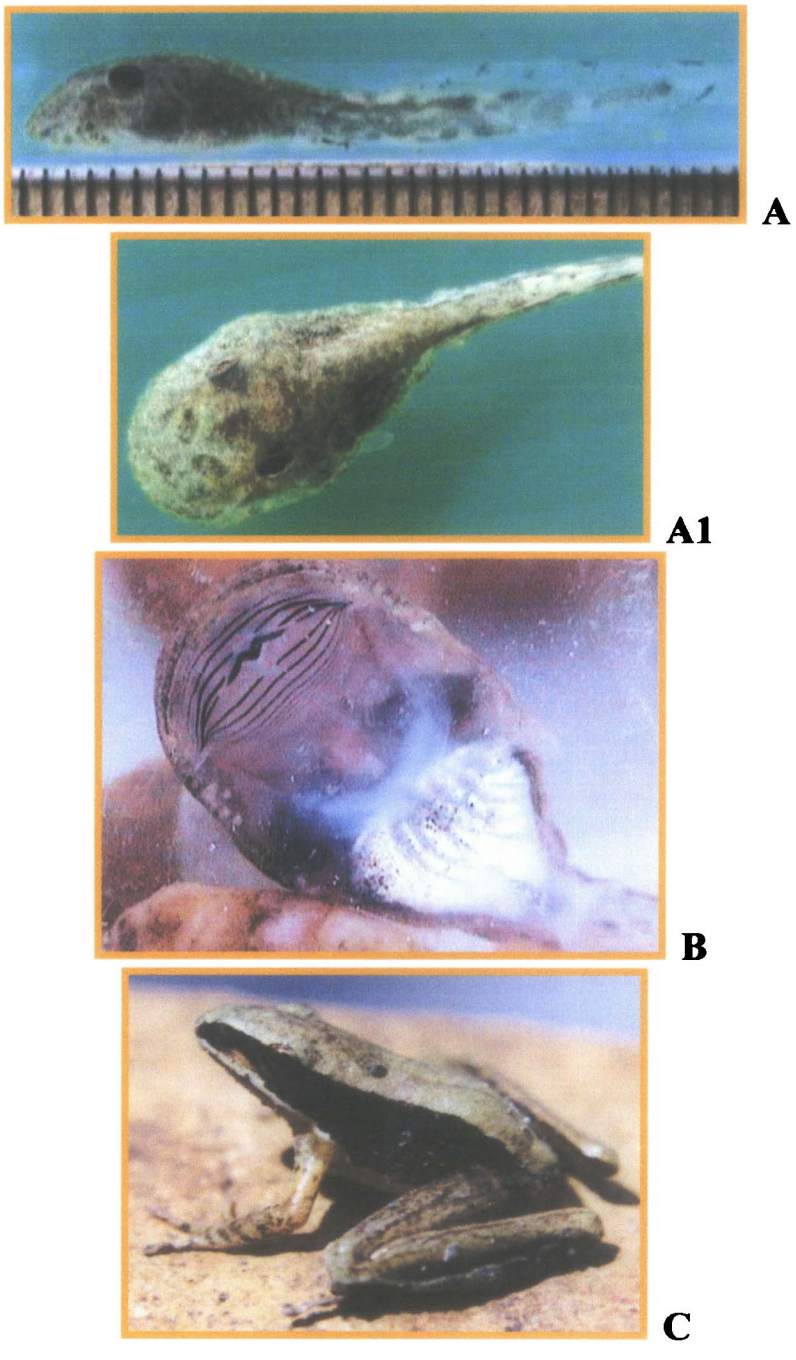


Figure 38 *Huia* sp.
A: Body shape of tadpole (stage 37, no. of specimen PT019)
A1: Top view B: Mouthparts of tadpole
C: Adult

Genus *Fejervarya*

Only one species of *Ferjervarya* has been found in this study, which is *Ferjervarya limnocharis*. External morphology of this tadpole is similar to *Limnonectes*, such as head-body, tail shape, size and color; oral disc anteroventral; LTRF 2(2)/3(1); spiracle sinistral; vent tube dextral; tail moderate.

20. *Ferjervarya limnocharis* (Boie, 1835)

Ferjervarya limnocharis larvae develop fast 42-46 stage (3-4 days). Association of larvae was similar to their adult from stage 42 onwards, back and dorsolateral ridges are obvious. The mouthparts of most larvae start reducing at stage 41.

20.1 External Morphology

Head-body oval, width half of length; eyes dorsolateral, not visible from below; interorbital distance twice internarial; mouth-snout 2/3 of snout-eye distance; spiracle sinistral, tubular, closer to root tail than to eye; anal tube dextral, opening at root of ventral fin; caudal muscle moderate; dorsal fin deeper than lower in median; tip pointed (Figure 39).

Oral disc anteroventral, length 2/3 of width; papillae on the corners of the mouth with grouping, long and thick; marginal lower lip and upper of corners of mouth with a single row; medial lower lip with gap, length equal or subequal third of lower teeth row; LTRF 2(2)/3 or 3(1); the second of upper teeth row with gap as long as each side of teeth; the first of lower teeth row with a slight gap, some individuals without a gap, third row with medial and slightly shorter than second row, tips bend into the second row; beaks black, marginal serrated, upper with ∩ shape and lower with ∨ shape.

Head-body and tail brownish or grayish, with dark spots or stripes; below eyes there is a dark stripe from mouth to mid-body; fins transparent, marginal with dark spots.

Total length 25-35 mm, (N=7).

20.3 Microhabitat

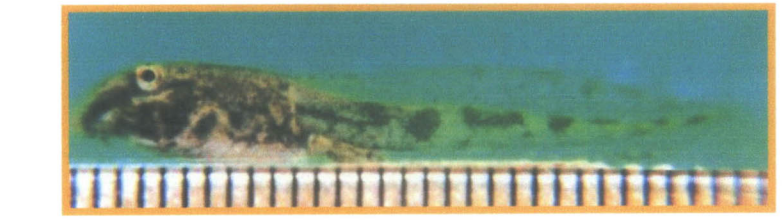
Tadpole have been found in roadside ditches and side pools, where there are some accumulated dead leaves on a silty or sand bottom, clear or turbid water, some brownish. The dimensions of ponds were 20-40 x 30-150 x 5-10 cm. (wide x long x deep). The average temperature is 30°C on the bed and 1 m above the water surface (air temperature) is 33°C (morning period). Elevations from MSL are 50-300 m.

20.4 Behavior

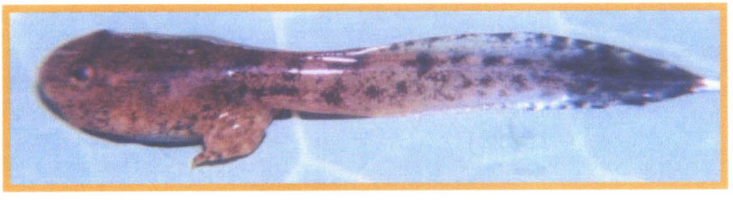
Some tadpoles live both under dead leaves in side pools and in roadside ditches, they often rise to the surface and they eat small animals, other tadpole and even their own kind. Moreover, they graze on some dead leaves or the smallest aquatic plants on rock surfaces for food. Sometimes other tadpole have been found living in pools, *Polypedates leucomystax* and *F. limnocharis* had eaten *B. parus* and *heymonsi* larvae for food. Daytime, *F. limnocharis* larvae usually live under rocks or on dead leaves. In aquarium and in the field their behavior is similar for swimming and feeding, even though there is always enough food.

20.5 Place and Duration

Khlong Nakha WS., Khao Luang NP. and Hala-Bala WS., all collecting the data.



A



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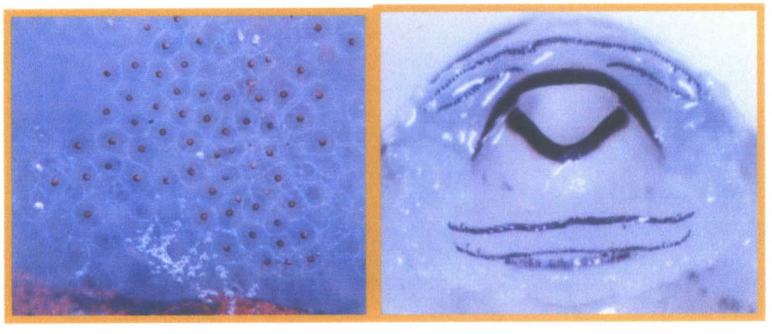


D B

C

Figure 39 *Ferjervarya limnocharis*
A: Body shape of tadpole (stage 37, no. of specimen PT020)
A1: Another form of color B: Mouthparts of tadpole
C: Adult D: Eggs

Genus *Limnonectes*

Head-body of *Limnonectes* larvae are rather small , elongated oval tail with dark or black marks or stripes in depth eyes dorsal; lateral both edged similarly convex, tip pointed; denticle no more than 2 rows in upper and 3 rows in lower, last of lower teeth rows are short; large papillae. A larva is quick to move and they are found in the side pools of stream banks.

21. *Limnonectes* sp.

In the field stage 26, 3 individuals of this tadpole have been collected but after 7 days they were dead. Thus, this tadpole can only be described in stage 26 and their association between tadpole and adulthood cannot be depicted.

21.1 External Morphology

Head-body ellipsoidal, width equals length somewhat flattened above body; eyes dorsolateral, not visible from below; internarial 2/3 of interorbital distance; mouth-snout equals snout-eyes distance; spiracle sinistral, tubular, closer to eye than to root tail; anal tube dextral, tubular, opening at edge of ventral fin; fins equal caudal muscle in depth of mid-tail; tip rounded (Figure 40).

Oral disc anteroventral, all specimens without beaks, teeth rows and papillae, although larvae commonly occurred with beaks, teeth and papillae in stage 26.

Head brownish; mouth to mid-body in dorsolateral with dark; interorbital with an dark anchor; body grayish, behind of interorbital dark Y shaped ventral transparent, visible gut; caudal muscle pale brown, root tail to mid-tail with 4 black circles, posterior half of tail blackish; both fins transparent in anterior half.

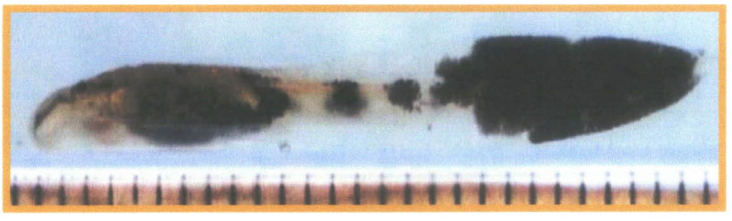
Total length 30 mm, (N=3).

21.2 Microhabitat

This tadpole has been encountered in side pools; where there are some accumulated dead leaves and many types of gravel on a sand bottom. The dimension of pools is 30 x 38 x 12 cm (W x L x D). The temperature (later morning period) is 27°C on bed and 1 m above the water surface (air temperature) is 28°C. Elevation from MSL is 300 m.

21.3 Behavior

Larvae were found living under dead leaves or nook gravel on bed. They do not swim quickly, although they are disturbed.



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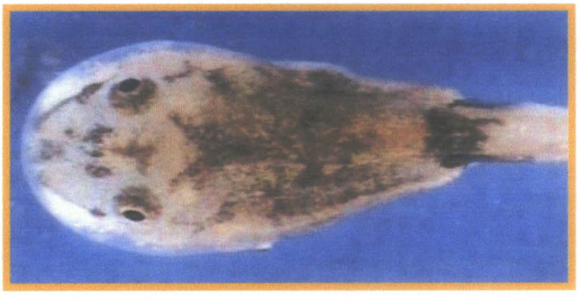


A1

Figure 40 *Limnonectes* sp.
A: Body shape (stage 35, no. of specimen PT021)
A1: Top view

21.4 Place and Duration

Hala-Bala WS. in January 2003.

22. *Limnonectes blythii* (Boulenger,1920)

External morphology of these larvae is similar to *L. macrognathus*, especially marks and bands on tail, most bands of *L blythii* larger than *L. macrognathus*. The metamorphoses of larvae are similar to their adults in stage 46 onwards, about 3-4 months after this.

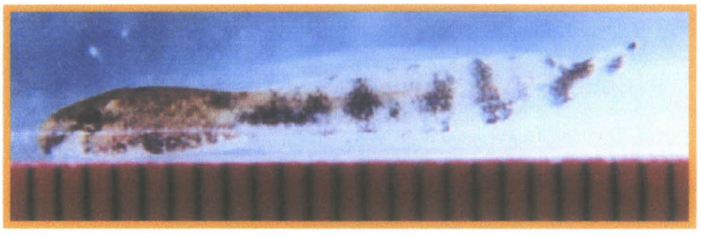
22.1 External Morphology

Head-body oval, width ¾ of length; eyes dorsal not visible from below; interorbital equal internarial distance; mouth-snout half of snout-eyes distance; spiracle sinistral, tubular, close to eye equal to root tail; anus dextral, opening at edge of ventral fin; tail heavy, both fins slightly convex, medial of dorsal equal ventral fin in depth but slightly deeper than caudal muscle; tip pointed (Figure 41).

Oral disc ventral, subterminal; thick papillae in a single row at lateral corners of upper lip and lower lip with single, staggered, median with gap; LTRF 1/3 (1); the first of lower teeth row with gap in medial, about 1/5 of each tooth distance, tip of second row convex into first row: the third row half shorter than in each tooth of first row and curving toward second.

Head-body pale brown; fins transparent; caudal muscle with dark mark or band; median eyes below with a vertical dark bar.

Total length 22-25 mm, (N=3).



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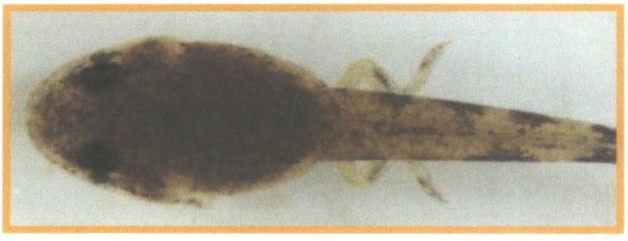

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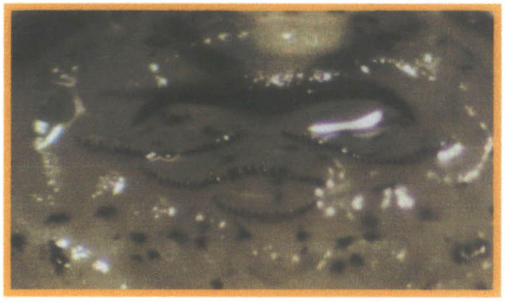


B

C

Figure 41 *Limnonectes blythii*
A: Body shape of tadpole (stage 37, no. of specimen PT022)
A1: Top view B: Mouthparts of tadpole C: Adult

22.2 Microhabitat

Larvae were collected in side pools of small stream banks, where there are accumulated dead leaves on sand or gravel bars on the bottom. The dimension of pools is 90X1.55X9 (W x L x D). The temperature (morning period) is 28°C on bed and 1 m above the water surface (air temperature) is 29°C. Elevation from MSL is 400m.

22.3 Behavior

Larvae have been found on accumulated dead leaves or small rocks in the daytime but nighttime they swim on sand or gravel bars at the bottom. Larvae are usually isolated living in side pools.

22.4 Place and Duration

Khlong Nakha WS.in February and Khao Luang NP. in January 2003.

23. *Limnonectes macrognathus* (Boulenger, 1917)

The Development of these larvae was similar to their adults in stage 46 onward, about 3-4 month. Stage 38, there are small tubercles on dorsolateral; hindlimbs with dark bands. On stage 40, there are dark bands on interorbital, and labial teeth have started to reduce.

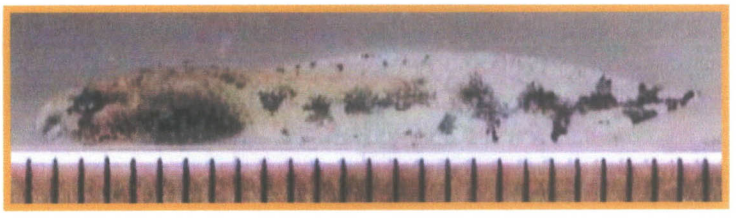
23.1 External Morphology

Head-body oval, length twice width; eyes dorsal; interorbital twice internarial distance; mouth-snout half of snout-eyes distance; spiracle sinistral, tubular, midway between eyes and root of hindlimbs; anus dextral; tail strong; dorsal fin equal ventral and caudal muscle in median; fins beginning at root tail; tip convex, pointed (Figure 42).

Oral disc ventral, subterminal; largest plates papillae at marginal lower lip and lateral corners; LTRF 1/3(1); the first of lower teeth row close to each tooth, tips of second row connected to first row and median convex, third row convex in median and tips connected to second row; beaks black, upper double that of the teeth and half of lower beak in depth.

Head-body pale brown; tail muscle with dark marks or stripes, fins transparent, posterior with dark bands in dorsal or ventral.

Total length 25-30 mm, (N=7).



A

A1

D B

C

Figure 42 *Limnonectes macrognathus*
A: Body shape of tadpole (stage 37, no. of specimen PT023)
A1: Top view B: Mouthparts
C: Adolt D: Eggs

23.2 Microhabitat

Tadpole have been found in side pools of small stream banks, where there are some accumulated dead leaves or some branches on sand and gravel bars at the bottom. The temperature on the bed (morning period) is 30°C and 1 m above the

water surface (air temperature) is 31°C. The dimensions are 80 X 175 X 18 cm (W x L x D). Elevations from MSL are 300 and 800 m.

23.3 Behavior

Larvae commonly live on dead leaves or some branches in pools in the daytime. Most swimming and feeding activities of larvae are present at nighttime. At night, they always move, rather fast and sometime rise to the surface.

23.4 Place and Duration

Khao Luang in February 2003.

24. *Limnonectes kuhlii* (Tschudi, 1838)

These tadpoles are similar to their adults in stage 45, hind limbs with small tubercles. On stage 41 labial teeth have started reducing. Mouthparts of *L. kuhlii* is different to other species in this genus, upper teeth with 2 rows, lower 3 rows, not convex and papillae smaller. Eggs of *L. kuhlii* usually stick to some root plants next to the pool or in small stream banks, eggs diameter about 5 mm, eggs sticking in lumps at water surface.

24.1 External Morphology

Head-body oval, width 2/3 of length, slightly depressd; eyes dorsal, not visible from below; interorbital double internarial distance; mouth-snout half of snout-eye distance spiracle sinistral, tubular, close to eye equal to root tail; vent tube dextral, opening at margin of ventral fin; tail strong, length twice that of head-body; upper fin twice that of lower, but 2/3 of caudal muscle in depth; tail tapering gradually in posterior; tip pointed (Figure 43).

Oral disc ventral, subterminal; papillae on upper corners mouth 4-5 times bigger than lower and marginal lower lip; lower lip with 2 rows 4-5 times, wriggly; LTRF 2(2)/3(1); the second of upper teeth row with gap, subequal last lower teeth row; first to second of lower teeth rows distance equal to second to third rows, last rows half the length of first and second rows, first and second rows equal in length; beak black, marginal with fine serration.

Head-body dark brown, tail same; interorbital with a dark line; fins with pale brow spots, distral one-third with dark spots or marks; ventral transparent, visible intestine 2/3 of head-body length. In aquarium head-body and tail changed color, brownish, dark spots or marks fading gradually.

Total length 45-60 mm, (N=3).

24.2 Microhabitat

Larvae were collected in side pools of small stream banks, where there are accumulated dead leaves and other plants on a sand or silty bottom. The side pool at Khao Luang is 27 cm depth, the temperature is 30°C and 1 m above the water surface (air temperature) is 31°C. Elevation from MSL is 800 m. Khlong Nakha is 18 cm depth, temperature 29°C on bed and above the water surface (air temperature) is 30°C, and Elevation from MSL is 300 m. For Hala-Bala is 22 cm depth, temperature 29°C on bed and 1 m above the water surface (air temperature) is 30°C, Elevation from MSL is 200 m.

24.3 Behavior

Larvae usually live under accumulated dead leaves or other plants on the bottom in the daytime and hardly moving. At nighttime, they are easy to find because most activities of the larvae are present in this time, they swim on the bottom but sometimes rise to the water surface. In aquarium, their behavior is similar to the field.

24.4 Place and Duration

Khlong Nakha, Hala-Bala WS. and Khao Luang NP. in February 2003.

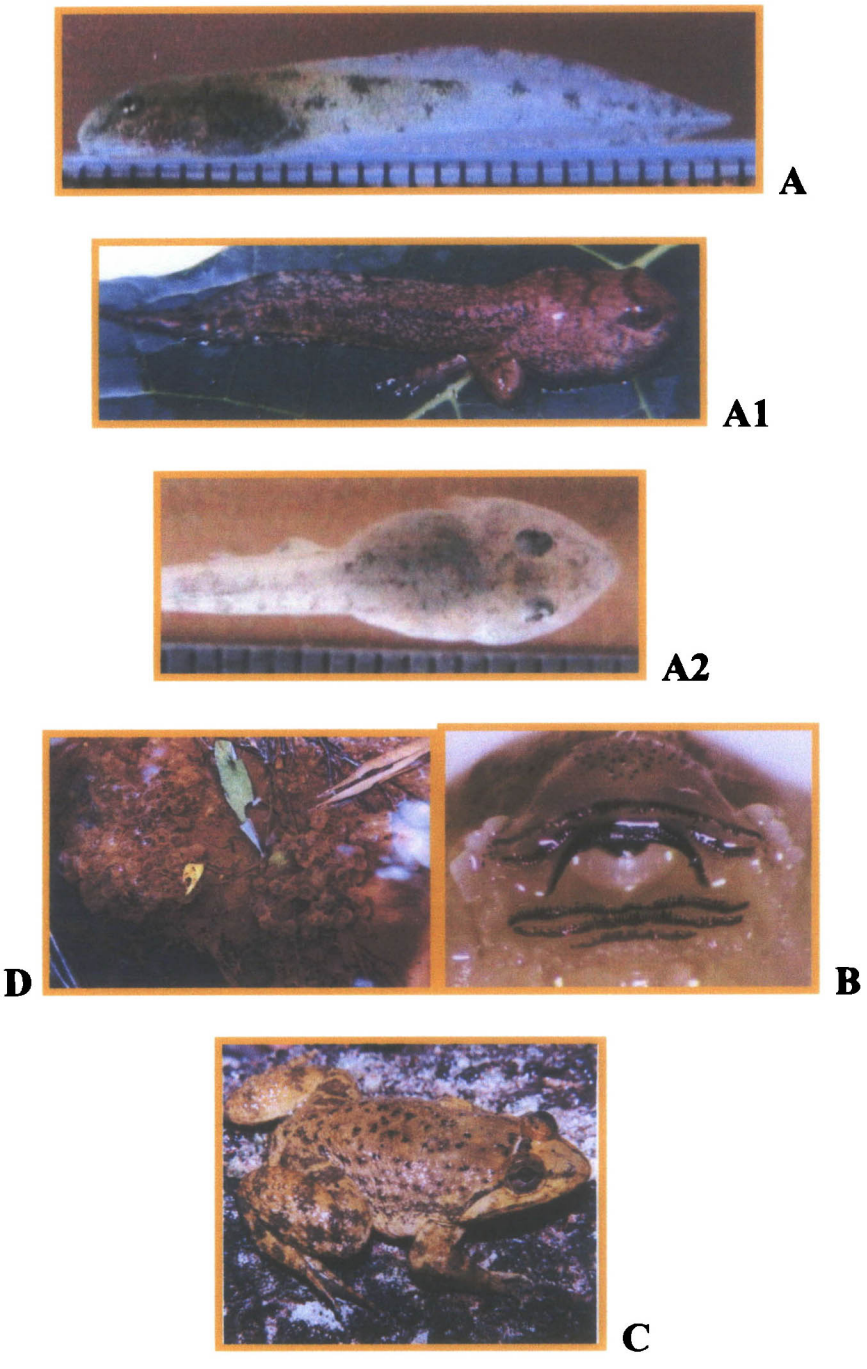


Figure 43 *Limnonectes kuhlii*
A: Body shape of tadpole (stage 37, no. of specimen Pt024)
A1: Another form A2: Top view B: Mouthparts of tadpole
C: Adult D: Eggs

Genus *Rana*

Larvae in this genus are bigger than the bodies of *Limnonectes* and most of *Rana* larvae are without a pattern on the body. Their external morphologies are rather more varied; 30-130 mm in size; LTRF 2(2)/3(1) to 8(3-8)/7(1); oral disc anteroventral; marginal papillae with a gap on the upper lip, some species also with lower; spiracle sinistral; vent tube dextral. They have been found in ponds and moderate streams.

25. *Rana alticola* (Boulenger, 1882)

Association of larvae and adult starts at stage 40. At stage 42 head-tail color is brownish, with a scattering of small dark spots; dorsolateral body is pale gray. At stage 44, lateral body is blackish and at stage 46 body color and body shape are mostly similar to adults.

25.1 External Morphology

Head-body oval, flattened below, width 2/3 of length; eyes dorsolatral, not visible from below; interorbital double internarial distance; mouth-snout half of snout-eye distance; spiracle sinistral, tubular; vent tube dextral, tubular, opening at the end of the body in ventral; tail muscle strong; both fins equal in depth, fins 1/3-1/4 of tail muscle in depth; tip rounded (Figure 44).

Oral disc ventral, width twice length; lower lip with a single row of paillae; commissures mouth with 3 rows of papillae, staggered; upper corners of mouthes with 2 rows, moderate; LTRF 8(2-8)/7/1; beaks black, marginal serrated, upper equal lower but 3 times teeth in depth.

Head-body and tail blackish, near root tail to tip with about 2-4 black circles, outer reddish-brown the black circle entirely reddish.

Total length 70-120 mm, (N=10).

25.2 Buccal carvity

Buccal roof: Prenarial arena of roof with a long single palp; postnarial with a single long palp on each side, equal length; buccal roof arena with about 20 pustules; lateral of buccal roof arena and dorsal velum smooth (Figure 45).

25.3 Microhabitat

Tadpoles have been found in open pools, where there are some accumulated dead leaves on some stones, gravel and sand bottoms. The dimensions of pools are 20-40 x 40-250 x 10-30 cm (W x L x D). The temperature on the bed (late morning period) is 29°C and 1 m above the water surface (air temperature) is 30°C. Elevations from MSL are 200-400 m.

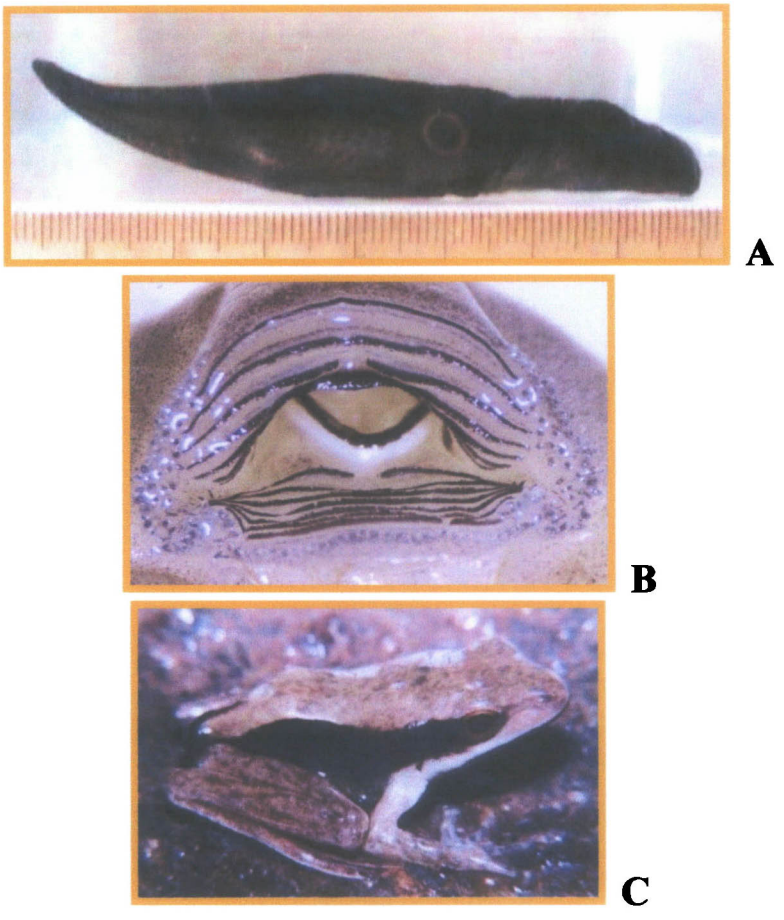


Figure 44 *Rana alticola*
A: Body shape of tadpole (stage 37, no. of specimen PT025)
B: Mouthparts of tadpole C: Adult

25.4 Behavior

Tadpoles usually live together, big groups in stone nooks or dead leaves on the bed, but some live together in lumps. In the daytime, they are still or move slightly and when they have been disturbed, they move into mid-water, sometimes to the bed, at 180 cm depth. Daytime they are most active, swimming forward and backward and sometimes rise to the water surface and they scrape some accumulated dead leaves on the bed or small aquatic plants on stone surfaces for food. When operated the intestine and stomach revealed some fragments of aquatic plants and sand or silt was found. Hence they have eaten accumulated dead leaves and moss on stone surfaces for food and sand or silty was sucked into the mouth, together with food and some water.

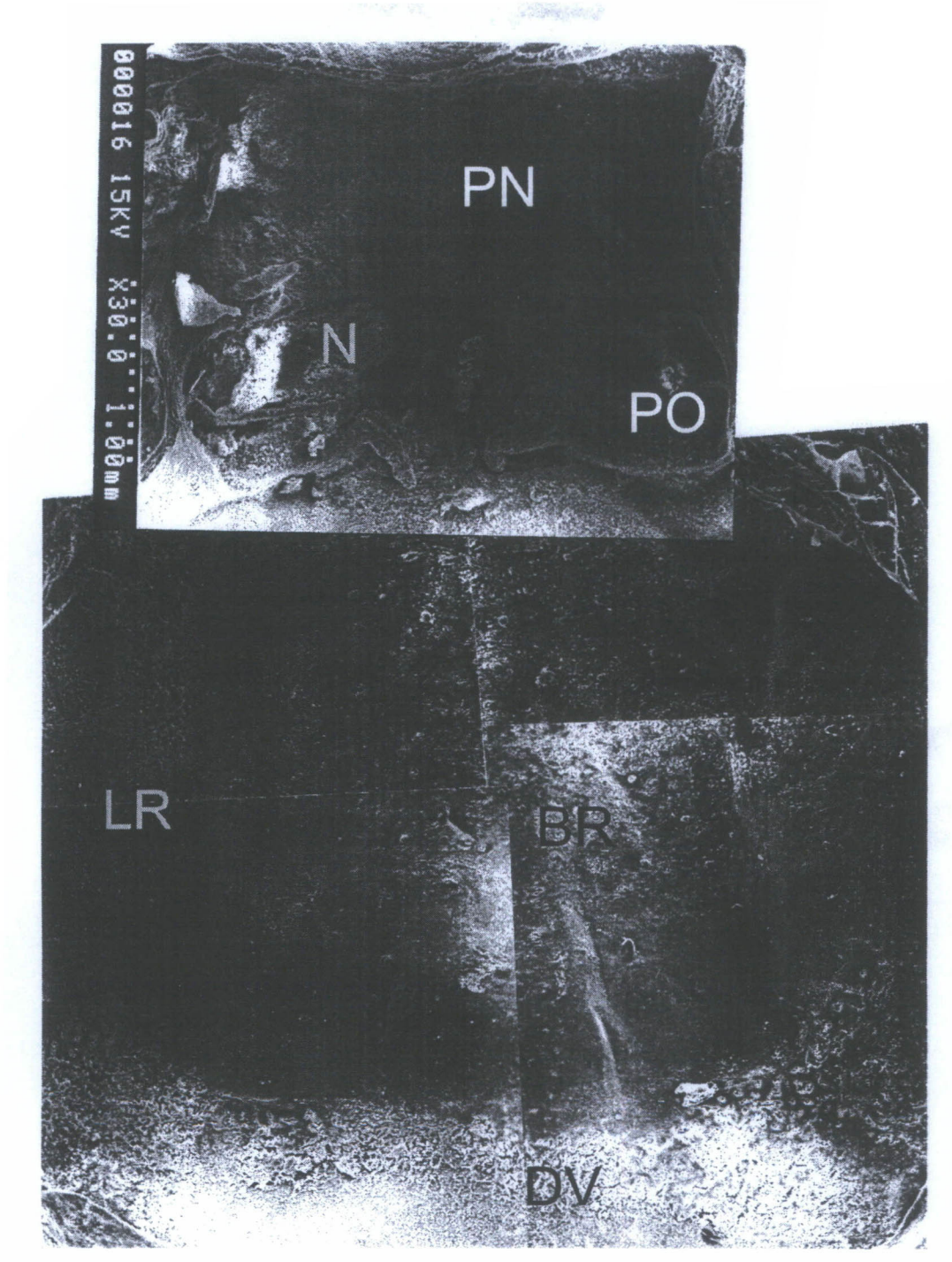


Figure 45 Buccal roof arena
PN-prenarial arena; N-nares; PO-postnarial arena; BR-buccal roof arena; LR-lateral of buccal roof arena; DV-dorsal velum

25.5 Place and Duration

Khlong Nakha WS. at all collecting the data, but most between December 2002-April 2003 and Khao Luang NP. in January 2003.

26. *Rana chalconata* (Schlegel, 1837)

The metamorphosis of these larvae is similar to their adult in stage 47 onwards, whole body with gray-brownish spots; snout to tympanum on lateral is brown.

26.1 External Morphology

Head-body oval, flattened below, length twice the width; eyes dorsolateral, not visible from below; internarial equal or slightly less then interorbital; mouth-snout 1/3 of snout-eye; spiracle sinistral, tubular, close to eye equal or slightly less than to root tail; anus dextral, tubular, opening at root of ventral fin; ventral fin 2/3 deeper than dorsal fin in mid-tail; tip rounded (Figure 46).

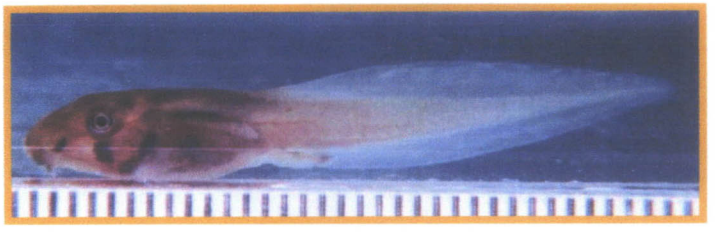
Oral disc anteroventral; commissures mouth with 2-3 rows of papillae, bigger than lower lip, upper lip without papillae; LTRF 4(2-4)/3, 4(2-4)/3(1) or 5(2-5)/3(1); beaks black, margin serrated, upper equal or slightly bigger than lower beak.

Head-body yellowish-brown, mid-body pale darkish; dorsolateral to belly in mid-body with a dark stripe; dorsolateral in mid-body to root tail with a pale brown or cream color stripe; interorbital with a dark stripe, triangle-like; behind eyes with a dark line, curved; mouth to eye with a dark spot in dorsolatral; vent transparent, visible gut; caudal muscle pale brownish; fins cloudy or the same color as the caudal muscle.

Total length 25-35 mm, (N=5).

26.3 Microhabitat

Larvae have been found in many microhabitats, ponds in plantations to open pools in forests. In pools, there are some accumulated dead leaves, some gravel and rock on the bottom. The dimension of pools is 30-50 x 50-200 x 10-50 cm (W x L x D) and the temperature on the bed (afternoon period) is 29-31°C and 1 m.above the water surface (air temperature) is 30-33°C. In ponds, there are some accumulated dead leaves or some branches on a sand or silty bottom. The dimensions of ponds are 30-50 x 50-1,000 x 20-50 cm and the temperature (afternoon period) is 30-33°C on the bed and 1 m above the water surface (air temperature) is 31-34°C. Elevations from MSL are 50-200 m.



A

A1

B C

Figure 46 *Rana chalconata*
A: Body shape of tadpole (stage 40, no. of specimen PT026)
A1: Top view B: Mouthparts of tadpole C: Adult

26.4 Behavior

Tadpoles usually live on or under dead leaves on the bottom, grouping about 20-50 individuals. They often rise to the water surface and swim rather fast. Most swimming and feeding activity was at night, but some of them were feeding all day and night. Their behavior in the field and aquarium is similar.

26.5 Place and Duration

Khlong Nakha Ws. , Khao Luang NP. and Hala-Bala WS. at all times to collect the data but most between December 2002 and January 2003.

27. *Rana hosii* (Boulenger, 1891)

Association of larvae and their adults present in stage 37, mouth to root tail with a pale brown small stripe on dorsolateral. At stage 41, the color on back changed, pale greenish and stage 45 there are 3-4 brown dots on the back.

27.1 External Morphology

Head-body slender, width about half-length eyes dorsal non-visible from below, interorbital twice internarial distance, mouth-snout half of snout-eyes distance, spiracle sinistral, closer to vent than to tip of snout; vent dextral. Tail lanceolate, end rounded; fins subequal, both fins and caudal muscle equal in depth on posterior half of tail (Figure 47).

Oral disc ventral, subterminal; papillae with lower lip and corners of upper lip; LTRF 5(2-5)/4(1) edge of lower teeth with convex; beaks narrow and undivided.

Head-body dark gray; snout-tip tail with white line on dorsal lateral; caudal muscle dark gray, fins not colored.

27.3 Microhabitat

Their eggs were found in a small pothole on rocks near the waterfall that is 1,200 m MSL. Eggs are white and gathered into a ball. The pothole is 10 cm depth, 33 cm width and 56 cm length. Eggs are on the bed under water. Four larvae were found in stream banks with 23 cm depth, 110 cm width and 187 cm length. The temperature (lata morning period) was 29.4°C in the bank and 1 m above the water surface (air temperature) was 31°C. Under the water there were sand and accumulated dead leaves on the bottom. Elevations from MSL are 200, 800, 1200 at Khao Luang, 200, 400 and 800 m at Khlong Nakha and 300 m at Hala-Bala.

27.4 Behavior

Larvae quickly move and they live on the ground on bottom. Larvae usually live together and sometimes they swim to the surface.

Total length47-51 mm, (N=5).

27.5 Place and Duration

Khlong Nakha WS., Khao Luang NP. in February and Hala-Bala WS. in April 2003.

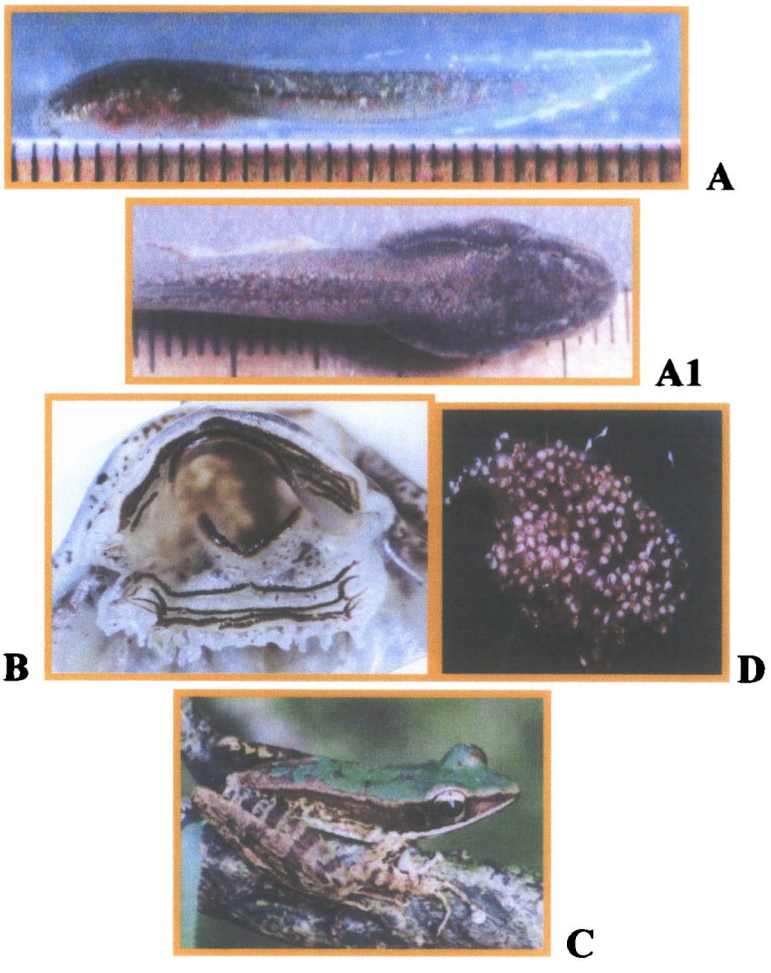


Figure 47 *Rana hosii*
A: Body shape of tadpole (stage 37, no. of specimen PT027)
A1: Top view B: Mouthparts of tadpole
C: Adult D: Eggs

28. *Rana signata* (Gunther, 1872)

Most of the external morphology of these larvae is similar to *Rana hosii*, except the color and streak on dorsolateral or even the mouthparts and their eggs. These eggs were found beside small stream banks, they stick on tree roots under the water, soft and separate, each egg is covered with silt and is not easy to find because they are not similar to other amphibian's eggs. Moreover, these eggs are also different to eggs and the microhabitat for the eggs of *R. hosii*. The metamorphosis of larvae is similar to their adult from stage 45 onward, dorsolateral fold has occurred, head-body dark, hind limbs with pale brown bands.

28.1 External Morphology

Head-body oval, slightly depressed, length twice the width; eyes dorsolateral not visible from below; interorbital equals internarial distance; mouth-snout half of snout-eyes distance; spiracle sinistral, short tube, opening between eye and hind limb; dextral, opening at margin of ventral fin; tail slender, length twice that of head-body; median of dorsal fin twice that of ventral but half that of caudal muscle in depth; tip blunt (Figure 48).

Oral disc ventral, subterminal; thick papillae in single row at lateral corners of upper lip and continuous to lower lip; LTRF 7(2-7)/4(1); the first to fourth of upper teeth rows adjoining upper beak, third to fourth of lower teeth rows distance 2/3 of second to third rows distance; beak black, fine serration, upper twice that of lower in depth.

Head-body red-brownish, tail same; caudal muscle with white dots; fins transparent.

Total length 35-40 mm, (N=3).

28.2 Microhabitat

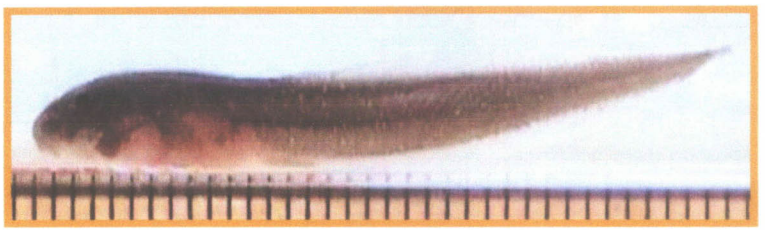
Larvae were found in side pools of small stream banks, where there are tree roots and accumulated dead leaves on a sand and silty bottom. The pool is 35 cm deep the temperature (morning period) is 30°C and 1 m above the water surface (air temperature) is 31°C. Elevation from MSL is 300 m.

28.3 Behavior

In aquarium larvae usually live under rocks or accumulated dead leaves on the bottom in the daytime. At nighttime, they come out of the rocks or dead leaves when most swimming or feeding activities occur. Larvae do not swim fast and they live on the bottom, sometimes they rise to the surface.

28.4 Place and Duration

Hala-Bala WS. in April 2003.



A

A1

B D

C

Figure 48 *Rana signata*
A: Body shape of tadpole (stage 37, no. of specimen PT028)
A1: Top view B: Mouthparts of tadpole
C: Adult D: Eggs

29. *Rana nigrovittata* (Blyth, 1855)

The metamorphosis of larvae is similar to their adult in stage 46 onward, dorsolateral fold and dark bands on hind limbs are present.

29.1 External Morphology

Head-body oval, length twice the width; eyes olorsolateral; internarial 2/3 of interorbital distance; mouth-snout equals snout-eyes distance; spiracle sinistral, tubular, close to eye equal to hind limb; vent tube dextral, opening at root of ventral fin; tail twice that of head-body length; dorsal fin slightly deeper than ventral and 2/3 of tail muscle in median, fins beginning at root tail, dorsal fin slightly convex in median tail tapering gradually, tip rounded (Figure 49).

Oral disc ventral, subterminal; papillae at lateral corners with three rows and wriggly, marginal lower lip with two rows, wriggly and double the length of corners; LTRF 2(2)/3(1); the second of upper teeth rows with gap; equal each tooth length, tips connected first row; first to second of lower teeth rows distance equals second to last rows; beaks black, marginal fine serration, lower 2/3 of upper in depth, upper twice that of teeth in depth.

Head-body dark-brownish or grey, the tail is the same but with brownish or darkish spots on tail and fins; fins transparent.

Total length 35-40 mm, (N=12).

29.2 Buccal Carvity

Buccal floor: Tongue arena of floor indistinct, tip triangular; buccal floor arena smooth; lateral papillae of buccal floor arena with about 5 branches palps on each side; ventral velum with about 10 pustules (Figure 50).

Buccal roof: Prenarial area of roof smooth; nares elongated oval, transverse; postnarial with ridge papillae, stick and transverse in median; median ridge is low and triangular, as wide as internarial, margin serrated; buccal roof with about 50-60 pustules; lateral papillae of buccal roof arena with 10 branches of palps on right and 15 palps on left (Figure 51).

29.3 Microhabitat

Larvae were found in rain pools nearby steam banks and side pools of stream banks; where there are accumulated dead leaves or other plants on a sand or silty bottom and sometimes nothing on the bottom. Rain pools or side pools are about 15-25 cm depth, 30-120 cm width and 50-180 cm length The average temperature of rain pool (morning period) is 30°C, 1 m above the water surface (air temperature) is 31 °C and side pools (morning period) is 29°C on bottom and 1 m above the water surface (air temperature) is 30°C. Elevation from MSL are 200, 400 and 800 mm.

29.4 Behavior

Larvae usually live under accumulated dead leaves or other plants on the bottom. Sometimes, they rise to the water surface. Larvae eat everything for food, such as dead plants, other larvae, insects and even their carcasses or food particles from humans. Their activities are present all the time, feeding, swimming, sometimes they swim to chase other larvae, which are *Microhyla heymonsi, M. ornata* and *Polypedates leucomystax*, but they are also eaten by *P. leucomstax.*

29.5 Place and Duration

Khlong Nakha WS. in February, Khao Luang NP. in February, May and September and Hala-Bala WS. in February and September 2003.

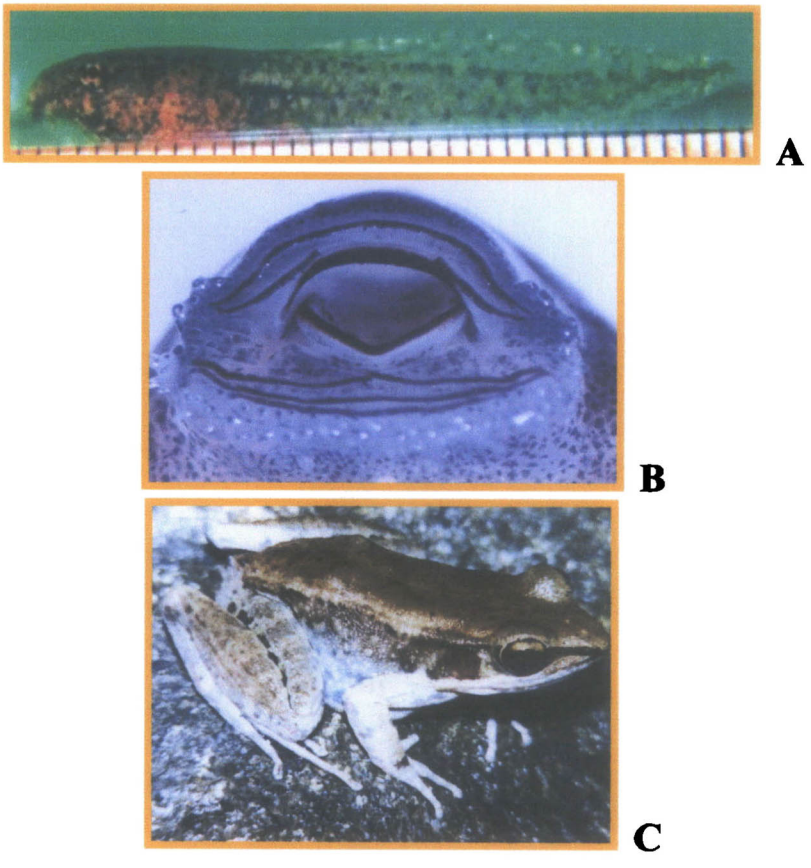


Figure 49 *Rana nigrovittata*
A: Body shape of tadpole (stage 37, no. of specimen PT029)
B: Mouthparts of tadpole C: Adult

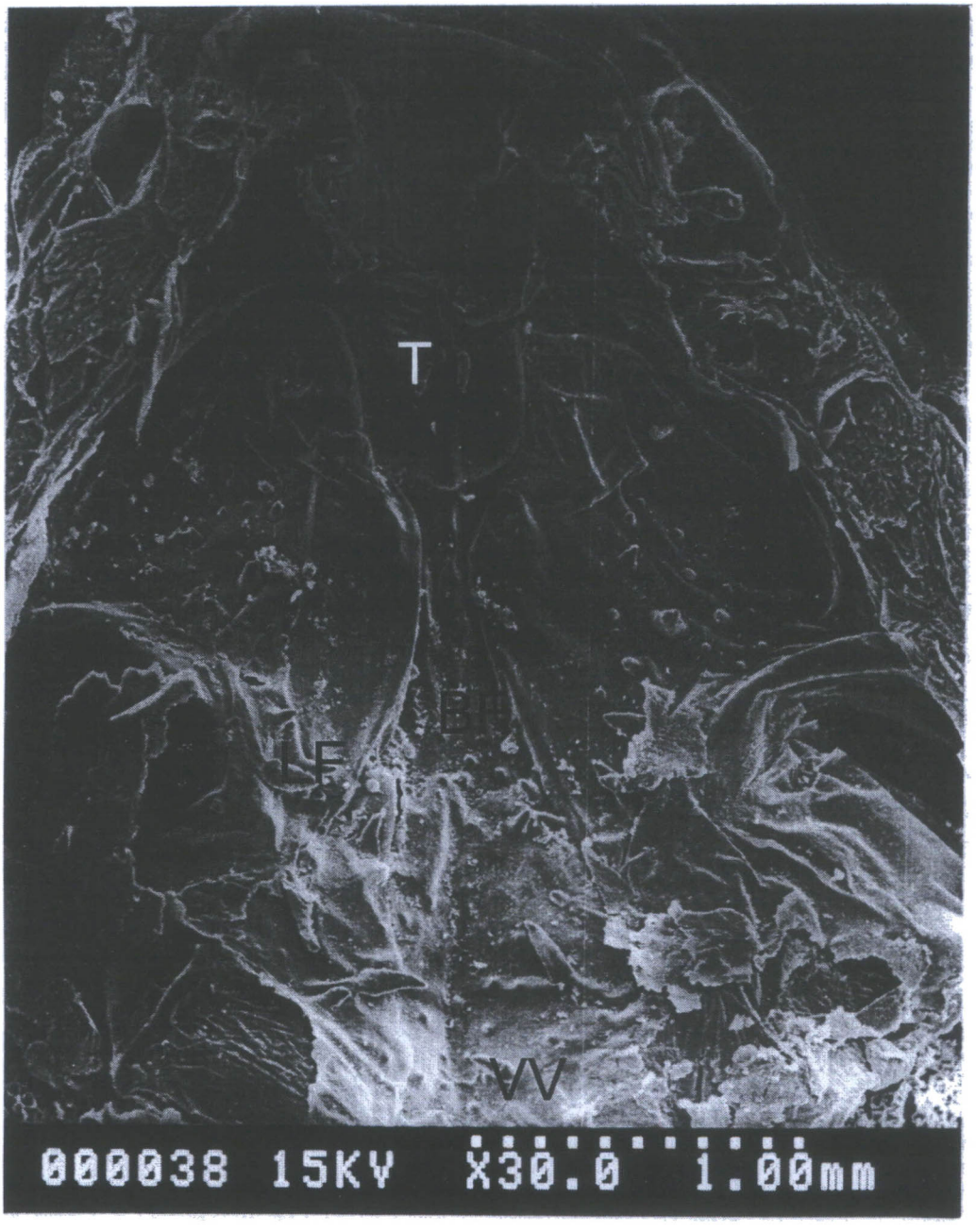


Figure 50 Buccal floor arena
T-tongue; BF-buccal floor arena; LF-lateral papillae of buccal floor arena; VV-ventral velum.

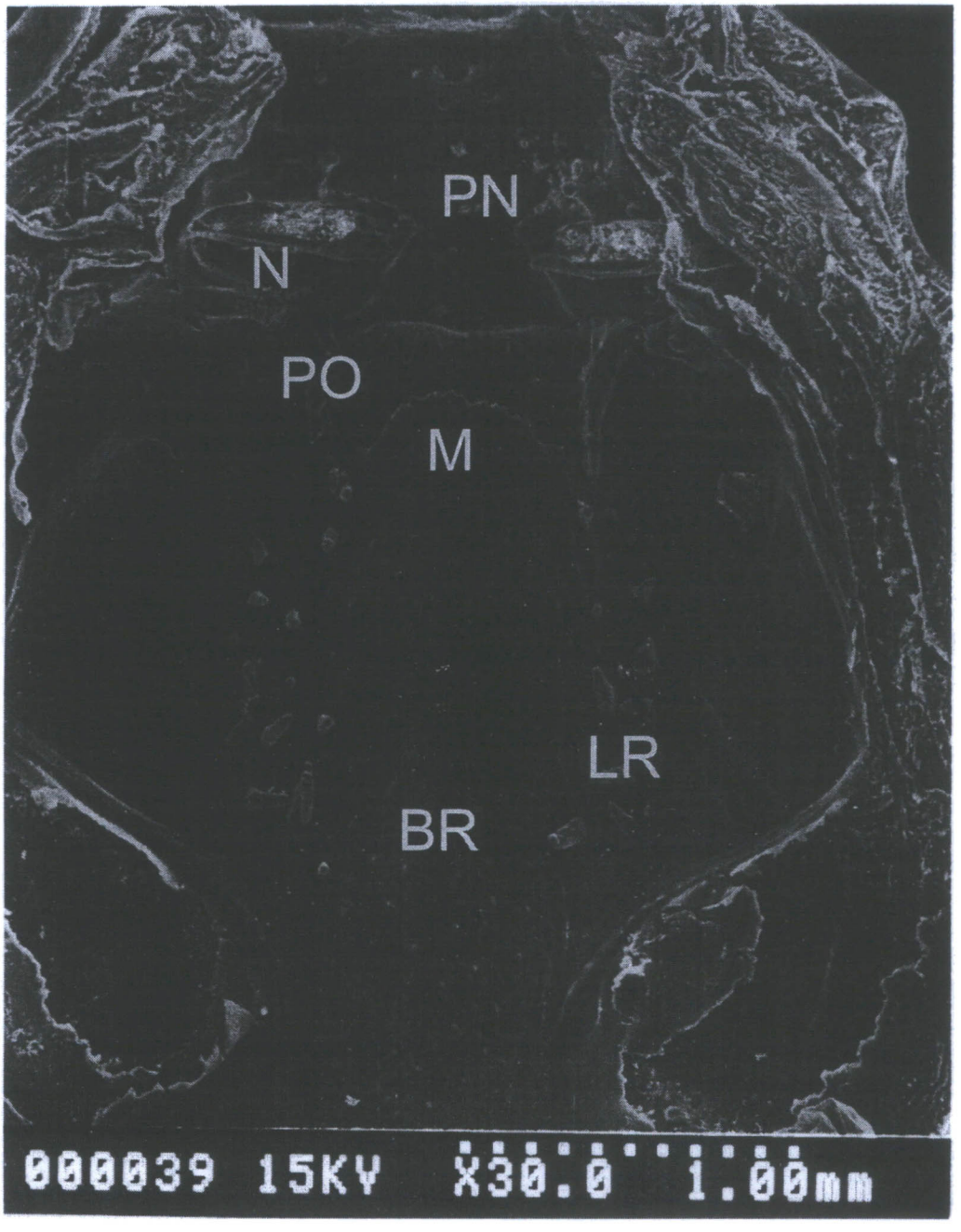


Figure 51 Buccal roof arena
PN-prenarial area; N-nares; PO-postnarial; M-median ridge;
BR-buccal roof arena; LR-lateral papillae of buccal roof

30. *Rana cubitalis* (Smith, 1917)

Larvae of *R. cubitalis* and *R. nigrovittata* are rather similar, but there are many differences too such as, body color and labial teeth. The metamorphosis of these larvae is similar to their adult at stage 46 onward, about 4-5 weeks, which are dorsolateral fold ridges on hind limbs and dark squares on tympanum. At stages 43-45, they are similar in body shape but the dorsolateral fold of *R. nigrovittata* is clear.

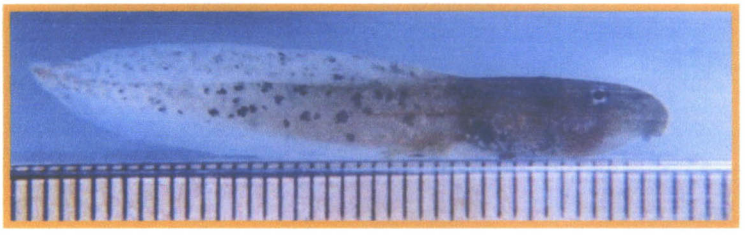
30.1 External

Head-body oval, length twice the width; eyes dorsolateral are not visible from below; interorbital ¾ of the internarial distance; mouth-snout half of snout-eyes distance; spiracle sinistrar tubular, close to eyes equal to hind limb; anus dextral, opening at root of ventral fin; tail strong, length twice that of head-body; midway of dorsal fin twice ventral in depth but half of caudal muscle in depth; fins beginning at root tail; caudal muscle tapering gradually, top rounded (Figure 52).

Oral disc ventral, subterminal; papillae on lateral corners with single row, length equal to lower lip; upper lip without papillae, lower lip with 3 rows upper of lateral corners with 2 rows, inner half the length of outer and wriggly; LTRF 2(2)/3(1); the second of upper teeth row with gap, ¼ of each tooth length; first to second of lower teeth rows distance twice that of second to third rows; beaks black marginal fine serration; upper equal lower twice that of teeth in depth.

Head-body brown or dark-brown; some body with dark spots all of head-body; tail muscle with dark or black spots; fins transparent or cloudy, upper sometimes with pale dark spots.

Total length 35-40 mm, (N=3).



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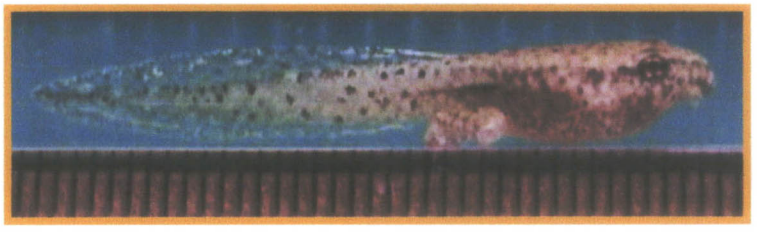
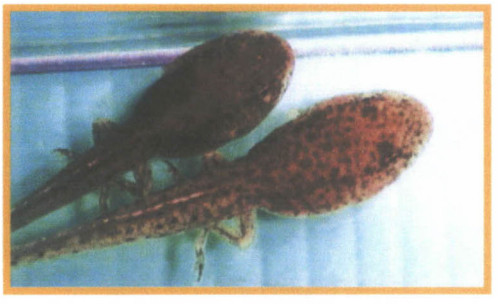


A1



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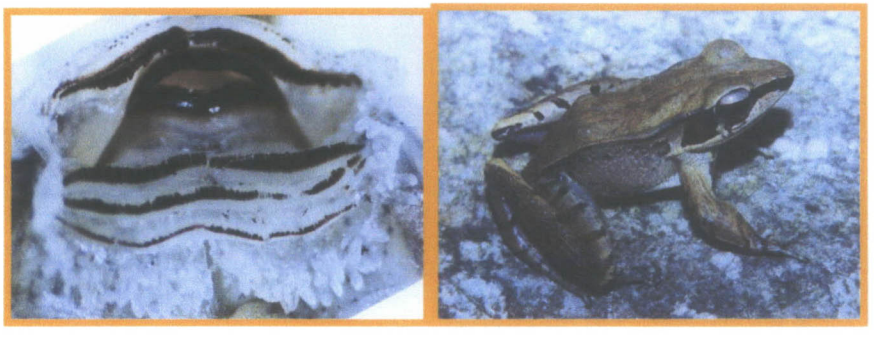


B C

Figure 52 *Rana cubitalis*
A: Body shape of tadpole (stage 40, no. of specimen PT030)
A1: Another form A2: *Rana nigrovittata* (left), *Rana cubitalis* (right)
B: Mouthparts C: Adult

30.2 Buccal Carvity

Buccal floor: Prelingual area of floor with 3 branches palps; tongue in tip with 3 lobes; buccal floor arena with about 10 pustules; lateral papillae of buccal floor arena with about 20-25 branches of palps on each side; ventral velum smooth (Figure 53).

Buccal roof: Prenarial arena of roof smooth; nares oval, transverse; anterior and posterior wall are curved and ridged; prenarial arena with a single branch palp on each side, as long as the naris, transverse; a low triangular median ridge, Elevation about width, margin serrated; buccal roof arena with about 30-40 pustules; lateral papillae of buccal roof arena with about 10-12 branches of palps on each side (Figure 54).

30.3 Microhabitat

Larvae were found in side pools of small stream banks, where there are accumulated dead leaves or other plants on sand, gravel bars and small rock bottom, at 22 cm depth. The temperature (morning period) is 28°C and 1 m above the water surface (air temperature) is 29°C. Elevation from MSL is 800 m.

30.4 Behavior

Larvae normally live on accumulated dead leaves, gravel bars or small rocks on the bottom, sometimes they rise to the water surface. They move slowly and are usually still on the bottom but when they swim they swim short distances and are still again.

30.5 Place and Duration

Khlong Nakha WS. and Khao Luang NP. in January 2003.

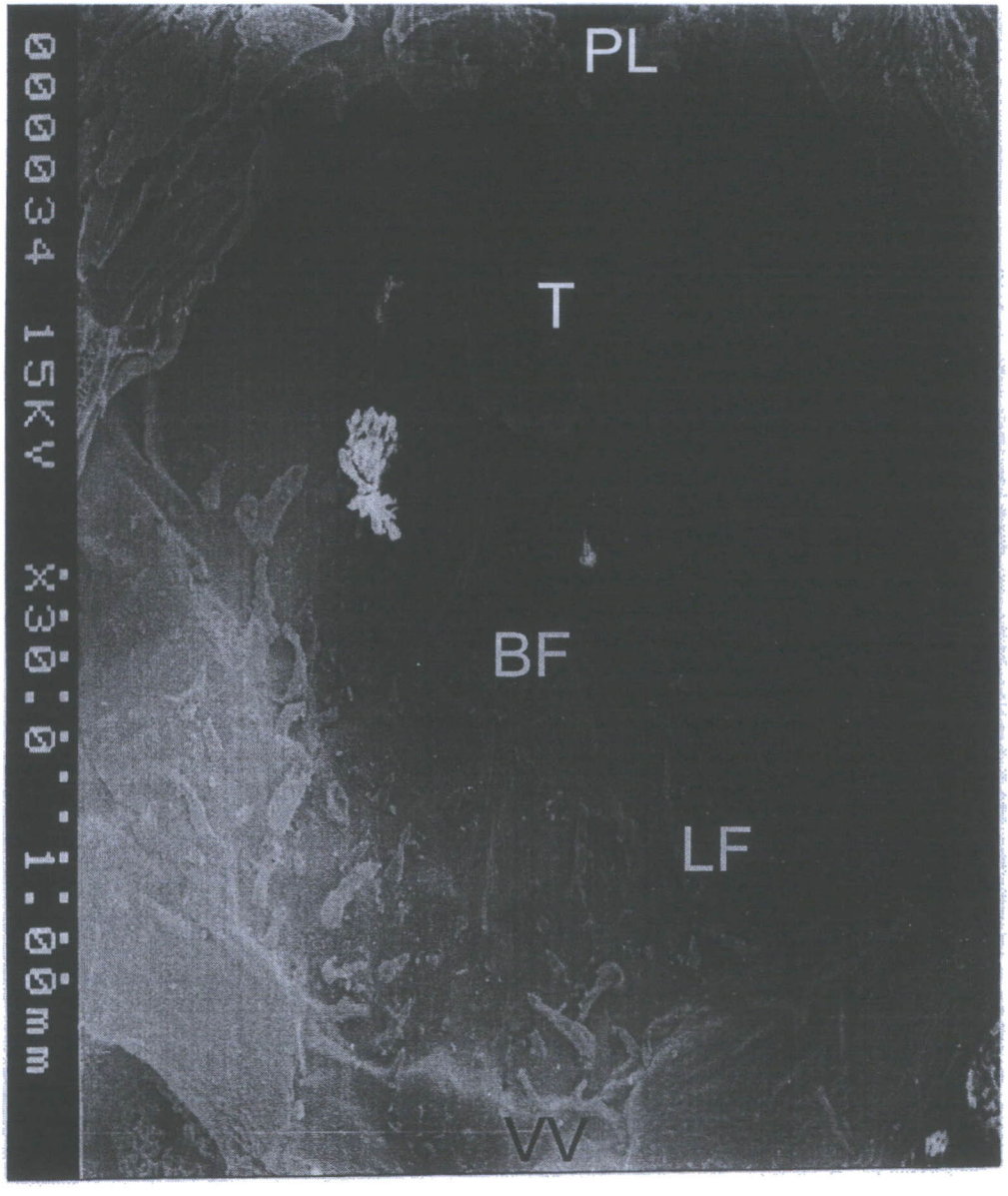


Figure 53 Buccal floor arena
PL-prelingual area; T-tongue; BF-buccal floor arena;
LF-lateral papillae of buccal floor arena; VV-ventral velum.

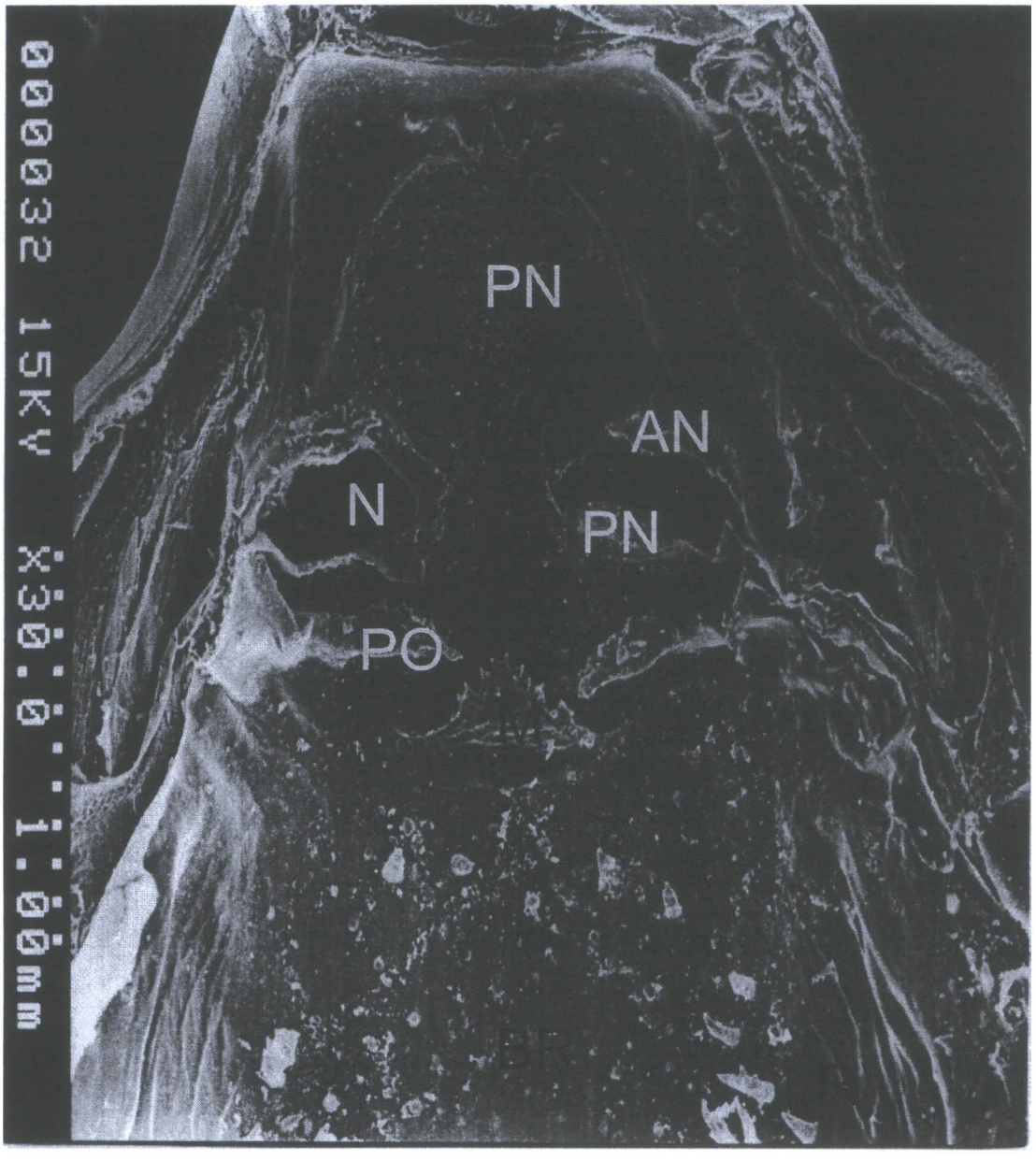


Figure 54 Buccal roof arena
PN-prenarial arena; N-nares; AN-anterior narial; PN-posterior narior;
PO-postnarian area; M-median ridge; BR-buccal roof arena;
LR-lateral papillae of buccal roof.

31. *Rana erythraea* (Schlegel, 1837)

External morphology of these larvae is similar to adults in stage 35 onward, dorsolateral with ivory white streaks. At stage 42 lateral of head-body with black ventrolateral with ivory white streaks, back pale green, web completed on hind-limb. Some individual's backs with ivory white streaks in stage 40 but after stage 45, the streak has faded.

31.1 External Morphology

Head-body oval, width about half the length; eyes lateral, visible from below; interorbital twice that of interbarial distance; mouth-snout distance twice that of snout-eyes; spiracle sinistral, tubular, close to eye 2/3 of hind limb; anus dextral opening at root of ventral fin; tail strong, length twice that of head-body; midway of dorsal and ventral fin equals caudal muscle in depth; fins beginning at root tail, median convex; caudal muscle tapering gradually, tip pointed (Figure 55).

Oral disc ventral, subterminal; large papillae on upper lateral corners and corners twice of inner lower lip. Lower lip with 3 rows, outer most length about 3-4 that of inner; LTRF1/2(1); the first of lower teeth row with gap in median, 6-7 times that of each tooth, each tooth of first row 2/3 of second row in length; beaks black, marginal fine serration, upper half that of lower and twice that of teeth in depth.

Head-body is dark-brown or grey, dorsal and lateral, ventral with dark spots or small streaks anterior of eyes with dark or black banded dorsolateral with pale ivory white streaks; the tail is the same, median of root tail muscle in depth with dark or black bands about 1/3-1/4 of caudal muscle length fins cloudy with dark spots or small streaks on it.

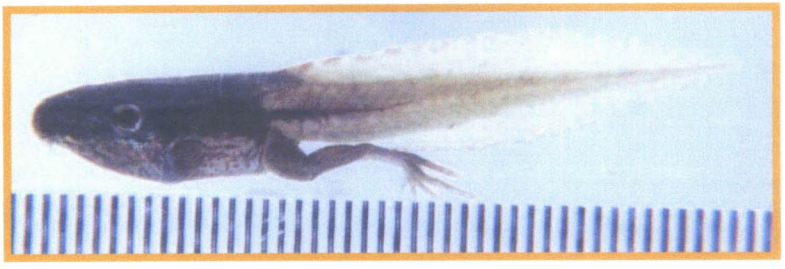
Total length 35-50 mm, (N=9).

31.2 Microhibitat

This larva are found in ponds and basins, where there are many aquatic plants on the water surface and silt on the bottom. The ponds and basins are deep and more than 1 m wide and more than 3 m long. The temperature (afternoon period) is 29°C on the bottom and 1 m above the water surface (air temperature) is 31°C. Elevations from MSL are 50 and 100 m.

31.3 Behavior

Larvae usually live on silty bottoms or under aquatic plants, they move quickly. At nighttime, they swim around the pond, but sometimes rise to the water surface and they do not group.



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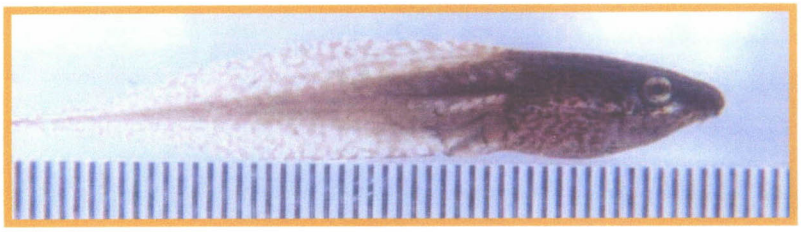


A1

B C

Figure 55 *Rana erythraea*
A: Body shape of tadpole (stage 40, no. of specimen PT031)
A1: Another form B: Mouthparts of tadpole
C: Adult

31.4 Place and Duration

Khlong Nakha WS., Khao Luang NP.and Hala-Bala WS. at all collecting the data.

Genus *Taylorana*

Only one species of this genus has been found and only one individual. It has an elongated body and external morphology is similar to *Limnonoctes* but the tail is longer and also plain in color.

32. *Taylorana hascheana* (Stoliczka, 1873)

The metamorphosis of this larva is similar to adult from stage 46 onward at about 2-3 weeks, with a W shape dark mark on back, smooth skin, and an upper tympanum ridge is present.

32.1 External Morphology.

Head-body oval, width 2/3 of length; eyes lateral visible from below; interorbital twice that of internarial; mouth-snout half of snout-eyes distance; spiracle sinistral, close to eyes equal to root tail; anus medial, tubular; tail 3 times longer than body; lower fin equal or subequal upper fin; fins beginning at root tail, tail muscle equals body in depth, tip pointed (Figure 56).

Oral disc vertical, subterminal, small, non-teeth beaks and papillae, upper lip half thicker than lower lip.

Head-body brownish; tail muscle pale brownish; upper and lower fins are cloudy and without marks or spots.

Total length 20 mm, (N=1).

32.2 Microhabitat

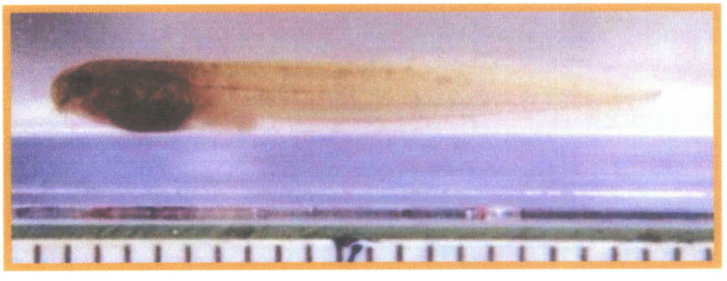
T. hascheana were collected in side pools of small stream banks, where there are accumulated dead leaves and other plants on the bottom, the bed is sand and silt. The pool is 18 cm deep, 30 cm width and 70 cm length. The temperature (morning period) is 29°C and 1 m above the water surface (air temperature) is 30°C. Elevation from MSL is 200 m at Hala-Bala and Khlong Nakha.

32.3 Behavior

Larvae usually live under dead leaves on the bottom, and move slowly.They usually live on the bottom in the day. At night, they swim around the side pools, sometime rising to the surface.

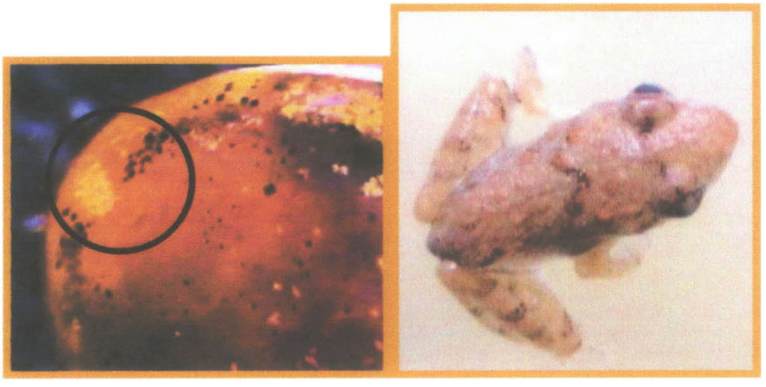
32.4 Place and Duration

Khlong Nakha WS. in January 2004 and Hala-Bala WS. in April 2003



A

A1



B C

Figure 56 *Taylorana hascheana*
A: Body shape of tadpole (strage 37, no. of specimen PT032)
A1: Top view B: Mouthparts C: Adult

Genus *Hoplobatrachus*

Only one species of this genus was found in Thailand. External morphology of them is sometimes like *Ferjervarya limnocharis*. They often have been found living together in pools or ponds but the body of *Hoplobatrachus* is bigger and especially their mouthparts are clearly different. From stage 46 forward, both species are similar.

33. *Hoplobatrachus rugulosa* (Wiegmann, 1835)

The metamorphosis is quick. At stage 37, their denticles start reducing. At stage 42, ridges on the back and dorsolateral are present.

33.1 External Morphology.

Head-body oval, depressed, flat below; length twice the width; eyes dorsolateral not visible from below, internarial 3 times interorbital distance; mouth-snout equals snout-eyes distance; spiracle sinistral, tubular, close to eye equal or slightly less than root tail; vent tube median; tail muscle strong; dorsal fin twice that of ventral in depth; dorsal fin slightly convex in median; caudal muscle tapering gradually; tip rounded (Figure 57).

Oral disc, ventral, subterminal; lips without papillae, lips thick; LTRF 5(3-5)/5(1-3), the last of lower teeth row shorter than the first row, marginal upper are median and half; beaks large lower beak and lower marginal upper beak are extended, like fangs

Head-body grey-brownish on dorsal and lateral, tail muscle is the same; ventral white or silver; fins muddy, upper with dark spots.

Total length 50-60 mm, (N=3).

33.2 Microhabitat

These larvae were found in pond and rain pool, where there are many aquatic plants and there are accumulated dead leaves on the bottom, with silty ground. The pond is 110 cm depth, 230 cm width and 580 cm length. The temperature is 30°C on bottom and 1 m above the water surface (air temperature) is 31°C (morning period). The rain pool is 20 cm depth, 50 cm width and 70 cm length. The temperature is 32°C on bottom and 1 m above the water surface (air temperature) is 34°C (afternoon period). Elevation from MSL is 100 m.

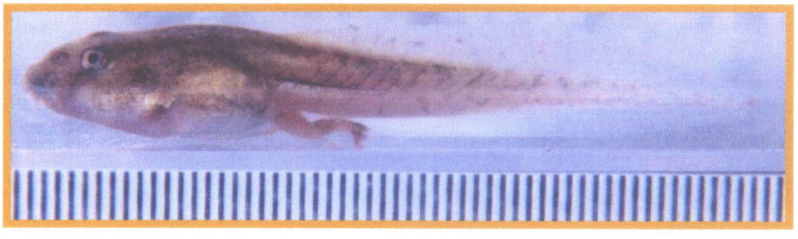
33.3 Behavior

They usually live on dead leaves, and do not move fast. They were found living with *Microhyla heymonsi* and *Ferjervarya limnocharis* and these tadpoles were

caught for food. *H. rugulosa* eats everything, plants or animals and even its own living larvae, and carcasses. They live separately, not grouping.

33.4 Place and Duration

Khlong Nakha WS. and Khao Luang NP. in Novemberber 2003.



A

A1

B C

Figure 57 *Hoplobatrachus rugulosa*
A: Body shape of tadpole (strage 40, no. of specimen PT033)
A1: Another form of tadpole
B: Mouthparts C: Adult

Genus *Occidozyga*

Only 2 species of *Occidozyga* have been found in this study which are *O. martensii* and *O. lima*. External morphology is different from other species especially the papillae on the oral disc. Their terminal mouths do not have papillae or labial teeth and the lower lip is horseshoe-shaped but it has large beaks. Moreover, their body shape and also fins are distinct from other species.

34. *Occidozyga lima* (Gravenhorst, 1829)

The metamorphosis of this larva is similar to adults from stage 45 onward, the web is complete and the body has small tubercles. Moreover, it can also jump very well at stage 45.

34.1 External Morphology

Head-body oval, flat above; body length 3 times width; eyes dorsolateral, not visible from below; interorbital distance twice internarial; mouth-snout subequals snout-eyes distance; spiracle sinistral midway up side, tubular, close to eye equal to root tail; tube median opening at root tails; tail log slender twice or more than head-body length; dorsal fin most convex in root tail and gradually tapering ventral fin and twice caudal muscle in length; tip pointed (Figure 58).

Oral disc terminal, small, tubular; no papillae and denticle; beaks black, marginal fine serration; lower lip consisting of a "U" shape, projecting, upper with gap; upper lip much smaller.

Head-body pale red-brownish, dorsal and lateral; tail same; ventral white or silver; eyes to snout tip with dark band; root tail to tip with a creamy-white lne; fins with dark speckles.

Total length 37 mm, (N=1).

34.2 Microhabitat

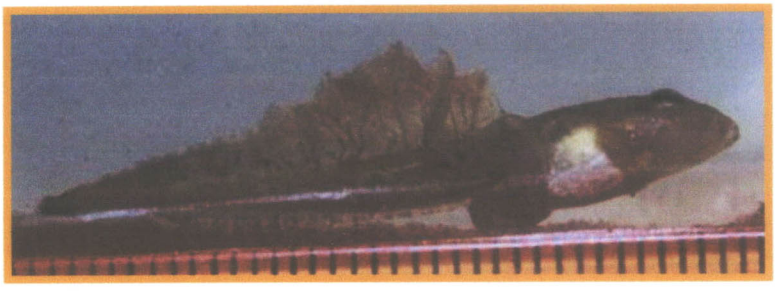
O. lima was found in ponds beside a mangosteen farm, where there are accumulated dead leaves on a silty bottom. The pond is 35 cm deep and 95 cm width. The temperature is 30°C on the bottom and 1 m above the water surface (air temperature) is 31°C (morning period). Elevation from MSL is 50 m.

34.3 Behavior

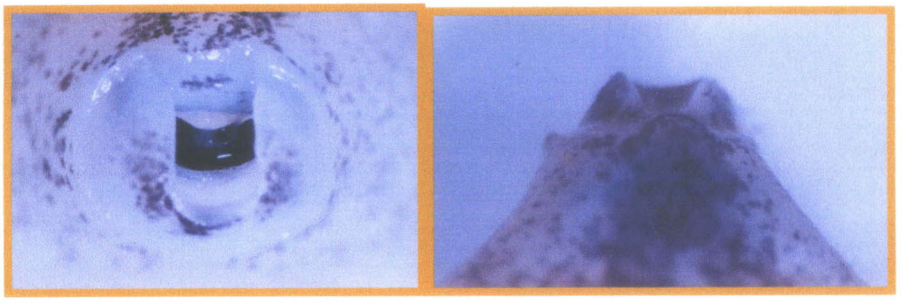
This larva was found living under accumulated dead leaves, it is very fast moving but is usually still on the bottom. In aquarium, it is active at nighttime, swimming forward and backward in the pond, sometimes rising to the surface. Its mouth moves like a piston to suck some organic matter in the water for food.

34.4 Place and Duration

Khao Luang NP. in April 2003.



A



B B1

C

Figure 58 *Occidozyga lima*
A: Body shape of tadpole (stage 40, no. of specimen PT034)
B: Mouthparts, front view B1: Mouthparts, top view
C: Adult

35. *Occidozyga martensii* (Peters, 1867)

The metamorphosis of tadpole is similar to adults in stage 45, full web in hind limb, back with small tubercles, fins reduced and head-body oval.

35.1 External Morphology

Head-body elongated oval, depressed, flat above; length 3 times width; eyes dorsolateral, not visible from below; internarial 2/3 of interorbital distance; mouth-snout subequals snout-eye distance; spiracle sinistral, tubular, close to eye equal to root tail vent short tube, median, opening at root tail; tail slender, twice or more than head-body length; dorsal fin equals ventral fin in depth; dorsal fin does not begin at root tail; caudal muscle gradually tapering; tip pointed (Figure 59).

Oral disc are similar to *O. lima*.

Head-body grayish, dorsal and lateral; ventral pale greyish, tail same; fins transparent; root tail to tip with dark in median eyes to snout tip and behind eyes is a dark band.

Total length 25 mm, (N=1).

35.2 Microhabitat

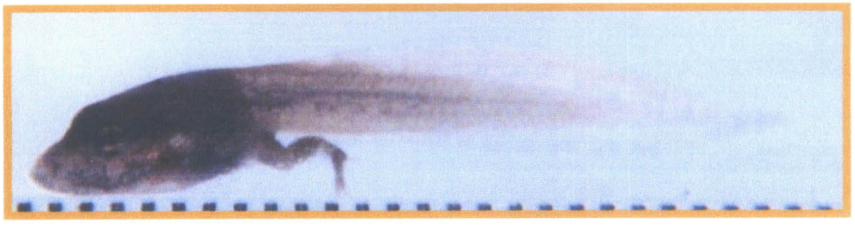
This larva was found in rail pools, where there are accumulated dead leaves on a silty bottom. At Khlong Nakha, the pool is 16 cm depth 80 cm width and 110 cm length. The temperature is 29°C on the bottom and 1 m above the water surface (air temperature) is 30°C (late morning period). At Hala-Bala, the pool is 160 x 90 x 14 cm (W x L x D). The temperature is 29°C on bottom and 1 m above the water surface (air temperature) is 30°C (late morning period). At Khao Luang, the pool is 80 x 140 x 20 cm. The temperature is 30°C on bottom and 1 m above the water surface (air temperature) is 32° C (late morning period). Elevation from MSL is 100 m.

35.3 Behavior

Behavior of these larvae is similar *O. lima*, they usually live on the bottom and move fast. Sometimes they rise to the surface and most activities are at nighttime.

35.4 Place and Duration

Khlong Nakha WS. and Khao Luang NP. in July 2003.



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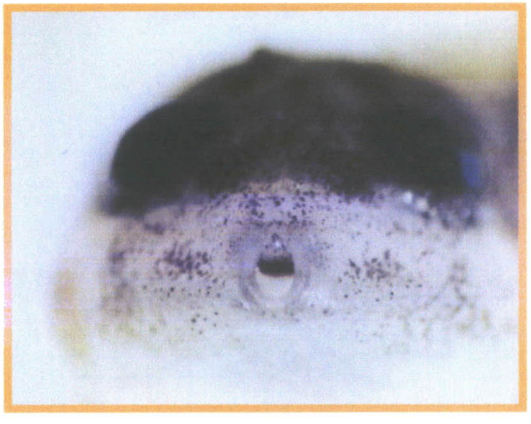


B

C

Figure 59 *Occidozyga maetensii*
A: Body shape of tadpole (stage 40, no. of speciment PT035)
B: Mouthparts C: Adult

Family Rhacopholidae

Thailand Rhacopholid larvae have been divided into 6 generas, which are *Rhacophorus, Polypedates, Chirixarus, Nyctixarus, Theloderma* and *Philautus*. 3 generas of Rhacopholid larvae were found in this study altogether, which are *Rhacophorus*, *Polypedates* and *Nyctixarus*. The external morphology of Rhacopholidae are as follows; Head-body oval, depressed, flat below; Labial tooth row formula (LTRF) many variations between 1/0 and 8/3, n/3 most common; oral disc terminal or anteroventral; vent tuba dextral, medial; spiracle sinistral; beaks U or V shaped; habitat lotic and lentic systems; total length 25-40 mm.

Key to Genus of Rhacophoridae

1. Eyes lateral; labial teeth with 4-5 rows in upper; marginal of lower lip with gap in medial.....*Polypedates*
   Eyes dorsal, labial teeth more than 5 rows in upper; marginal of lower lip without gap in medial.....2
2. Head-body flattened; eyes dorsal; papillae on lower lip with staggered, double row, slender.....*Nyctixarus*
   Head-body thicked; eyes dorsolateral; papillae on lower lip without staggered, double row, no slender.....*Rhacophorus*

Key to Species of Rhacophoridae

1. Upper teeth 4 rows; second row with gap; gap with 1/8 of each tooth length; snout to eye distance with a single white dot.....*Polypedates leucomystax*
   Upper teeth 5 rows or more.....2
2. Upper teeth 5rows.....3
   Upper teeth more than 5 rows.....4
3. Head-body flattened; upper lip with crowded papillae at lateral corner; third to fifth of upper teeth rows with gap.....*Nyctixarus pictus*
   Head-body thicked; root to median of tail muscle deeoer than median to tip; Second to third of upper teeth rows with gap.....*Polypedates macrotis*
4. Upper teeth 6 rows; median of upper fins less than twice of tail muscle in depth.....
  5
   Upper teeth 6-7 rows; median of upper fin 2/3 of tail muscle in depth.....
  6
5. Tail muscle plained brown; fins transparent; interorbital with dark mark (⬠)
   .....*Rhacophorus prominanus*
   All of tail in median to tip with dark dots; interorbital without mark.....
   .....*Rhacophorus bipunctatus*
6. Upper teeth 7 rows.....*Rhacophorus reinwardtii*
   Upper teeth 6 rows.....7
7. Tail long, twice of body; first to second lower teeth rows twice of second to third rows.....*Rhacophorus nigropalmatus*
   Tail long, less than twice of body; first to second lower teeth rows equal or sub equal Of second to third rows.....*Rhacophorus padalis*

Genus *Rhacophorus*

Rhacophorus and *Polypedates* are similar in general external morphology, but some features are different, such as eye position, *Rhacophorus* have doesalateral eyes but *Polypedates* have lateral eyes. Moreover, the coloration of *Rhacophorus* larvae varies more than *Polypedates*. External Morphology of *Rhacophorus* is as follows; oral disc anteroventral; Labial tooth row formula (LTRF) 4(2/3)/3(1), 5(2-5)/3(1); vent tube dextral; spiracle sinistral; total length 35-45 mm.

36. *Rhacophorus pardalis* Gunther, 1859"1858"

Association of this larva with adults is present in stage 42, having full webbed outer fingers and in stage 45 body color is changed, red-brownish, with pale cream color spots.

36.1 External Morphology.

Head-body oval; length twice width; eyes dorsolateral, not visible from below; internarial half of interorbital distance; mouth-snout distance half of snout-eye; spiracle sinistral closer to eye than to root tail; vent tube median; tail muscle heavy; dorsal fin equals ventral in depth, median convex and tapering gradually in tip; tip pointed (Figure 60).

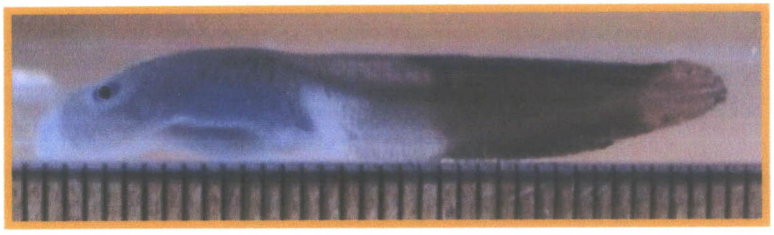
Oral disc anteroventral; papillae with single row on upper corners and corners lower lip with 2 rows; labial tooth row formula (LTRF) 6(2-6)/3(1); the third of upper teeth row with gap distance 2/3 of each tooth distance; beaks black, strong, margin serrated.

Head-body brownish, dorsal and lateral; white below; tail muscle pale brown; fins cloudy.

Total length 38 mm, (N=1).

36.2 Microhabitat

This larva was collected in rain pools in the forest, where there are accumulated dead leaves on a silty bottom. The pool is 40 cm width, 65 cm length and 17 cm. depth. The temperature on bottom (late morning period) is 28°C and 1 m above the water surface (air temperature) is 29°C. Elevation from mean sea level (MSL) is 500 m.



A

B

C

Figure 60 *Rhacophorus padalis*
A: Body shape of tadpole (stage 35, no. of specimen PT036)
B: Mouthparts C: Adult

36.3 Behavior

Larvae usually live on accumulated dead leaves on the bottom. They move rather slowly and sometimes rise to the water surface. In aquarium, they are normally still on the bottom in the daytime but most activities are at nighttime.

36.4 Place and Duration

Hala-Bala WS. in January 2003.

37. *Rhacophorus nigropalmatus* (Boulenger, 1875)

The metamorphosis of these larvae is similar to adults from stage 45 onward, the body color is pale green, and the webs on the hind limbs are grey. Around 1-2 weeks later, the dark small lines on the lateral body are present (like the net).

37.1 External Morphology.

Head-body oval, length is twice the width; eyes dorsolateral, not visible from below; interorbital distance twice the internarial; mouth-snout equals snout-eye distance; spiracle sinistral, tubular closer to eye than to root tail; vent tube dextral, opening at margin of ventral fin; tail weakly convex, tapering near end to narrow; dorsal fin equals ventral in depth; median of caudal muscle in depth with ⟪⟪ mark from root tail to tip; tip pointed (Figure 61)

Oral disc anteroventral; papillae small, homogeneous, in a double row narrowly interrupted or continuous across lower lip; corners of upper lip with confined, LTRF 6(2-6)/3(1); the irst of lower teeth row with gap in median, third teeth deep ½ of first row; beaks black, finely serrated.

Head-body pale greyish above, lighter below; tail cloudy with conspicuous grey spots on fins and dorsal muscle edge of dorsal and ventral fins with a dark line from root to tip.

Total length 42-45 mm, (N=3).

37.2 Microhabitat

Larvae were found in rain pools in forest, 56 cm width, 90 cm length and 22 cm depth. The temperature on bottom (morning period) is 28°C and 1 m above the water surface (air temperature) is 29°C. Elevation from MSL is 400 m. In the rain pools there are some accumulated dead leaves on a clay bottom but without rocks or gravel.

37.3 Behavior

In rain pools, tadpole are usually still, living on accumulated dead leaves on the bottom in the daytime but at nighttime they are active, swimming around the pool and scraping dead leaves for food and sometime rising to the surface. In aquarium, their behavior is similar to the field but new behavior was shown every time in aquarium, in which some of them over turn their body, ventral is at the surface and they suck food at the surface.

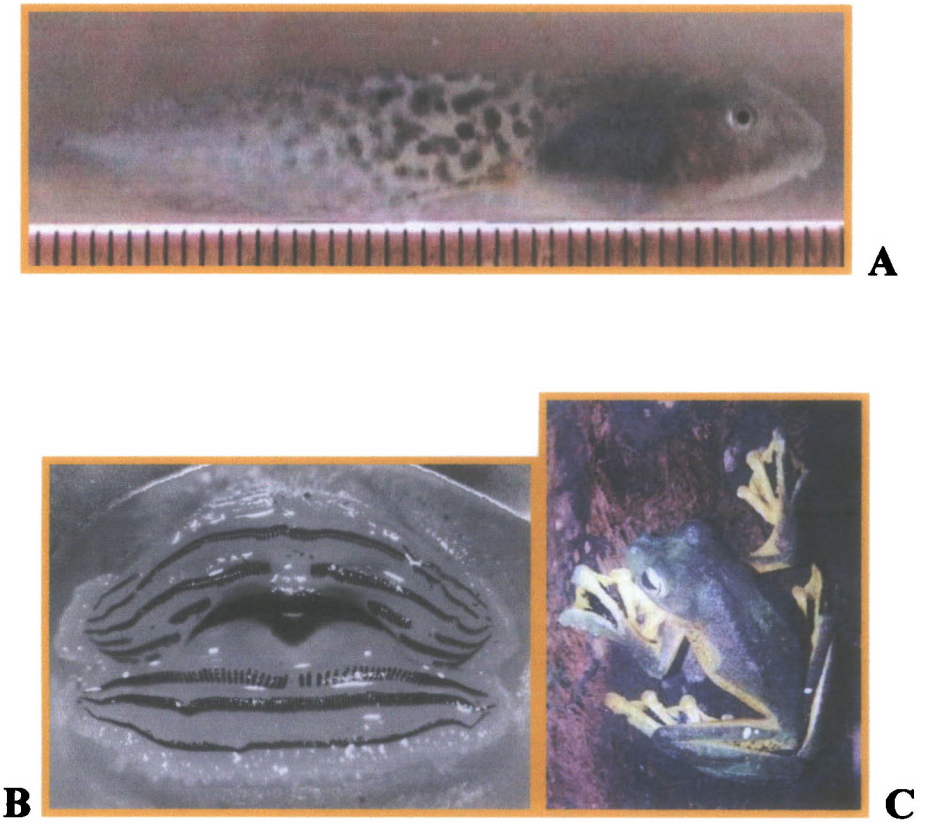


Figure 61 *Rhacopholus nigropalmatus*
A: Body shape of tadpole (stage 37, no. of specimen PT037)
B: Mouthparts C: Adult

37.4 Place and Duration

Hala-Bala WS. in January 2003.

38. *Rhacophorus reinwardtii* (Schlegel, 1837)

The tadpole is similar to adults in stage 46 onward, pale greenish on body, web without color. About 1-2 months after stage 46, a pale dark colour will be present on web.

38.1 External Morphology

Head-body oval, long twice the width; eyes dorsolateral, not visible from below; interorbital twice of internarial distance; mouth-snout half of snout eyes distance; spiracle sinistral, closer to eye than to root tail; vent tube dextral, opening at margin of ventral fin; fins slightly convex at the in tip, dorsal equals ventral in depth; tip rounded (Figure 62)

Oral disc anteroventral; papillae small, homogenous in a double row; dorsal lip without papillae, ventral completed; LTRF 7(2-7)/3(1); the first of lower teeth row with narrow gap in median, the third row half of first in depth; black beaks, finely serrated.

Head-body pale darkish above, lighter below; tail muscle pale greyish; fins cloudy, marginal with dark line; interorbital with dark mark ( )

Total length 38-40 mm, (N=2).

38.2 Microhabitat

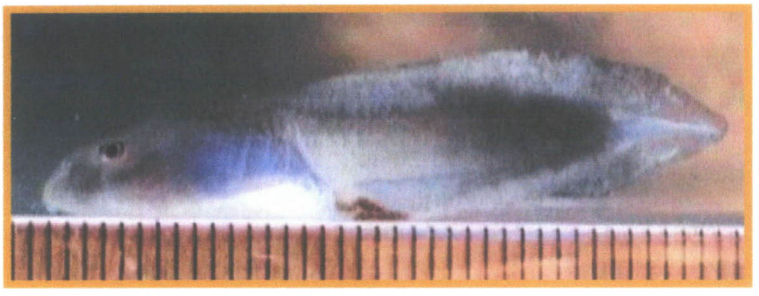
Larvae were collected in rain pools in the forest, where there are accumulated dead leaves and some branchs on a sand or silty bottom. The pool is 135 cm wide, 215 cm long and 37 cm deep. The temperature on the bottom (morning period).is 27°C and 1 m above the water surface (air temperature) is 28°C. Elevation from MSL is 200 m.

38.3 Behavior

Tadpole are usually still and live on dead leaves on the bottom, they sometimes rise to the surface and return to the bottom. In the pools, other tadpole were found living with these tadpole which are *Leptobrachium hendricksoni, Rana chaconata, Microhyla ornata* and *M. borneensis*. In aquarium, most swimming and feeding activities of the tadpole were at nighttime. They scape dead leaves or small aquatic plants on rocks or gravel for food. Their behavior is not similar to *Rhacophorus nigropalmatus*, which overturns its body. The tadpole moves rather slowly in both daytime and nighttime.

38.4 Place and Duration

Hala-Bala WS. in January 2003.



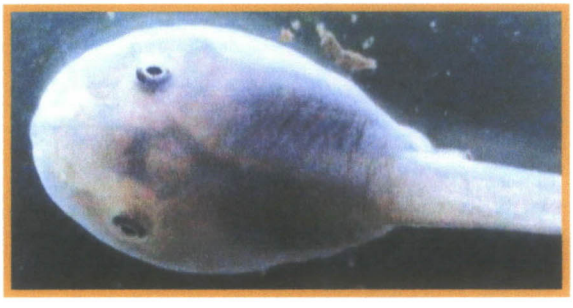


Figure 62 *Rhacophorus reinwardtii*
A: Body shape of tadpole (stage 37, no. of specimen PT038)
A1: Top view B: Mouthparts C: Adult

39. *Rhacophorus prominanus* (Smith, 1924)

The metamorphosis of these tadpoles occurs in stage 47 onrward, when some characteristics are like adults. 2-3 months after the stage, their webs on toes would be obvious, pale orange and a pale dark dot occurs on the body.

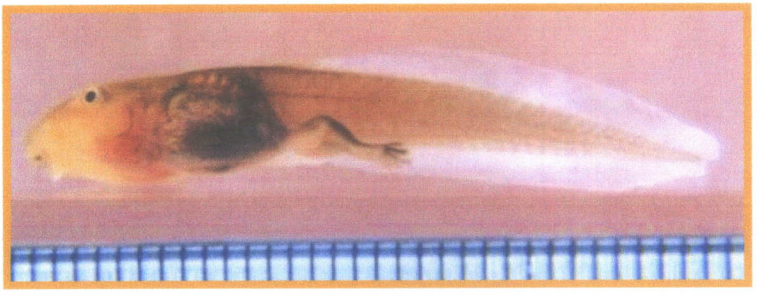
39.1 External Morphology

Head-body oval, length twice the width; eyes dorsolaterial; internarial 2/3 of interorbital distance; mouth-snout distance 2/3 of snout-eye distance; spiracle sinistral, tubular; vent tube dextral opening at margin of ventral fin; dorsal fin equals ventral but 2/3 of caudal muscle in depth; tip pointed (Figure 63)

Oral disc anteroventral; papillae small, homogenous, in a double row on the lower lip, upper of corners with irregular staggering; LTRF 5(2-5)/3, 6(2-6)/3; black beaks, finely serrated.

Head-body yellow-brownish above, pale yellowish below, caudal muscle same; fines cloudy; interorbital with a dark mark (⬠).

Total length 30-32 mm, (N=10).



A

A1

B C

Figure 63 *Rhacophorus prominanus*
A: Body shape of tadpole (stage 40, no. of speciment PT039)
A1: Top view B: Mouthparts C: Adult

39.2 Microhabitat

These tadpoles were found in potholes on rock banks. Where there are dead leaves on sand bottom. The dimensions of the potholes are 78 x 146 x 16 cm (wide x long x deep). The temperature on the bottom (afternoon period) is 29°C and 1 m above the water surface (air temperature) is 30°C. Elevation from MSL is 100 m.

In the potholes, other tadpole were found which are *Microhyla borneensis, M. heymonsi* and *Ferjervarya limnocharis.*

39.3 Behavior

The tadpoles are usually still and live on the bottom in the daytime but they are active, swimming around the pothole, scraping dead leaves in the daytime. In aquarium, their behavior is similar to the field.

39.4 Place and Duration

Hala-Bala WS. in January, March, May and November 2003.

40. *Rhacophosus bipunctatus* (Ahl, 1927)

The metamorphosis is similar to adults in stage 42, a long pointed dermal appendage at heel and about 3-4 weeks after stage 47, digits and web yellowish, while the body has pale dark dots and with spots under the armpits.

40.1 External Morphology

Head-body oval, length twice the width; eyes dorsolateral; interorbital twice internarial distance; spiracle sinistral, tubular, closer to eye than root tail; anus opening at margin of ventral fin; dorsal equal to ventral fin, but 2/3 of caudal muscle in depth; dorsal fin slightly convex in median; tip pointed (Figure 64).

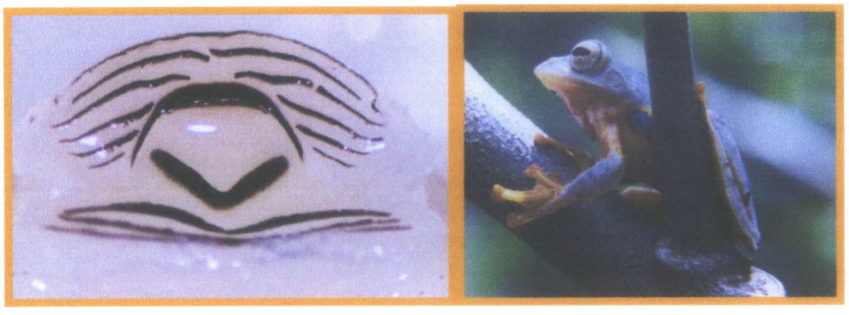
Oral disc anteroventral; papillae with single row on corners, corners of upper lip and lower lip; LTRF 6(2-6)/3(1); beaks black, inner marginal finely serrated. In the field, above head-body dark-brownish, lighter below; tail muscle pale dark-brownish; fins transparent, 2/3 of tail length in tip with all dark spots and marks on fins and tail muscle. In aquarium, above head-tail is pale light brown, but all dark spots and marks are not different.

Total length 35-37 mm, (N=3).

40.2 Microhabitat

These tadpoles were collected in rain pools in a forest, where there are accumulated dead leaves and some branches on a silty bottom. The dimension of the pool is 87 x 163 x 19 cm. The temperature on the bottom (late morning period) is 27°C and 1 m above the water surface (air temperature) is 28°C. Elevation from MSL is 400 m. Other tadpoles which were found living in the pool are *Microhyla heymonsi, Rana nigrovittata* and *Polypedates leucomystax.*

A



B C

Figure 64 *Rhacophorus bipunctatus*
A: Body shape of tadpole (stage 37, no. of specimen PT040)
B: Mouthparts C: Adult (Right)

40.3 Behavior

Tadpoles are usually still or move slightly on dead leaves on the bottom. Sometimes they move under the dead leaves in the daytime. Nighttime, they actively move in the water, swimming to rise to the surface and down to the bottom and feeding by scraping the dead leaves or the branches on the bottom. In aquarium, in the daytime they are also still on the bottom, but at nighttime they are active as in the field.

40.4 Place and Duration

Khlong Nakha WS. in September 2003.

Genus *Polypedates*

Tadpoles in this genus have been found more than *Rhacophorus*. They have been revealed in ponds or rain pools, but some species of them have been found in potholes on rock banks, such as *Polypedates macrotis*, External morphology of *Polypedates* is as follows: Oral disc anteroventral; LTRF 4(2-4)/3(1), rarely 5(2-5)/3(1); without papillae on upper lip and median of lower lip; ventube dextral; spiracle sinistral; total length 25-45 cm.

41. *Polypedates leucomystax* (Gravenhorst, 1829)

This species' metamorphosis is rather fast. Association of these larvae and their adults is revealed at stage 42 onward, bodies yellowish or grayish.

41.1 External morphology

Head-body oval, length twice the width; eyes lateral and visible from below; interorbital 3 times that of internarial; mouth-snout ¼ of snout-eye distance; spiracle sinistral, not tubular, opening in center of body, closer to eye than to root tail; vent tube dextral, opening at mid-depth of ventral fin; dorsal equal ventral fin in depth; dorsal and ventral fin slightly convex in median; tip pointed (Figure 65).

Oral disc anteroventral; papillae with single row on corners and corners of two rows on upper lip, median of lower lip with gap; LTRF 4(2-4)/3(1); the first to second of lower teeth rows longer than second to third row distance; beak strong, finely serrated, entirely black.

Head-body have been found to be several colors, grey or pale grey and rarely yellowish above and lateral, whitish below; tail muscle same head-body; fins cloudy or transparent, with conspicuous grey or black spots on fin and tail muscle or whiter spots on fins; interorbital with white dots.

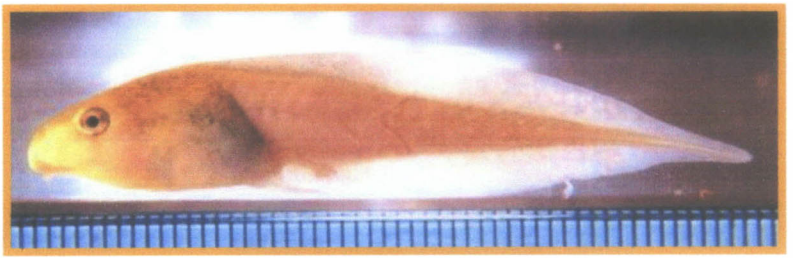
Total length 40-55 mm, (N=6).

41.2 Microhabitat

Larvae had been found in rain pools and the drainage ditches beside roads; where there are some accumulated dead leaves on a silty bottom. The dimensions of rain pools are about 50-140 x 100-250 x 15-30 cm. The temperature on the bed (afternoon period) is about 29-31°C and 1 m above the water surface (air temperature) is 30-32°C. Elevation from MSL is about 50-200 m in rain pools and 300 m in the drainage ditches.

41.3 Behavior

Larvae usually live on accumulated dead leaves on a silty bottom. They sometimes rise to the surface and return to the bottom, where they scrape accumulated dead leaves for food but they also had been found eating some larvae for food such as *Microhyla heymonsi* and even of their own larvae. Most larvae are rather still on the bottom in the daytime but at nighttime, they are active and there are many activities, feeding and swimming and they often rise to the surface and return to the bottom.



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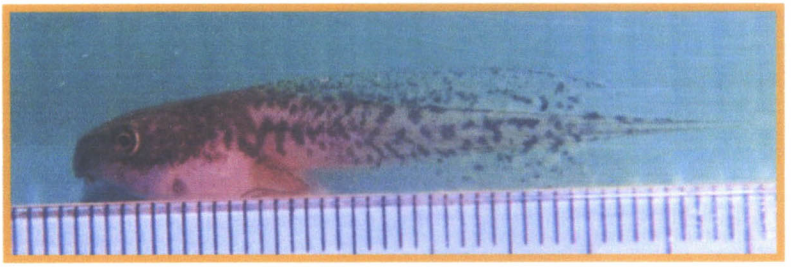

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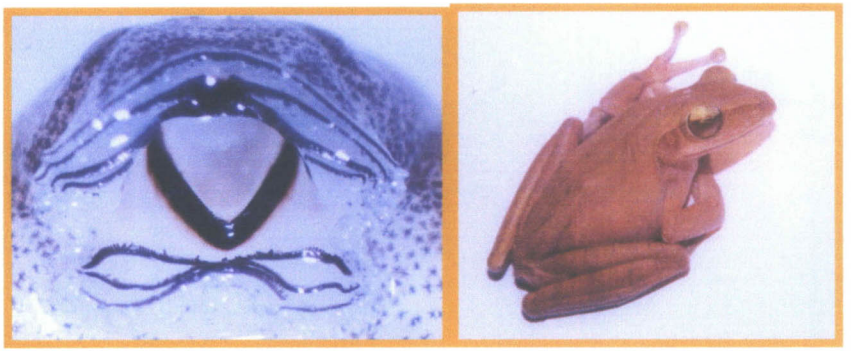


B C

Figure 65 *Polypedates leucomystax*
A: Body shape of tadpole (stage 37, no. of specimen PT041)
A1: Another form B: Mouthparts C: Adult

41.4 Place and Duration

Khao Luang NP., Khlong Nakha and Hala-Bala WS. at all periods of data collection.

42. *Polypedats macrotis* (Boulenger, 1891)

Association of these larvae with adults is revealed from stage 44-45, there are rudiments of web between the 2 inner fingers and webbing between the toes, stage 45 forward (2-3 weeks) a broad pale dark stripe was seen from the eyes to beyond the axilla, covering tympanum.

42.1 External Morphology

Head-body oval flattened above except at the root of the tail, rounded below, width 2-3 times that of the length; eyes lateral visible from below; internarial half or interorbital distance; mouth-snout equals snout-eye length; spiracle sinistral, low on side, tube fused to body wall, closer to eye than root tail; anal tube dextral; tail with margins convex; tapering gradually in distal third to narrow tip; origin of dorsal fin over end of body, deeper than ventral fin only in distal half; both fins are deeper than tail muscle at center except at base; about 2/3 of caudal muscle length with thickened areas proximately near muscle; tip pointed (Figure 66).

Oral disc anteroventral; short, thick papillae with single row on corner and two rows on lower lip; lower lip with gap in median; LTRF usually 5(2-5)/3(1), rarely 6(2-6)/3(1), second to third rows half of first to second of lower teeth rows distance; beak finely serrated, upper with convex weak median .

Head-body and root tail to near the median of caudal muscle is dark; slightly pale darkish below; rest of caudal muscle is pale dark; both fins transparent; interorbital without the small white dot.

Total length 35-40 mm, (N=5).

42.2 Buccal Cavity

Buccal floor: Prelingual area of floor smooth; tongue oval, entire with pustules; buccal floor arena smooth; lateral papillae of buccal floor arena with about 5-6 pustules and 2 branches palps on each side; ventral velum with about 23-25 pustules on medial and 8-10 branches palps on each side (Figure 67).

Buccal roof: Prenarial area of roof smooth; nares transverse, oval, width 2/3 of length, anterior narial wall thick, raised, pustulose a medially curved, postulose papillae rising from middle of the anterior wall; posterior wall taller, thin, smooth, a rounded valuular expansion in medial corner. Posterior area has a branch pulp on each side. Lateral ridge papillae with a branch pulp on each side, marginal serrated. Median ridge with 2 rows as long as internarial; anterior with flap on medial, margin with 5 pustules; posterior wall, taller than anterior margin with about 20-22 putules. Buccal roof arena are about 90-100 pustules. Lateral papillae of buccal roof arena with about 8-10 branches pulps, inner long, outer short. Dorsal velum is more than 200 pustules, lower fine pustule, upper bigger (Figure 68).

42.3 Microhabitat

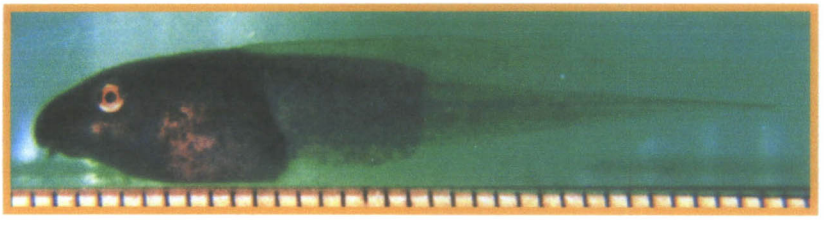
These larvae had been found in potholes on rock banks, where there are some accumulated dead leaves on a sand or silty bottom. The dimension of the pothole is 80 x 120 x 20 cm. The temperature (afternoon period) is 29°C on the bed and 1 m above the water surface (air temperature) is 30°C. Elevation from MSL is 300 m.

42.4 Behavior

Most larvae are usually still on accumulated dead leaves on the bottom. They rise to the water surface less than *P. leucomystax* and most activities are at nighttime. In aquarium, their behavior was not like *P. leucomystax*, which is a predator. They did not catch other larvae or their own larvae for food, even when they were without food for 3-5 days.

42.5 Place and Duration

Hala-Bala WS. in Januaray and June 2003.



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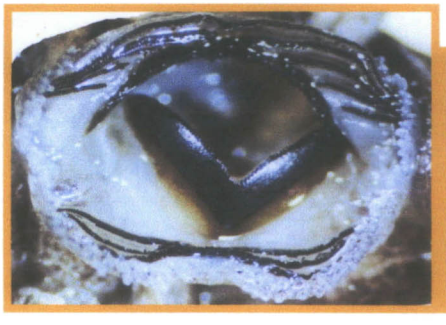


B

C

Figure 66. *Polypedates macrotis*
A: Body shape of tadpole (strage 34, no. of specimen PT042)
B: Mouthparts C: Adult

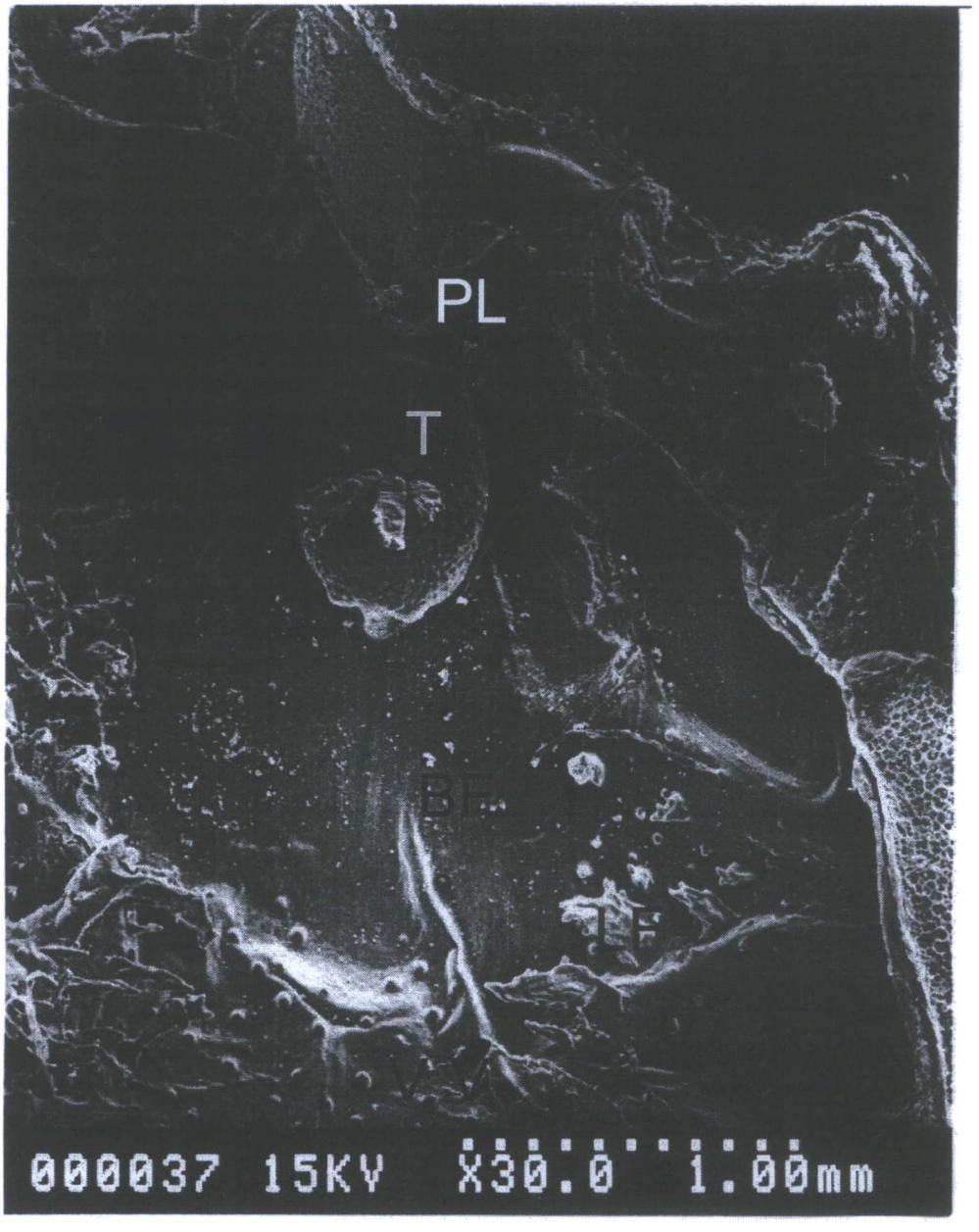


Figure 67. Buccal floor arena
PL-prelingual area; T-tongue; BF-buccal floor arena;
LF-lateral papillae of buccal floor arena; VV-ventral velum.

Figure 68. Buccal roof arena
PN-prenarial arena; N-nares; AN-anterior wall; LP-lateral ridge papillae; BR-buccal roof arena; LR-lateral papillae; DV-dorsal velum.

Genus *Nyctixalus*

A single species of this genus has been encountered and only one specimen that is *N. pictus*. Its external morphology is distinct from other species in Rhacophoridae such as body color, shape and microhabitat. External morphology of *N. pictus* is as follows: oral disc anteroventral; LTRF 5(3-5)/3; ventube median; spiracle sinistral; total length 40 mm.

43. *Nyctixalus pictus* (Peters, 1871)

Only one specimen in this tadpole was found in stage 40, its mouthparts had started reducing. External morphology is similar to adults such as white-bands on legs, toes and tip of toes; dorsal body with pale white ellipsoids and dots; web and metatarsal tubercle are present.

43.1 External Morphology

Head-body oval, flattened above, width about 3 times length; eyes dorsal not visible from below; interorbital twice the internarial distance; mouth-snout distance equals snout-eyes; spiracle sinistral, low on side, tube attached to body wall, closer to eye than root tail; anal tube median; tail weakly convex, tapering gradually to broadly rounded tip; caudal muscle deeper than both fins in proximal two-thirds; origins of fins at end of body; dorsal fin deeper than ventral in proximal half; tip rounded (Figure 69).

Oral disc anteroventral; single row short papillae on corners, double on corners of upper lip, lower lip with staggered double rows; LTRF 5(3-5)/3; beak black, upper with weak median convexity.

Head-body and tail red-brownish, ventral light translucent; dorsal and ventral fins lighter than caudal muscle; marginal fins white; behind of eyes with white ellipsoid marks.

Total length 40 mm, (N=1).

43.2 Microhabitat

This tadpole was found living in a buttress tank, where there are some accumulated dead leaves on a silty bottom. The temperature at the bed (afternoon period) is 30°C and 1 m above the water surface (air temperature) is 31°C. Elevation from MSL is 200 m.

43.3 Behavior

Tadpoles are still on dead leaves on a silty bottom. In aquarium, most activities of this tadpole were at nighttime, swimming and scraping some dead leaves

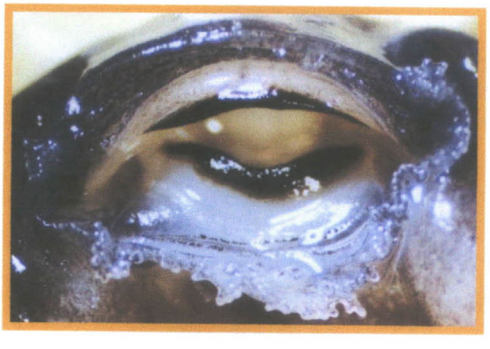
or rock on the bed for food. In the daytime, it lives under rocks on the bed, rarely moving.

43.4 Place and Duration

Hala-Bala Ws. in January 2003.

A

A1



B

Figure 69. *Nyctixalus pictus*
A: Body shape of tadpole (stage 40, no. of specimen PT043)
A1: Top view B: Mouthparts of tadpole

Family Microhylidae

In Thailand's fauna there are seven generas of microhylid adults and in this study three generas of tadpole have been found, those of *Microhyla, Kaloula* and *Chaperina*. Larvae of *Chaperina* and some *Microhyla,* which is *M. inornata* are similar in external morphology such as body shape, mouth position and even behavior. Two of the other *Microhyla* that are *M. heymonsi* and *M. borneensis*, are rather similar in external morphology, body shape and body colors.

External morphology of Microhylidae is as follows: Oral disc terminal, dorsoterminal; labial tooth row formula (LTRF): 0/0; OA: kelatinized structures absent, umbelliform in Microhyla; vent median, dextral; spiracle midventral on chest, abdomen or near vent.

Key to Genera of Microhylidae

1. Head-body blackish; spiracle opening at end of body, tubular.....*Kaloula*
   Head-body transparent.....2
2. Fins cloudy; end of tail blunt.....*Chaperina*
   Fin transparent; spiracle covered by flap; end of tail projecting, pointed..*Microhyla*

Key to species of Microhylidae

1. Lips expanded.....2
   Lips not expanded.....3
2. Lower lip slightly expanded; tail with dark band in dorsal to ventral fin.....
   .....*Microhyla borneensis*
   Lower lip broadly expanded; tail plain.....*Microhyla heymonsi*
3. Head-body and tailgrayish-black.....4
   Head-body transparent.....5
4. Tail muscle and lateral body with ivory-white bands from eyes to end of body.....
   .....*Microhyla inornata*
   Tail and lateral body plain.....*Kaloula pulchra*
5. Tail cloudy; fins transparent.....6
   Tail orange-red; interorbital with black Y shaped.....*Miceohyla butleri*
6. Interorbital with mark.....7
   Interorbital plained; head-body half-circle shaped.....*Microhyla berdmorri*
7. Interorbital with dark mark (< >); fins cloudy, dorsal equals ventral in depth
   .....*Chaperina fusca*
   Interorbital with dark mark (I I); fins transparent, dorsal half of ventral in depth....
   .....*Microhyla ornata*

Genus *Microhyla*

Most microhylids tadpole has been revealed in these generas. They have been found in both Lentic and Lotic, that are rain pools, side pools, potholes on rock banks and pools of intermittent stream. They commonly live at thw water surface, where they suck organic matter at the surface for food. Their external morphologies are as follows: labial tooth row formula (LTRF) 0/0; oral disc small to large semicircular oral flaps with smooth edges pendant over terminal mouth, umbelliform has oral disc with radially arranged submarginal papillae; vent tube median; spiracle midventral on belly or near vent; body color dark.

44. *Microhyla ornata* (Dumeril and Bibron, 1841)

Association with adult is based on a developmental series extending from stages 42 onward, back with grey sand glass symble, subarticular tubercle completed.

44.1 External Morphology

Head-body oval, flattened above, rounded below, length twice the width; eyes lateral, visible from below; interorbital distance 7 times that of internarial; mouth-snout equals snout-eye distance; spiracle median ventral margin concave; anal tube median in ventral fin; dorsal fins weakly convex, ventral strongly convex; tail muscle deeper than dorsal fins in median arising at the end of the body; tip tapering (Figure 70).

Oral disc terminal; lips not expanded; lower lip protruded; both lips without papillae, beak and denticle.

Head body transparent; snout with dark spots; back with black symbol (⟨ ⟩); tail muscle cloudy, upper and lower marginal with dark filament; both fins transparent.

Total length 25-27 mm, (N=3).

44.2 Buccal carvity

Prenarial area of roof has 4 pustules. Nares rounded, anterior and posterior thick, tall. Buccal roof arena with puddle and smooth (Figure 71).

44.3 Microhabitat

These tadpoles have been found in rain pools, where there are some accumulated dead leaves and some branches on a silty bottom. The dimensions are 47 x 92 x 17 cm (wide x long x deep). The temperature (afternoon period) is 32°C, depth 2 cm from water surface and 1 m above the water surface (air temperature) is 32°C. Elevations from Mean Sea Level (MSL) are 50-200 m.

44.4 Behavior

Larvae of *Microhyla ornata* were found living with other larvae, which are *Polypedates leusomystax* and *Fejervarya limnocharis*. *M. ornate* are still at the water surface, and they suck organic matter for food, but when they are disturbed that they will swim to hide under stones or dead leaves on the bed. Furthermore, they were gnawed and eaten for food by *P. leucomystax* and *F. limnocharis*. Their activities were at day and night, still floating, swimming and feeding.

44.5 Place and Duration

Khao Luang NP., Khlong Nakha and Hala-Bala Ws. in January 2003 and 2004.

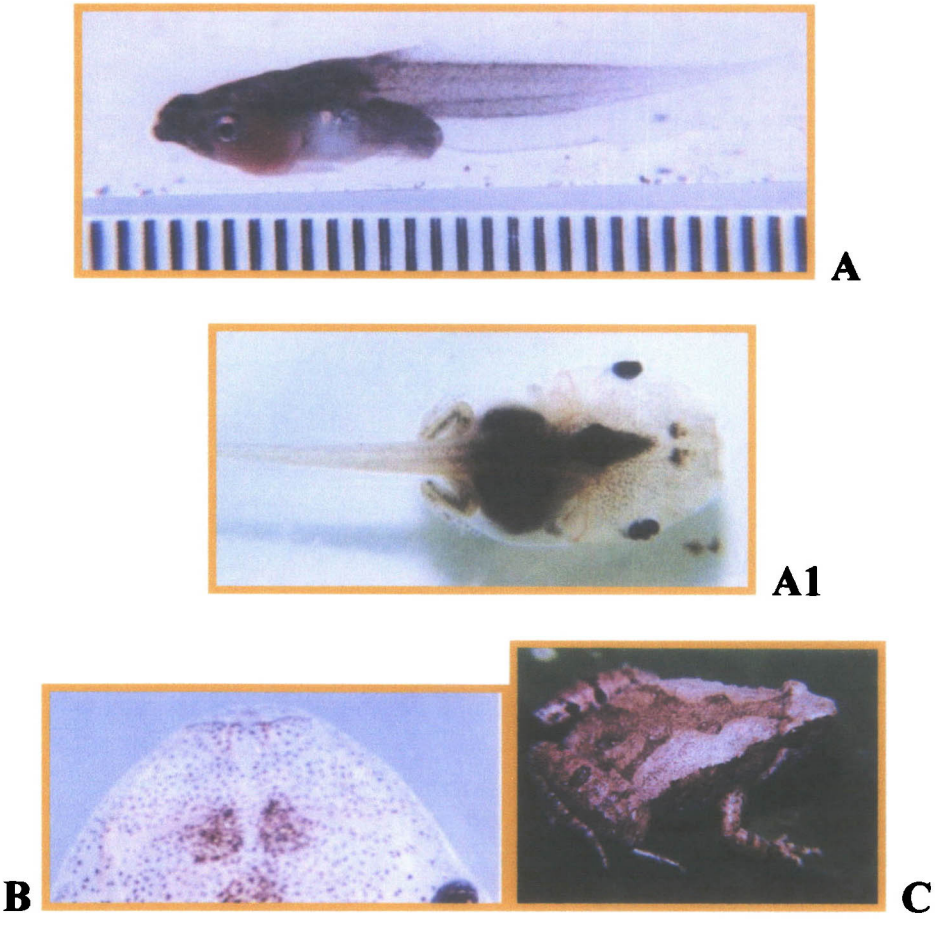


Figure 70 *Microhyla ornate*
A: Body shape of tadpole (stage40, no. of specimen PT044)
A1: Top view B: Mouthparts C: Adult

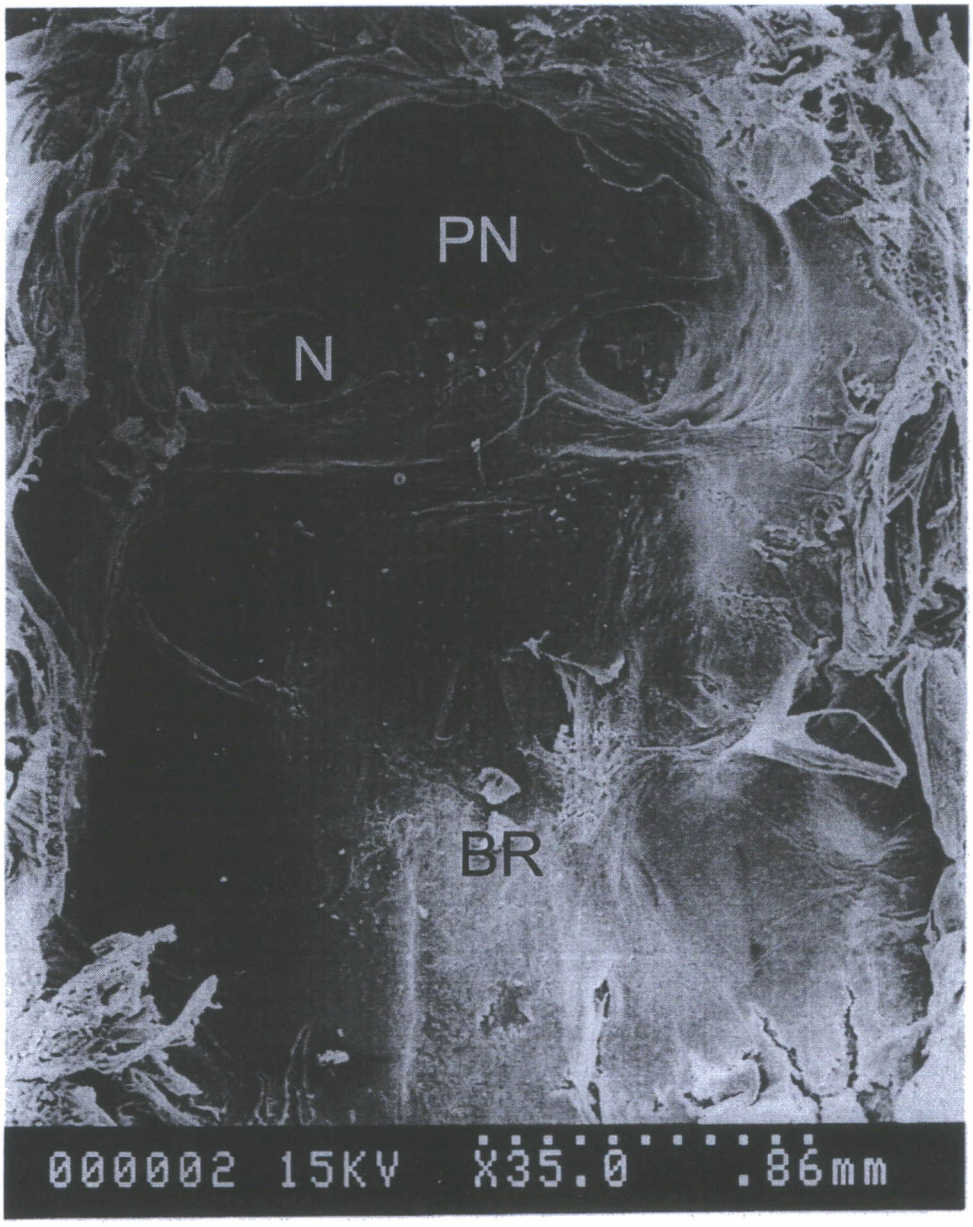


Figure 71 Buccal roof arena
PN-prenarial arena; N-nares; BR-buccal roof arena.

45. *Microhyla borneensis* (Parker, 1928)

Association of this tadpole with adult is based on a developmental series in a stage 41 larva. At this stage, the tadpole has full hind limbs, web and subarticular tubecles, lateral with darkness and tip of head to vent with whitish filament on the middle of the back.

45.1 External Morphology

Head-body oval, flattened above, width half of length; eyes lateral, visible from below; interorbital 3 times the internarial distance; mouth-snout equals snout-eye distance; spiracle midventral ventral margin forming rounded flap, closer to eye than end of body; vent median in ventral fin; tail with straight margins, deepest just behind anal tube, tapering gradually to attenuated tip; dorsal fin less than ventral fin in depth; ventral fin deeper than caudal muscle in median; tip tapering (Figure72).

Oral disc terminal, lower lip only slightly expanded, turned inward, supporting U-shape; upper lip a down-turned flap with median notch; lateral corners of lip with knob-like; oral papillae, labial teeth rows and jaw sheaths absent.

Head-body reddish-brown above; lateral with dark band running from mouth to root tail, through the eyes; head speckled with orange-gold iridocytes; lateral corners of lips reddish-brown; interorbital with light band; caudal muscle densely pigmented; dorsal fins faintly dark ventral very faintly; margin of tail muscle with dark line, ventral dark band.

Total length 17-19 mm, (N=6).

45.2 Microhabitat

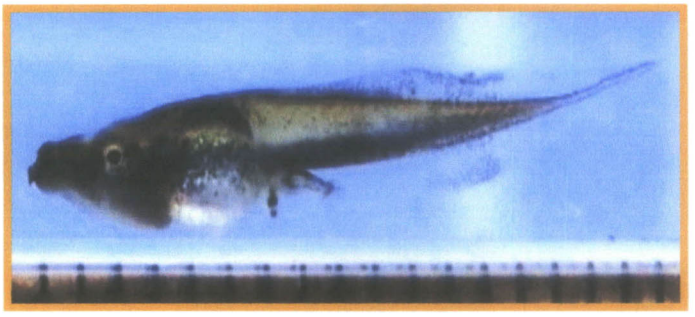
These tadpoles have been found in potholes on rock bands, where there is sand on the bottom. The dimension of the pothole is 65 x 145 x 15 cm. The average temperature (late morning period) is 29°C at 2 cm depth from the water surface and 1 m above the water surface (air temperature) is 30°C. Elevation from MSL is 200 m.

45.3 Behavior

Tadpoles commonly live at the water surface, where they are still and drift with their lower lip moving, in and out to push water into the mouth; while the mouth sucks organic matter in the water will be carried into the mouth in a greater quantity than by only sucking. However, when they are disturbed, they move to the bottom.

45.4 Place and Duration

Hala-Bala WS. in January, April and September 2003.



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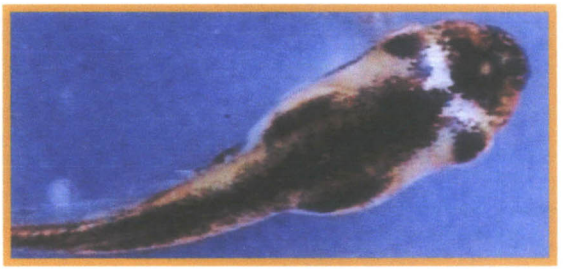

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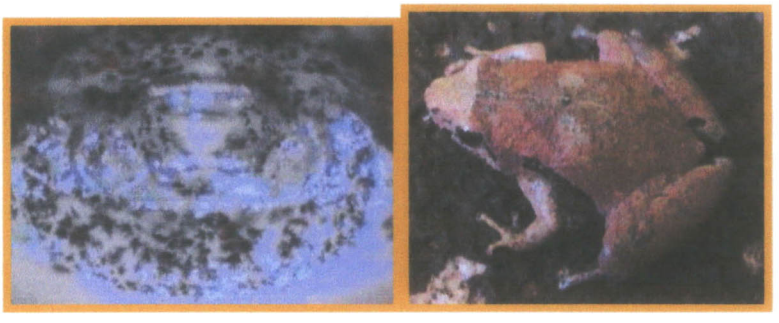


B C

Figure 72. *Microhyla borneensis*
A: Body shape of tadpole (stage 37, no. of specimen PT045)
A1: Top view
B: Mouthparts C: Adult

46. *Microhyla heymonsi* (Vogt, 1911)

These tadpoles are similar to *M. borneensis*, but there are many distinct differences such as body size, color and even distribution. *M. heymonsi* can be found around Thailand but *M. borneensis* is only found in the south for. Association with adult is based on a developmental series extending from stage 42 onward, subarticular tubeocle and web complete.At stage 45 lateral bodies are dark.

46.1 External Morphology

Head-body oval, flattened above, width half of length; eyes lateral, visible from below; interorbital 3 times internarial distance; mouth-snout distance equal to snout-eye; spiracle midventral; vent tube median margin of ventral fin, short tubular; marginal fins tapering gradually at posterior third, to a fine point; lower fin

slightly deeper than upper fin; anterior half of caudal muscle deeper than lower fin; tip tapering (Figure 73).

Oral disc terminal; lower lip expanded, broad funnel surrounding the mouth; upper lip with horse-shoe shapes; both sides of the mouth within the oral disc with knob-like protuberance; papillae, labial tooth rows and jaw sheaths absent.

Head-body and tail muscle pale buff or pale dark; ventral transparent, visible gut; interorbital with two silver marks dorsal marginal of caudal muscle with dark line, ventral with dark bands; both fins transparent.

Total length 13-15 mm, (N=5).

46.2 Microhabitat

This tadpole have been found in potholes on rock banks, pools of intermittent stream, ponds and rain pools where there are some accumulated dead leaves or some sticks on silty or sandy bottom. The dimensions are 40-85 x 50-280 x 10-20 cm. The average temperature (afternoon period) is 31°C at 2 cm depth from the water surface and 1 m above the water surface (air temperature) is 32°C. Elevations from MSL are 50, 100 and 200 m.

46.3 Behavior

Their behavior is similar to *M. borneensis* but they live together, more than *M. borneensis* groups, 5-20 individuals or more.

46.4 Place and Duration

Khlong Nakha, Hala-Baka WS. and Khao Luang NP. at all of data collection.

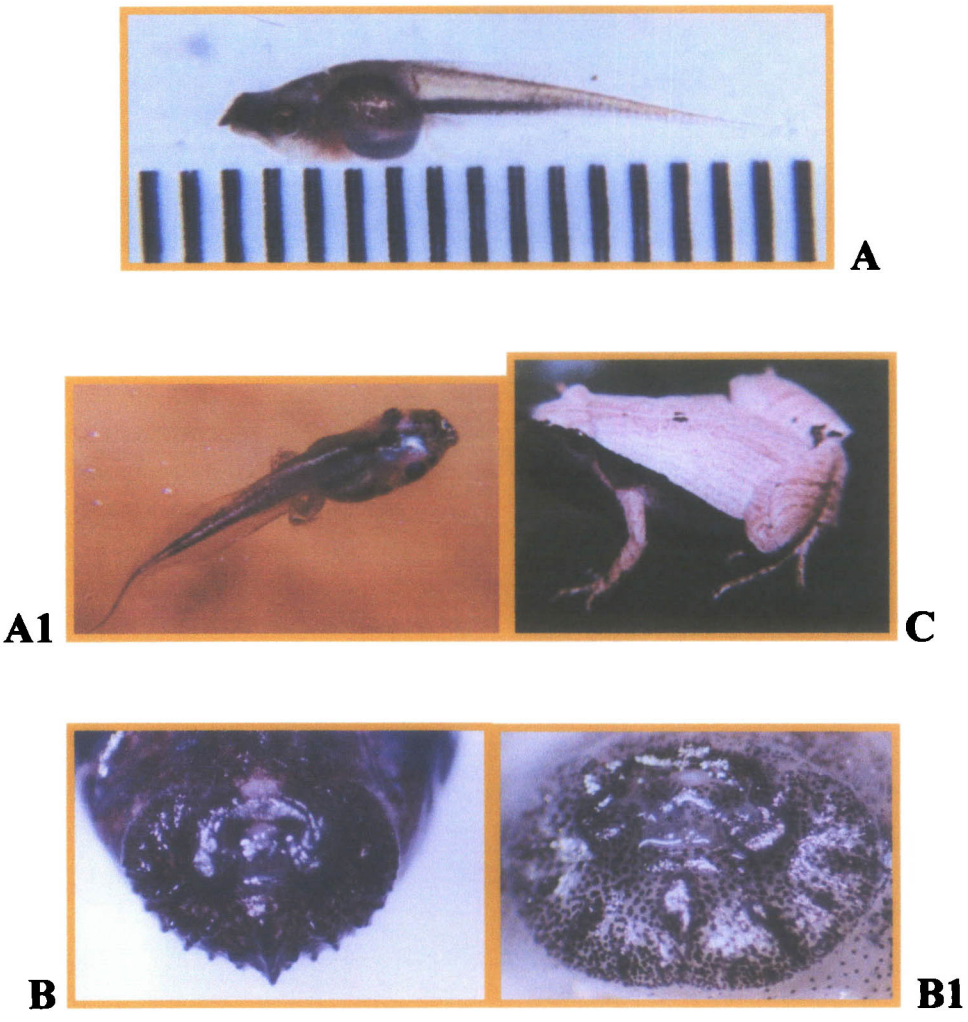


Figure 73. *Microhyla heymonsi*
A: Body shape of tadpole (stage 33, no. of specimen PT046)
A1: Top view B, B1: Mouthparts C: Adult

47. *Microhyla berdmorei* (Blyth, 1856 "1855")

Association of this tadpole with adult is based on a developmental series in a stage 41 larva. At this stage, tadpoles have completesubarticular tubercle in hind limbs. Stage 45 has full web development and dark stripes on hind limbs.

47.1 External Morphology

M. berdmorei are distinct from other species, especially the body shape, head-body semicircular-like, end of midbody circular, interorbital 5 times internarial distance; mouth-snout equal to snout bilobed flap wider than long; anal tube running vertically to edge of ventral fin; tail weak; ventral fin deeper than dorsal but less than twice as deep; both fins deeper than caudal muscle beyond proximal fourth; tip tapering (Figure 74).

Oral disc terminal, width half of interorbital distance; without papillae, jaw sheaths and labial tooth rows.

Head-body and caudal muscle pale grayish, end of body dark grey or black; back with dark line in median, interorbital to root tail; both fins transparent.

Total length 20-23 mm, (N=2).

47.2 Microhabitat

Larvae had been found in potholes on rock banks where there are some accumulated dead leaves on silt bottom. The dimensions are 46 x 82 x 27 cm. The temperature (afternoon period) is 30°C at 5 cm depth from the water surface and 1 m above the water surface (air temperature) is 31°C. Elevation from MSL is 100 m.

47.3 Behavior

These tadpoles live at the water surface to midwater, where they swim to suck some organic matter for food. When they were disturbed, they dived to the bottom. They usually gape, while they were moving at the water surface and so increase the organic matter that goes into the mouth.

47.4 Place and Duration

Khao Luang in January 2003.

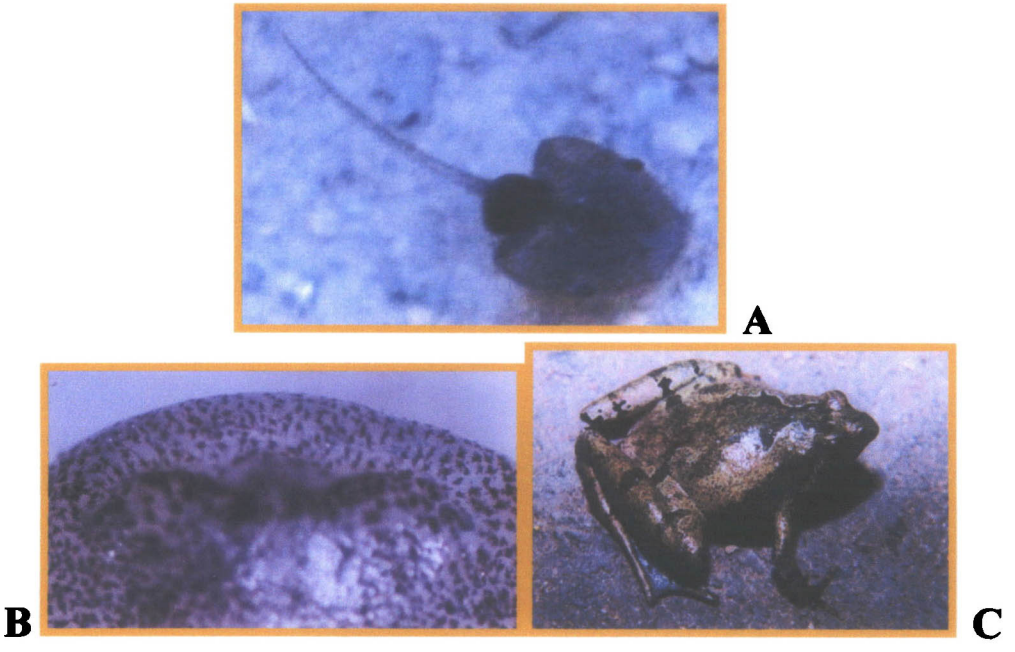


Figure 74 *Microhyla berdmorei*
A: Body shape of tadpole (stage 32, no. of specimen PT047)
B: Mouthparts C: Adult

48. *Microhyla butleri* (Boulenger, 1900)

Association of this tadpole with adult is based on a developmental series in stage 42 onwards, subarticular tubercle completed. Stage 44 with iridescent wavy bands over a dark brown dorsum and the lips with a crossbar is noticeable.

48.1 External Morphology

Head-body oval, widlh ¾ of length; eyes lateral visible from below; interorbital distance 3 times that of internarial; mouth-snout distance equal to snout-eye; spiracle median, opening under a transparent sheath, anterior of anus; vent tube median, tubular, opening at margin of ventral fin; ventral fin deeper than dorsal and caudal muscle; tail tapering gradually at posterior; tip tapering (Figure 75).

Oral disc terminal without labial teeth row, jaw sheaths and papillae; lower lip equal upper in width.

Head-body transparent, visible gut from below; interorbital to root tail with "Y" dark symbol; root tail with dark bands; posterior half of tail is reddish or reddish yellow; marginal ventral fin and tip is darkish.

Total length 19 mm, (N=1).

48.2 Microhabitat

This tadpole has been found in potholes on rock banks and side pools, where there are accumulated dead leaves and sticks on a sand and silty bottom. The dimension of potholes is 46 x 110 x 25 cm and side pool is 37 x 215 x 15 cm. The average temperature (morning period) is 29°C at the water surface and 1 m. above the water surface (air temperature) is 29.5°C. Elevations from MSL are 50 and 100 m.

48.3 Behavior

They live at the water surface to mid-water, where they swim slowly, while they are sucking organic matter for food. They do not live together, grouping like *M. heymonsi, M. borneensis* and *M. ornata*. When they are disturbed they dive to mid-water but they are easily seen because of the pigment on their tail.

48.4 Place and Duration

Hala-Bala WS. and Khao Luang NP. in January 2003.

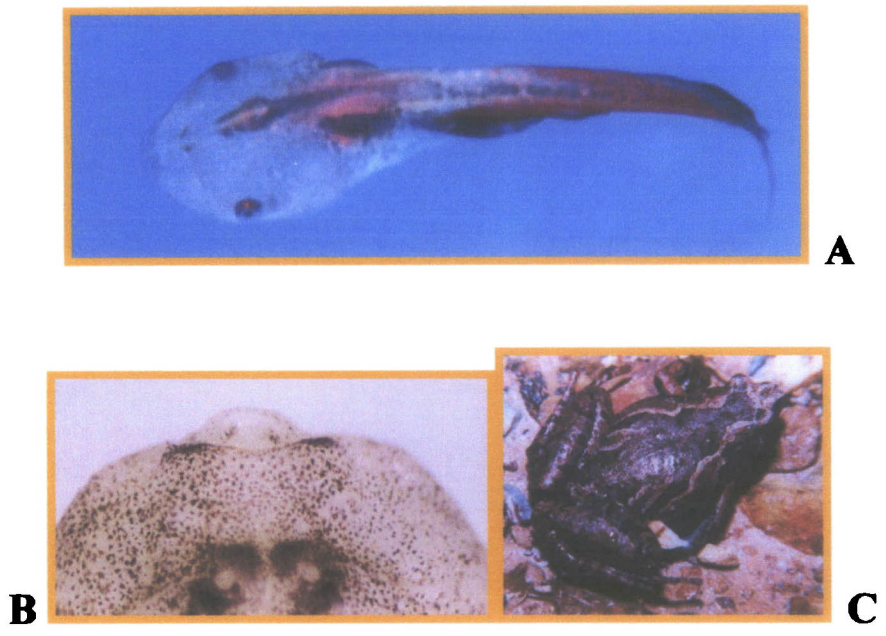


Figure 75 *Microhyla butleri*
A: Body shape of tadpole (stage 32, no. of specimen PT048)
B: Mouthparts C: Adult

49. *Microhyla inornata* (Boulenger, 1890)

Association with adult is based on a developmental series extending from stage 43 onward, subarticular tubercle complete and at stage 45 back with dark spots.

49.1 External Morphology

Head-body oval, flattened above, width 2/3 of length; eyes lateral, visible from below; interorbital 3 times that of internarial distance; mouth-snout distance equal to snout-eye; spiracle median, ventral margin concave; anal tube median in ventral fin; fin slight convex; ventral fin slightly deeper than ventral and caudal muscle; tail tapering gradually to an attenuated tip; tip tapering (Figure 76).

Oral disc terminal; lip not extended; lower lip protruded; both lips without papillae, beak and denticle.

Head-body and tail muscle dark-brownish to grayish; interorbital to root tail with dark symbol, Y-like; lateral body-tail with light brown banded, snout to tip tail; marginal tail muscle with dark, fins cloudy, tip transparent.

Total length 19.5 mm, (N=1).

49.2 Microhabitat

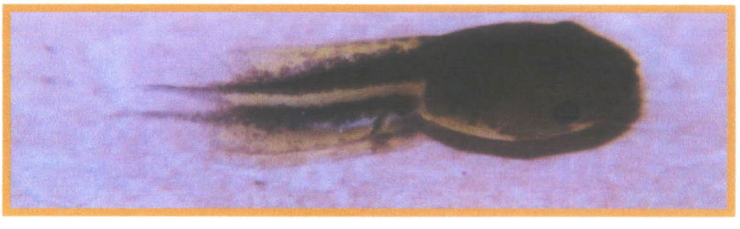
This tadpole was encountered in potholes on rock banks, where there were many species of tadpole, including *M. borneensis, Bufo quadriporcatus* and *Fejervarya limnocharis*.

49.3 Behavior

They live at the water surface to mid-water, where they swim slowly, while they suck organic matter in the water for food. They do not move on the bed but when they are disturbed they swim forward fast.

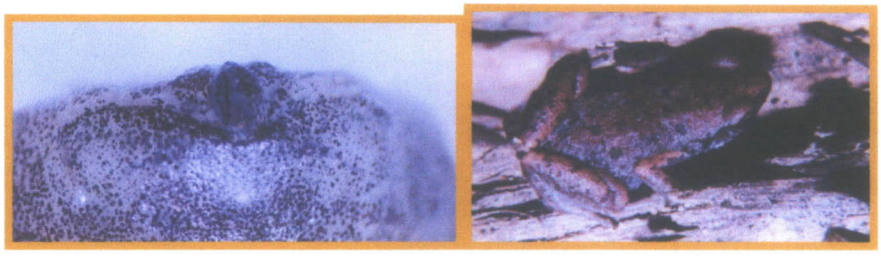
49.4 Place and Duration

Hala-Bala WS. in January 2003.



A

A1



B C

Figure 76. *Microhyla inornata*
A: Body shape of tadpole (stage 37, no of specimen PT049)
A1: Top view
B: Mouthparts C: Adult

Genus *Kaloula*

Only one species has been found in the study, which is *Kaloula pulchra.* The external morphology and microhabitat of this tadpole is similar to the tadpole *Microhyla ornata.* Some external morphology are as follows; LTRF 0/1; oral disc straight-edged upper lip without oral flaps above terminal mouth; spiracle midventral near vent; vent tube medial; body color darkish to blackish.

50. *Kaloula pulchra* (Gray, 1831)

The metamorphosis of this tadpole is similar to their adults in stage 37 onward. At stage 37, interorbital to vent has pale dark shape, gourd-like. At stage 40, subarticular tubercle and web are complete, hind limb with white stripes and tip of toes are white. At stage 45, tip of fingers are white and back more obvious than stage 37 and gourd-like.

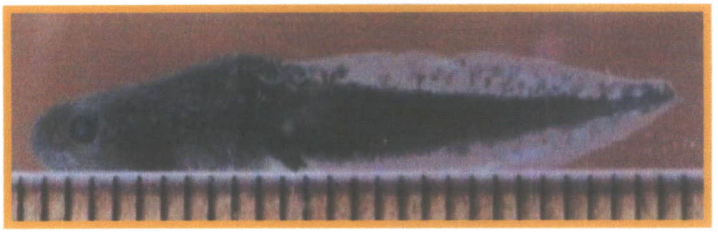
50.1 External Morphology

Head-body oval, flattened, length about 1.5 that of width; eyes lateral; interorbital 7 times that of internarial distance; mouth-snout distance equal to snout-eye; spiracle median, prolonged posteriorly as a transparent tube, opening at rear of body, anus median, tube projecting from lower caudal fin; tail without filament; ventral fin convex, dorsal slightly; medial of dorsal fin equal tail muscle in depth, tip pointed (Figure 77).

Oral disc terminal, small; papillae, jaw sheaths and labial tooth rows absent.

Head-body and tail muscle blackish above, below lighter, marble-like white; head with dark line connecting nostril with anterior corner of eyes; both fins transparent; with dark speckles.

Total length 18-19.5 mm, (N=5).



A

A1

B C

Figure 77 *Kaloula pulchra*
A: Body shape of tadpole (stage 40, no. of specimen PT050)
A1: Top view B: Mouthparts C: Adult

50.2 Microhabitat

Larvae have been encountered in flooded, stagnant drains, ponds and roadside ditches where they may or may not be present. The dimensions of the sites are 25-40 x 35-220 x 15-35 cm. The temperatures (afternoon period) are 29°C-30°C at the water surface and 1 m above the water surface (air temperature) is 30°C-32°C. Elevations from MSL is 50-150 m.

50.3 Behavior

Larvae usually active and suck organic matter at the water surface for food. For the whole day, they feed and when they are disturbed, that always dive to the bed. In aquarium, from stage 37 onward, they rarely dive to the bed, when disturbed. A few weeks after stage 45, these tadpoles can climb the wall of the aquarium.

50.4 Place and Duration

Khao Luang NP. in May, Hala-Bala and Khlong Nakha WS. in November 2003.

Genus *Chaperica*

A single species of *Chaperina* was found, which is *C. fusca*. Its external morphology is similar to *Microhyla*, body shape, color, even oral disc. Furthermore, their microhabitat and living or feeding behavior was also similar. External morphology is as follows: LTRF 0/0; oral disc terminal; spiracle mid-ventral; vent tube median; body color darkish.

51. *Chaperina fusca* (Mosquard, 1892)

Association of tadpole with adult is based on a developmental series in stage 41; subarticular tubercle and a small spine-like projection on skin at heel were present.

51.1 External Morphology

Head-body oval, flattened above, width 2/3 of length; interobital distance twice that of internarial distance; mouth-snout 2/3 that of snout-eye distance; spiracle median, ventral margin concave, tubular closer to eye than end of body; vent tube median, opening at end of long tube attached to ventral fin, dextral; tail weakly convex dorsally; strongly convex below, as deep as body, tapering gradually to a point; dorsal fin deeper than caudal muscle in distal half, ventral deeper than caudal muscle and dorsal fin (Figure 78).

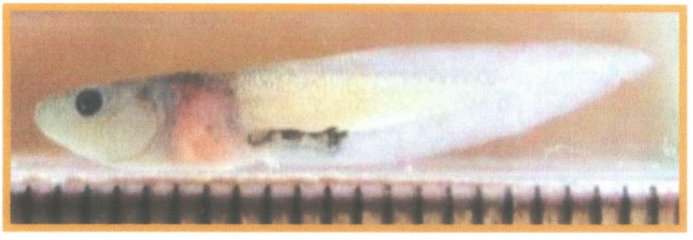
Oral disc terminal; upper lip with obtuse point, down-turned lateral lobes separated by wide, curved median; lower lip narrow laterally covered by lobes of upper lip; papillae, beaks and denticle absent.

In the field, head-body darkish, lighter below; tail muscle grey. In aquarium, head-body rather transparent, visible blood vessel, below and lateral body transparent, visible gut; root tail darkish; tail muscle light brow; both fins cloudy.

Total length 20-21 mm, (N=3).

51.2 Microhabitat

Larvae had been found in potholes on rock banks where there are some accumulated dead leaves and some sticks on a sand bottom. The dimension of the bank is 35 x 67 x 22 cm. The temperature (afternoon period) is 28°C at the water surface and 1 m above the water surface (air temperature) is 29°C. Elevation from MSL is 900 m.



A

A1

B C

Figure 78. *Chaperina fusca*
A: Body shape of tadpole (stage 40, no of specimen PT051)
A1: Top view B: Mouthparts C: Adult

51.3 Behavior

These tadpoles are usually still and living separately on the water surface, where they suck some organic matter for food. They move rather slowly when they are disturbed but some of them dive to the bed.

51.4 Place and Duration

Khlong Nakha WS. in December 2002.

Microhabitats

Microhabitat can be divided into two systems, which are Lotic and Lentic as follows:

Lotic or Streams

The Lotic can be divided into 7 microhabitats, where there are some tadpole living, that are

1. Torrents (Figure 79), this microhabitat has broken surface water, occasionally foaming, bed with rocks, current strong. Some tadpoles have been found, such as *Amolops laratensis, Ansonia malayana* and *Bufo asper.*

Figure 79. Torrents at Hala-Bala.

2. Riffle (Figure 80) has shallow wave on the surface of the water, but is never foaming, bed with gravel and occasional rocks, current moderate. Some tadpoles have been found in both microhabitats, torrents and riffle, which are *Ansonia malayana* and *Bufo asper* but *Huia* sp. has been encountered in this microhabitat.

Figure 80. Riffle at Hala-Bala.

3. The shingle area, microhabitat (Figure 81) has smooth surface water, bottom with circular oval or flattened rocks and gravel, current weak to moderate. Some tadpoles have beenfound, such as *Rana alticola, Megophrys nasuta, Xenophrys aceras* and *X. longipes.*

Figure 81. Shingle area at Khao Luang.

4. The Open pool microhabitat (Figure 82) is the pond part of streams, bottom with some accumulated dead leaves, gravel and sand, current weak. Some tadpole had beenfound, such as *Limnonectes macrognathus, L. kuhlii, L. blythii, Rana hosii, R. cubitalis, Taylorlana hascheana, Bufo quadriporcatus, Microhyla heymonsi, Leptobrachium hendricksoni* and *Leptolalax heteropus.*

Figure 82. Open pool at Hala-Bala.

5. Side pool (Figure 83) is an embayment off a main channel, partially or completely cut off from the current by sand or a gravel bar, with some accumulated dead leavesare on sand, silty or gravel bottom, current weak to absent. Some tadpole have been found, such as *Rana chalconata, R. nigrovittata, Leptobrachium* sp.1 (White-eyes), *Bufo quadriporcatus, B. macrotis, Pedostibes hosii, Microhyla butleri* and *M. berdmorei.*

Figure 83. Side pool at Khlong Nakha.

6. Potholes on rock banks (Figure 84) are water-filled depressions on rock banks, next to streams, bottom with sand, gravel or silt, occasionally some accumulated dead leaves, no current. Some tadpole have been found, such as *Fejervarya limnocharis, Rana nigrovittata, Polypedates macrotis, Rhacophorus prominanus, Microhyla inornata, M. borneensis* and *Chaperina fusca.*

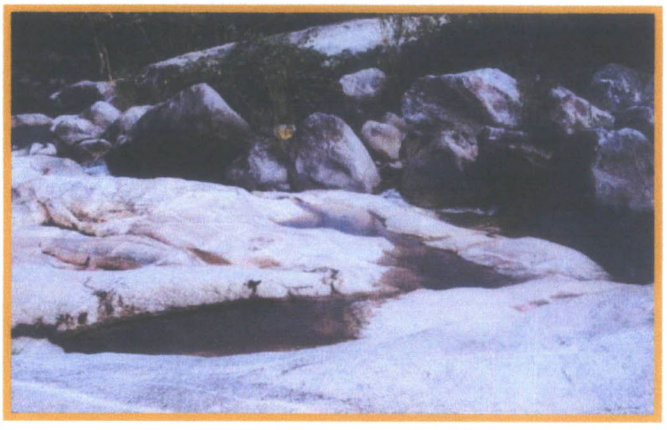


Figure 84. Pothole on rock bank at Hala-Bala.

7. Pools of intermittent streams (Figure 85), this microhabitat is a pond or pool by tie down of a tree or moving rock, where there is fine silt, sand and pea-gravel, usually scattered dead leaves, no current except after moderate or heavy rain. Some tadpoles have been revealed, such as *Occidozyga lima, Bufo parvus, Fejervarya limnocharis* and *Polypedates leucomystax*.

Figure 85. Pool of intermittent stream at Khao Luang.

Lentic or non stream

This system is usually away from streams, there is no current except in unusual circumstances. There are some tadpole living and Lentic can be divided into microhabitats as follows:

1. Pool or Pond communities, this microhabitat usually has been dug or built by humans, where there are some accumulated dead leaves on a silty bottom, surface with some water plants. Some tadpole have been found, which are *Rana erytheaea, Microhyla heymonsi, Polypedates leucomystax* and *Occidozyga lima.*

2. Rain pool, this microhabitat (Figure 86) is a rain-filled depression of variable size and depth, bottom usually clay or silty, occasional with dead leaves on the bed. Some tadpoles have been found, such as *Fejervarya limnocharis, Occidozyga martensii* and *Microhyla ornata.*

Figure 86. Rain pool at Khao Luang.

3. Buttress tank (Figure 87) is some tree roots, two or more joining and that when it is raining; rain water will be stored in it. Only one tadpole had been encountered, which is *Nyctixalus pictus*.

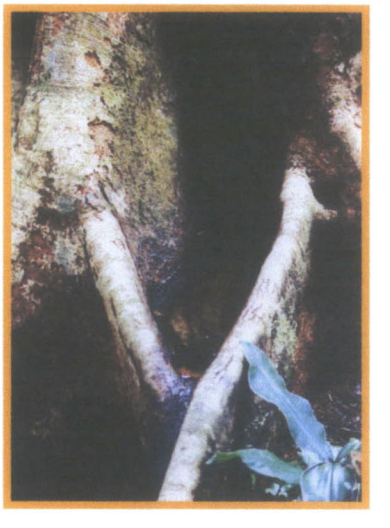


Figure 87. Buttress tank at Hala-Bala.

External Morphology

Although at present the study of amphibians has been studied continuously in Thailand, there has been little study. Particularly, the study of Anuran tadpoles has beem seriously studied around 5 years ago and successively studied until now. However, in each study by each researcher for Anuran tadpoles, the discovered species might be different or similar because of the variation of external morphology especially color and marks of their body or even their mouthparts. It has happened due to the difference of environmental conditions in nature or rearing in a laboratory and the stage of development that is used to explain the details for identification in each species. Moreover, some Anuran tadpole's species has developed their external morphology, such as color, marks, tubercle and ridge on body, from stage 46 to adult stage in varied shapes. All these characteristics, if they died before adult stage might cause confusion and also mistakes in species identification. Different results might result from different references for species identification in each study.

As with this study, 11 species of Anuran tadpoles were found to be different from other studies both in Thailand and from abroad. The 11 species are as follows:

Family Megophryidae

Leptobrachium sp.2 (Red-eyes and Yellow-eyes) *L.* sp.1 (White-eyes) and *L. dendricksoni* have similar mouthparts. The differences can be slight in teeth rows. The external morphology, the color of *L. hendricksoni* is different from *L.* sp.1 and *L.* sp.2, especially *L.* sp.2 (Red-eyes and Yellow eyes). From the study, 5 individuals of these kinds of tadpoles were found, which were brought for rearing in the laboratory and three of them were looked after until the adult stage and two of them were taken care of until stage 40. At the adult stage, there were two individuals that had reddish eye-dorsal and another one had a yellow eye-dorsal. Their mouthparts and body color are very similar but the body colors of both species are different from *L.*sp.1 (White-eyes) in which the red and yellow-eyes have dark spots on the posterior mid-tail but white-eyes have dark circles on the caudal muscle.

Therefore, the color and marks of Red and Yellow-eyed larvae that were found in this study are different *L.* sp. (Red-eyes) from Thong Phaphum district, which have dark spots on the caudal muscle from root tail to tip and marginal fins with dark dots (Inthara, 2000). In addition, it was also different from *L. pullum* (Red-eyes) larvae that were found at Khlong Sang Wildlife Sanctuary by Taksintum (2003). However, the color and marks on the bodies of these larvae resembled *L.* sp.1 (White eyes) in this study.

Only one individual of *Leptolalax heteropus* larvae in this study was found at Hala-Bala. Its external morphology; color, tail, shape and even mouthparts are very similar to *L. graciris* at Thong Phapum District by Inthara (2000) but they have differed from *L. graciris* in Borneo such as the caudal muscle, the shape of the tail tip and mouthparts. Moreover, its color was similar, especially on the fore limb, heel and eyes color ats stage 42 onward.

Xenophrys longipes was found in both of adult and tadpole from Guici and 1000 m waterfall in Khlong Nakha. The external morphology of *X. longipes* in this study resembled *Xenophrys parva* in Khlong Sang by Taksintum (2003) including the body shape, color, marks on body and also mouthparts. It is possible that tadpoles of both species are similar in external morphology, thus the investigation needs to use tadpole which are beyond stage 46 and are difficult to examine and confusing for identification. In this study, tadpoles that are beyond stage 46 for 3 months were like *X. parva* by Taksintum (2003). The characteristics of them is brown colour on the back but after stage 46 around 5 months the color on back changes, becoming darkish-brown. (According to *Megophrys parva* by Frost, 2000)

Family Bufonidae

In this family, there is only one species, which is *Bufo quadriporcatus*. It has been found at only Hala-Bala but Chan-ard (2000) has described that it is *B. divergens*. However, in this study *B. quadriporcatus* is the new record in Thailand.

Family Ranidae

In this study, there were different characteristics of tadpoles in which differences have been found both in Thailand and studies from abroad. These tadpoles are:

Amolops sp.1 from Khlong Nakha which has mouthparts similar to *Amolops marmomoratus* from Khlong Sang by Taksintum (2003) and *A. afganus* from Thong Phaphum by Inthara (2000), but their body colors are different. *Amolops afganus* from Thong Phaphum is similar to *Amolops* sp.1 from Khlong Nakha, but different to *Amolops marmomoratu* from Khlong Sang. Furthermore, *A. larutensis* adults at Khlong Sang by Taksintum (2003) are clearly different to *A. larutensis* in this study (Figure 36).

Another is *Amolops* sp.2 only one individual was encountered at Hala-Bala in the same place as *A. larutensis* but their microhabitat is different. Hence, there are 2 species of *Amolops* in Hala-Bala Wildlife Sanctuary, but only one species in adult stage has been found by Chan-ard (2001), which is *A. larutensis*. Both tadpoles have very different body shapes, body color and especially mouthparts. The microhabitat of *A.* sp.2 is in small streams, but *A. larutensishave* been found in strong and moderate streams. Perhaps, *A.* sp.2 is the new species of the World.

Limnonectes blythii was collected at Khlong Nakha. This species has mouthparts which differed from Inger (1966) as recorded in "The Amphibia of Borneo". But *Limnonectes kuhlii* was found in all three study areas and they had similar mouthparts but they are different from Inger (1966) in "The Amphibia of Borneo", Smith (1917) in "On Tadpoles of Siam" and Pope (1933) in "Note on Amphibians from Fukien, Hainan and Other Parts of China". The difference of these mouthparts may have occurred due to different microhabitats. Sometimes the

difference of mouthparts can make researchers confused if the characteristics of adults were ignored for species identification.

Other species whose mouthparts are similar are *Rana signata* and *Rana hosii*. Nevertheless, *R. signata* in this study is different from *R. signata* in "The Amphibia of Borneo" by Inger (1966). Even though the mouthparts of *R. signata* and *R. hosii* in this study are quite similar some external morphology is different, such as body color, marks or stripes on body. Furthermore, the outstanding characteristics that have been shown to be different in both species are egg shapes, habitat and microhabitat for these two species. When these two species were brought to feed together in an aquarium (separate feeding), it was found that at stage 37 onward these 2 species are definitely different.

Another is *Huia* sp. and *Meristogenys jerboa*. In this study *Huia* sp. Larvae had been encountered in small streams at Khlong Nakha but *Meristorgenys jerboa* larvae had been found in Khlong Sang by Taksintum (2003). But, both species are similar on all external morphology, tadpole and adult. Perhaps, both of them are the same species. Nevertheless, Taksintum used *Meristorgenys jerboa*, which perhaps was confused in its description of adults, moreover *M. jerboa* have not been found on mainland, it has lived on Island.

Family Rhacophoridae

Rhacophorus padalis was found at Hala-Bala and their external morphology in this study resembled those in Borneo by Inger (2000) but they were distinct from Khlong Sang by Taksintum (2003). Some differences have been found, which are body color and labial tooth row formula (LTRF) in some individuals of tadpole. In this study, tadpoles have been revealed in gray, posterior mid-tail dark and LTRF 6(3-6)/3 the same as Borneo, but Khlong Sang by Taksintum (2003) found brownish colour on the body and LTRF 6(2-5)/3(2-3), 6(3-6)/3(2-3) and 5(3-5)/3(2-3). These differences might have happened because of the differences of microhabitat or feeding in an aquarium.

Another species is *Rhacophorus nigropalmatus*, this tadpole has been disclosed in Hala-Bala, their mouthpartss resembled larvae of Khlong Sang, that is 6(3-6)/3(2-3) but are distinct from Borneo, that is 5(2-5)/3(2-3). Even though, LTRF in Hala-Bala and Khlong Sang were similar, some external morphology of larvae was different, including body color and marks on the tail. The head-body and tail muscle of tadpole in Khlong Sang is brown, but at Hala-Bala it is pale gray on the head-body and tail with pale gray spots. The differences of color can be due to different microhabitats or their food might influence the change in their color which is lighter.

Only one individual of *Nictixalus pictus* was found in this study in a Buttress tank at Hala-Bala and it is stage 42. This stage, some papillae and tooth had started reducing thus perhaps its mouthparts were completing before stage 40, but its mouthparts resembled those found in Borneo.

Family Microhylidae

In this family, there were 2 genera and 2 species. However, in this study, there was only 1 species that is *Microhyla bornnensis* from Hala-Bala and some characteristics of this tadpole are different from Taksintum (2003). Another is *Chaperina fusca*, 7 adults of this tadpole were found at Khlong Nakha beside a pothole on a rock bank in December 2002. In the pothole, there were many of these tadpoles, more than 50 individuals and about 30 individuals were collected. However, there are only 5 individuals used for study samples and continuous feeding, the remainder had died while returned to the camp. The 7 adults that were collected were eaten by some animals which were the same as the adult of *Megophrys* sp. that were found at the same place of *Chaperina fusca*. For *Megophrys*, it has columelia-bone stretch from both sides out, about 0.5 mm. from the median of tympanum. After being examined in detail in "The Amphiia of Borneo" by Inger (1966), it was found that the 5 individual tadpole were *Chaperina fusca* and were reared in an aquarium for about 3 months at stage 25 to after stage 46 for about 1 month. *Megophrys* adults can not be identified as a species.

The external morphology of *M. bornnensis* resembled larvae of Borneo by Inger (1984) and Singapore by Leong (1999), but they were distinct from larvae of Khlong Sang by Taksintum (2003), that had black bands on the lateral body, mouth to tip tail; black line on margin of dorsal fin and black band next to the root tail and also reddish-brown marks next to the corners of the mouth. The above characteristics were found in this study, in Borneo and in Singapore but they have not been found in Khlong Sang. It is possible that the mentioned characteristics have disappeared because they were taken to be reared in an aquarium. On the other hand, 5 individuals of *M. bornnensis* from Hala-Bala still have the above-mentioned characteristics but the color is lighter. However, when the structure of mouthparts was investigated similar characteristics were found both in Khlong Sang and Hala-Bala.

Some characteristics of tadpole's external morphology were used to identify species of each adult. However, there are some characteristics of tadpoles that contradicts taxonomic classification of adults. In this study, the identification of species taxonomic classification was used in adulthood and they can classify into 22 genera and 51 species. Nevertheless, if the taxonomic arrangement of external morphology of tadpole was used, hence that they can be classified into 17 genera in 5 families. The details are as follows:

Family Megophryidae

This family has been divided into 5 genera that are *Xenophrys, Megophrys, Brachytarsophrys, Leptolalax* and *Leptobrachium*. Three genus *Xenophrys, Megophry* and *Brachytarsophrys* could be grouped into 1 genus by using their mouthparts that are mouth dorsoterminal; lips expanded; beak, labial tooth row and papillae on marginal lip absent.

Family Bufonidae

This family could be divided into 2 genera by tadpole from 3 genera of adult that are *Bufo, Pedostibes* and *Ansonid.* Two generas could be grouped into 1 genus by their mouthparts, that is, mouth anteroventral; papillae on marginal lips present; labial tooth row formula (LTRF) 2(2)/3(1); body blackish and without marks on the body and tail.

Family Ranidae

This family have been divided into 8 genera in adults , that are *Amolops, Rana, Limnonectes, Ferjervarya, Taylorana, Hoplobatrachus, Occidozyga* and *Huia* but the larvae have been divided into 6 genera ,t hat are *Amolops, Rana, Hoplobatrachus, Occidozyga, Huia* and 3 genera could be assembled into 1 genus by body shape, size and color; mouthparts, 1-2 of teeth rows on dorsal lip and 2-3 rows on ventral lip and also papillae on marginal lips, size, shape and number of rows.

Family Rhacophoridae

Rhacophoridae larvae could be divided as their adults, which are *Rhacophorus, Polypedates* and *Nyctixalus.*

Family Microhylidae

This family has been divided into 3 genera, that are *Microhyla, Kaloula* and *Chaperina*, but they can be grouped into 2 genera by mouthpart position and form, that are some species of *Microhyla,* which are *M. heymonsi* and *M. bornensis* and could be grouped because of terminal mouth and expanded lips. Other species *in Microhyla, Kaloula* and *Chaperina* can be grouped and they can be divided into 2 subgenera by body shape and color. First is *M. inornata* can be grouped with *kaloula puchra*, by body blackish and body oval. Another is *M. ornata, M.berdmorei, M. butteri* and *Chaperina fusca* these tadpoles resemble each other because they were similar in head-body body color and transparent fins, flattened body and a terminal mouth with lips not expanded.

Although some taxonomic classification of larvae was inconsistent with the classification by adult body, the characteristics of tadpole can support the adult group classification/identification clearly such as *Megophrys, Xenophrys* and *Brachytarsophrys* larvae. Three generas are similar in mouthparts, body shape, microhabitat and even feeding behavior. Thus, the adoption of tadpole's characteristics is helpful for taxonomic classification in adults and it is a good technique.

Conversely, the classification by using tadpole can fulfill taxonomic classification, species identification or even the behavior of adults will be observed easier. In addition it can increasingly promote understanding in this group of this animal.

The understanding of this group of animals especially tadpole , larvae or polliwog, is greater because they have differences in shape and behavior even though they are in the same group of animal.However, sometimes they have similar shapes and behaviors but they are in different groups. All these things depend on many factors in their bodies and that will determine the eating behavior, food and habitation including the relationships of their evolution. These mentioned factors are head-body and tail, shape and mouthparts.

Some tadpoles have flattened body, below. They have mouthes lower and are expanded larger equal to head. These tadpoles live on stones and scrape small aquatic plant on rock surfaces for food. They have been divided into 2 groups, which have disc present and absent on ventral. The first group is disc absent, this group will have expanded lips that are used instead of the disc and live in moderate streams. The other group of tadpole can live only on large stones and scrape the smallest plants on stones as their food. Their mouth shift with their movement and the disc will be used for sticking the body to stones. Tails of these tadpoles are tapered because it is not against the water current. They also have narrow fins in depth, because they have no need to use the tail for their movement and probably these tadpoles have lived in strong water currents because they need oxygen and more food, perhaps that quickens their metamorphosis when developing and also protects them.These tadpole are *Amolops, Ansonia, Huia* and *Bofo asper*.

Some tadpoles have flat bodies above and oval bodies, they have terminal mouthes without teeth. Some species have expanded lips such as *M. heymonsi* and *M. bornnensis* both suck organic matter on the surface to mid-water for food but *Kaloula pulchra, Occidozyga lima* and *O. martensii* have oval bodies and they suck organic matter on the bed for food. Moreover, their fins are moderate, fins equal tail muscle in depth because they are usually still or move slightly by using their tails on the water surface or on the bed in still water, ponds, potholes, on rock banks, rain pools and also side pools. These characteristic have fixed the microhabitat and behavior of tadpole. Hense, they live in streams because they cannot suck organic matter in water for food which maybe has been moved by water currents.

Some tadpoles have oval or elongated bodies. They usually live on the bed in rain pools to slow streams where there are some accumulated dead leaves and rocks on a sand or silty bottom. In addition, they scrape dead leaves or the smallest water plants on rock surfaces using their teeth to feed because their mouths are anteroventral. Furthermore, their caudal muscle in median is equal or wider than the fins in depth because they usually use them for swimming, thus the tail is rather large. These tadpoles have not been found in moderate to strong streams, maybe because they cannot scrape dead leaves on the bottom or stone surfaces. However, sometime they have been encountered in moderate currents such as *Rana alticda, Limnonectes blythii, L. macrognathus* and *Rana hosii* but these tadpoles hide in rocks or rock holes where they live as well. Other species or most have been found in still water such as *Ferjervarya limnocharis, Leptobrachium hendricksoni, Bufo quadriporcatus* and *Rana cubitalis*. Other species have elongated bodies but their mouthes are ventral; lips expanded cup-like, weak teeth and moderate tail, fins less than caudal muscle.

These characters are resultant from the microhabitat and feeding behavior because these tadpoles suck some organic matter on the bottom for food by using their mouthes and the mouth especially lateral lips will contact gravel or dead leaves on the bed. Thus, these tadpoles have been found in open pools or side pools of small streams because there are not strong water currents but lots of organic matter on the bottom and safety, this tadpole is *Leptolalax heteropus*. Another tadpole has a dorsoterminal mouth, expanded horn-like lateral lips, moderate tail, and the caudal muscle is deeper than the fins. These characters are appropriate for living in streamw, especially weak to moderate water currents because these tadpole suck organic matter on the water surface, following the water as the lateral lips move in and out to push organic matter into the mouth and also they are grouping together, which increases organic matter moving into their mouthes more than only sucking. Moreover, they bend the tail and expand their lips to support the body. Hence, this tadpole cannot dwell in strong currents because perhaps they drift with the current or they live in non-current because they have to use a lot of power to suck organic matter and have a large tail for swimming and also they cannot live mid-water or at the bottom because it probably is not good for sucking some organic matter and also swimming. These tadpoles are *Megophrys, Xenophrys* and *Brachytarsophrys*.

Feeding Strategy

Feeding of Anuran tadpoles for each type of mouthparts (upper, terminal, anteroventral and ventral mouth), is different because they have to adapt their mouth, bodies and behavior to feed in particular microhabitats in which they live. Feeding strategies of each character of mouth are as follows:

Dorsal Mouth

This type of mouth sucks some dusty organic matters which floats on the surface, while the lips move backwards to the mouth and papillae on inner lips (only *Megophrys* and *Brachylarsophrys*) to obstruct organic matter floating on the surface. These strategies help to retrieve water and organic matter into the mouth better. This mouth usually has beaks, dental and also marginal lip papillae. 6 species of anuran tadpoles have been found, which are *Megophrys nasuta, Brachytasophrys carinensis* in Megophryidae and *Microhyla heymonsi* and *M. borneensis* in Microhylidae.

Ventral Mouth

The Ventral mouth is very different from other mouthe, because it has a special mouth structure, with expanded and thick marginal lips, hanging to form a weak deep cup denticle and heavy beaks. This mouth can be divided into 2 characters. The first character is used to suck dusty organic matters on the bottom. The lips have 2 functions which are to support the body to put something on the bottom and marginal lips to move backward to the mouth while the ridge papillae are moving (in and out) to scrape accumulated dead leaves or other matter, increasing water and organic matter intake in the mouth. This mouth has been found in *Leptolalax*.

The other character is the expanded mouth, wide subequal head, flattened ventral in *Ansonia* and *Bufo asper* and disc-like in *Amolops*, teeth rows and heavy beaks. The mouth and disc stick on the stone surfaces in heavy streams, while the teeth rows move up and down to scrape the smallest water plants (seaweed or moss) on the stone surfaces. Marginal lips also move in and out to suck water and organic matter into the mouth for food. These mouths have been found in 7 species, such as *Amolops larutensis, Ansonia malayana* and *Bufo asper*.

Anteroventral

Anuran tadpoles in this character have been found in many families, such as Ranidae, Bufonidae and Rhacophoridae. The feeding strategy moves the denticle up and down to scrape organic matter or the smallest water plants on the stone surfaces or parts of the tree on the bottom. While they scrape, their lips and papillae will be also moved in and out to push more water and organic matter into the mouth than would be taken in by sucking only.

These tadpoles have been found in 31 species altogether, such as *Limnonectes kuhlii, Polypedates leucomystax, Bufo melanostictus, Pedostibes hosii, Leptobrachium hendricksoni*, and *Nyctixalus pictus*.

Terminal Mouth

Although this mouth has been found in 2 groups of anuran tadpoles, their feeding is similar in that the mouth will stretch and shrink like a cylinder and that some water and the smallest organic matter will be carried into the mouth as food. These mouthes have been found in 8 species such as *Microhyla ornate, M. berdmorei* and *Occiolozyga lima*.

Feeding Behavior

The behavior in each tadpole group is different, and that is caused by differences in microhabitat. Although they have been classified into the same group, family or genus their mouthpartss and behavior is not similar. The mouth characters will be accordant with their microhabitats and feeding behavior. Moreover, the size and type of food are also different in each tadpole group. Feeding behavior of these tadpoles is as follows:

Dorsal Mouth

This tadpole group lives in 2 systems and microhabitats. The first group, *Megophrys, Xenophrys* and *Brachytarsophrys* live in lotic systems, open pools, where they feed on dead leaves or a rock by sucking small organic matter that float on the surface for food. Moreover, their bodies incline about 30-45° from the water surface. Another group is *Microhyla heymosi* and *M. borneensis*. Both live in lentic systems, rain pools, lotic and pot holes on rock banks, where they float or swim at the water

surface and the lower lips are expanded to suck small organic matter for feeding. Their bodies incline less than 45° from the water surface.

Although these tadpoles have similar mouthes (dorsal mouth) and feeding strategies their feeding behaviors are obviously different because of the conditions of the microhabitats. *Megophrys*, *Xenophrys* and *Brachytarsophrys* live in open pools, where there is some continuous water flow; hence organic matters always pass by. These tadpoles lie still and expand their lips at the water surface, especially the lateral lips, which may be 1.5-2 times as long of the width. When their lips are expanded, increasingly they can catch and suck organic matters passing into their mouths. The feeding of these tadpoles is called "Passive Feeding".

Microhyla heynonsi and *M. borneensis* live in rain pools and pot holes on rock banks, where there is non flowing-water, so some organic matter does not move. These tadpoles will move and suck organic matter at the surface for food using their lips which are slightly expanded. The lower lips of *M. heymonsi* expand into a broad funnel surrounding the mouth, but the lower lips of *M. borneensis* are slightly expanded. The feeding of these tadpoles is called "Active Feeding"

Ventral Mouth

This character has been found in 4 anuran tadpoles groups, which are *Amolops, Ansonia, Bufo (B. asper)* and *Leptolalax (L. heteropus)*. Although the mouth positions of these tadpole are similar (ventral mouth), the mouth morphology, microhabitat and feeding behaviors are obviously distinctive. *Amolops* and *Ansonia* live on the stone surfaces in strong currents where they scrape some small aquatic plants on the stone surfaces for food with their teeth moving up and down. *Amolops* move and stick on the stone with their disc while *Ansonia* move and stick on the stone usimg their mouth. They usually stick their bodies to the upper or middle parts of a stone with their heads against the current. They have often been found under stones, with the body obstructing the current in the daytime. In moderate currents, *Bufo asper* live on the stone surfaces, where they move and stick on the stone with their mouthes (like *Ansonia*) and they scrape small aquatic plants for food. These tadpoles live in water currents, so their mouths adhere to the stone surface to protect from water getting into the mouths. While they are scraping, the marginal lips move slightly, so that some water will be carried into the mouths, then they suck some water and small aquatic plants into the mouths for food. For *Leptolalax heteropus*, they live on dead leaves on the sand bottom, where they suck dusty organic matters on leaves for food. Their mouthparts are used for sticking the body on to a leaf on the bottom, while the lips are moving in and out to push organic matters into the mouths.

Anteroventral Mouth

Many of this type have been found in this research, such as Bufonidae, *Bufo quadriporcatus, B. parvus, B. melanostictus* and *Pedostibes hosii*; Rhacophoridae, *Polypedate leucomystax, Rhacophorus prominanus* and *Nytixalus pictus*; Ranidae,

Rana hosii, Limnonectes kuhlii, and *Ferjervarya limnocharis* were found in many microhabitats which are;

1. Shingle areas: tadpoles live on an accumulated dead leaves with silt or sand at the bottom, such as *Limnonectes kuhlii, Limnonectes blythii, Rana hosii* and *R. alticola*

2. Side pools: some tadpoles live on dead leaves or sand on the bottom such as *Limnonectes hosii* and *Limnonectes blyhtii.*

3. Potholes on rock banks: Some tadpoles live on accumulated dead leaves on a sand and silt bottom such as *Bufo quadriporcatus, Rhacophorus nigropalmatus* and *Polypedates macrotis.*

4. Rain pools: here there were accumulated dead leaves on a silt or clay bottom and tadpole found living in it, were *Ferjervarya limnocharis.*

5. Buttress tanks: the tadpole found living on accumulated leaves was *Nyctixalus pictus.*

All tadpoles which were found in several microhabitats had similar behaviors. They lay still but sometimes gradually moved on to accumulated dead leaves, rocks, on sand or silt bottom, they usually scrape the dead leaves or small aquatic plants on rocks for food. While they scrape the bodies are inclined about 10° from the ground. Inclining the bodies supported the scraping, because their mouths were anteroventral mouths. But, some of them also ate animals, insect larvae, carcasses and even other types of tadpole or the same tadpole. These tadpoles swam to another tadpole to bite it (vent or tail), then it scraped the tadpole for food. These tadpoles have been found in rain pools and pothols on rock banks, and are *Ferjervarya limnocharis, B. quadriporcatus* and *P. leucomystax.*

Terminal Mouth

Terminal mouths have been found in *Microhyla* and *Occidozyga* tadpole. They live in rain pool where sometimes there are accumulated dead leaves on a sand or silt bottom. The feeding of both tadpole groups involves sucking organic matter in the water for food, but these tadpoles are distinctive in their living. *Microhyla* float in mid water or a little bit deeper from the surface, horizontal to the surface but *Occidozyga*, lie still or gradually move on accumulated dead leaves or silt on the bottom. Some tadpoles have been found in this research, such as *Microhyla ornate, M. inornata, M. berdmorei* in Microhylidae, *Occidozyga lima* and *O. martonsii* in Ranidae.

For some anuran tadpoles have not been found in this study but their mature in other researcher have been revealed or some anuran tadpoles have been found but their mature have not been found in each study area (detailed in table 3,4 and 5)that perhaps, the surveying in other researcher and this study could not cover all area and also period of studing or surveying are different.

Table 3 Some anuran tadpoles species and their mature in Khlong Nakha

Species	Amphibians Anura	
	Matures	Tadpoles
1. *Leptobrachium* sp.2	-	x
2. *L. smithi*	x	-
3. *Xenophrys aceras*	x	x
4. *X. longipes*	x	x
5. *Bufo asper*	x	x
6. *B. macrotis*	x	x
7. *B. melanostictus*	x	x
8. *B. parvus*	x	x
9. *Ansonia malayana*	x	x
10 *Amolops* sp.1	-	x
11. *Huia* sp.	-	x
12. *Occidozyga laevis*	x	-
13. *O. lima*	x	-
14. *O. martensii*	x	x
15. *Fejervarya. limnocharis*	x	x
16. *Hoplobatrachus rugulosa*	x	x
17. *Ingerana tarsanae*	x	-
18. *I. tenasserimensis*	x	-
19. *Limnonectes blythii*	x	x
20. *L. kuhlii*	x	x
21. *L. laticeps*	x	-
22. *L. macrognathus*	x	-
23. *Rana alticola*	x	x
24. *R. cubitalis*	x	x
25. *R. hosii*	x	x
26. *R. miopus*	x	-
27. *R. nigrovittata*	x	x
28. *R. chalconota*	x	x
29. *R. erythraea*	x	x
30. *Taylorana hascheana*	x	x
31. *R. bipunctatus*	x	x
32. *P. leucomystax*	x	x
33. *Chaperina fusca*	x	x
34. *Calluella guttulata*	x	-

Table 3 (Cont'd)

Species	Amphibians Anura	
	Matures	Tadpoles
35. *K. pulchra*	-	x
36. *Kalophrynus pleurostigma*	x	-
37. *M. berdmorei*	x	-
38. *M. butleri*	x	-
39. *M. heymonsi*	x	x
40. *M. pulchra*	x	-
41. *M. ornata*	x	x
42. *M. inornata*	x	-

Remark: x= Present

Table 4 Some anuran tadpoles species and their mature in Khao Luang

Species	Amphibians Anura	
	Matures	Tadpoles
1. *Leptobrachium* sp.1	-	x
2. *L. smithi*	x	-
3. *L.* sp.2	-	x
4. *Brachytarsophrys carinense*	-	x
5. *Xenophrys aceras*	-	x
6. *X. longipes*	x	-
7. *Bufo asper*	x	x
8. *B. macrotis*	-	x
9. *B. melanostictus*	x	x
10 .*B. parvus*	x	x
11. *Ansonia malayana*	x	-
12. *O. lima*	x	x
13. *O. martensii*	x	x
14. *Fejervarya cancrivora*	x	-
15. *F. limnocharis*	x	x
16. *Hoplobatrachus rugulosa*	x	x
17. *I. tenasserimensis*	x	-
18. *Limnonectes blythii*	x	x
19. *L. doriae*	x	-
20. *L. kuhlii*	x	x
21. *L. laticeps*	-	
22. *L. macrognathus*	x	x
23. *Rana alticola*	x	x
24. *R. cubitalis*	x	x
25. *R. hosii*	x	x
26. *R. luctuosa*	x	-
27. *R. macrodactyla*	x	-
28. *R. miopus*	x	-
29. *R. nicobariensis*	x	-
30. *R. nigrovittata*	x	x
31. *R. chalconota*	x	x
32. *R. erythraea*	x	x
33. *Taylorana hascheana*	x	-
34. *Philautus parvulus*	x	-
35. *Rhacophorus appendiculatus*	x	-
36. *R. bipunctatus*	x	-
37. *P. leucomystax*	x	x
38. *P. macrotis*	x	-
39. *K. pulchra*	x	x
40. *M. berdmorei*	-	x
41. *M. butleri*	-	x
42. *M. heymonsi*	-	x

Table 4 (Cont'd)

Species	Amphibians Anura	
	Matures	Tadpoles
43. *M. pulchra*	x	-
44. *M. ornata*	x	x
45. *M. inornata*	x	-

Remark: x= Present

Table 5 Some anuran tadpoles species and their mature in Hala-Bala (Only Bala)

Species	Amphibians Anura	
	Matures	Tadpoles
1. *Leptobrachium hendricksoni*	x	x
2. *Leptolalax heteropus*	x	x
3. *Megophrys nasuta*	x	x
4. *Xenophrys longipes*	x	-
5. *Bufo asper*	x	x
6. *B. divergens* (*B. quadriporcatus* in this study)	x	x
7. *B. macrotis*	x	-
8. *B. melanostictus*	-	x
9. *Ansonia malayana*	x	x
11 .*Leptophryne borbonica*	x	-
12. *Pedostibes hosii*	x	x
13. *Amolops larutensis*	x	x
14. *Amolops* sp.2	-	x
15. *Occidozyga laevis*	x	-
16. *Fejervarya cancrivora*	-	-
17. *F. limnocharis*	x	x
18. *Limnonectes blythii*	x	-
19. *L.* sp.	-	x
20. *L. kuhlii*	x	x
21. *L. laticeps*	x	-
22. *L. malesianus*	x	-
23. *L. paramacrodon*	-	-
24. *L. plicatellus*	x	-
25. *R. baramica*	x	-
26. *R. hosii*	x	x
27. *R. nigrovittata*	x	x
28. *R. chalconota*	-	x
29. *R. signata*	x	x
30. *R. erythraea*	x	x
31. *Taylorana hascheana*	x	x
32. *P. vermiculatus*	x	-
33. *Rhacophorus appendiculatus*	x	-
34. *R. reinwardtii*	-	x
35. *R. cyanopunctatus*	x	-
36. *R. nigropalmatus*	x	x
37. *R. pardalis*	x	x
38. *R prominanus*	x	x
39. *P. leucomystax*	x	x
40. *P. macrotis*	x	x
41. *Nyctixalus pictus*	x	x

Table 5 (Cont'd)

Species	Amphibians Anura	
	Matures	Tadpoles
42. *K. pulchra*	x	-
46. *M. berdmorei*	x	-
44. *M. borneensis*	x	x
45. *M. butleri*	x	x
46. *M. heymonsi*	x	x
47. *M. pulchra*	x	x
48. *M. ornata*	x	x
49. *M. inornata*	x	x

Remark: x= Present

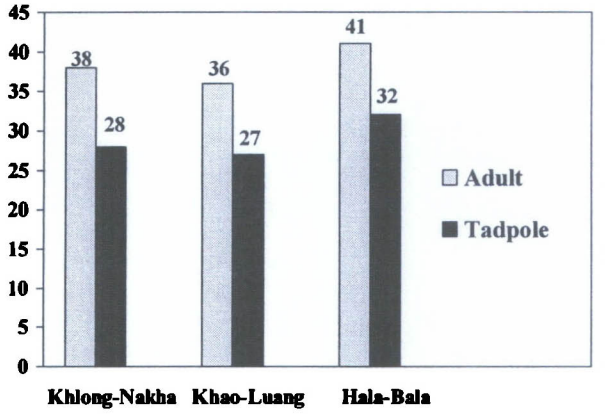


Figure 88 Number of anuran tadpoles have been found in this study and their adult from other reseach in this study areas.

Furthermore, differently, those anuran tadpoles have been found in each period around year, rainy or and summer season (detailed in Appendix Table 2) and that perhaps it depend on the climate in each study area (detailed in Appendix Table 3) as the Figure 89, 90 and 91.

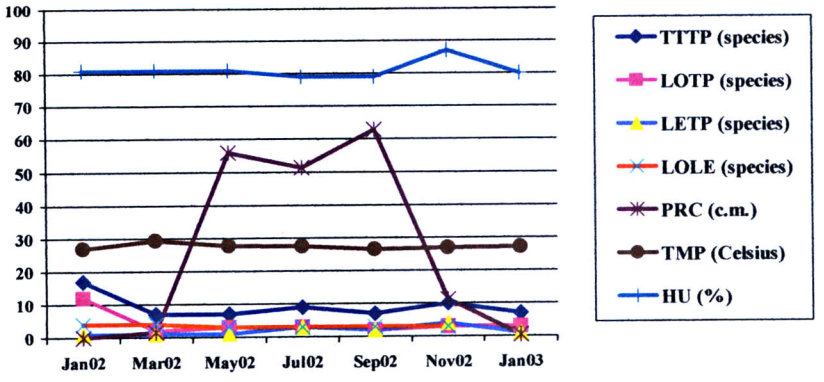


Figure 89 The relationship between anuran tadpoles and climate factors in Khlong Nakha Wildlife Sanctuary.

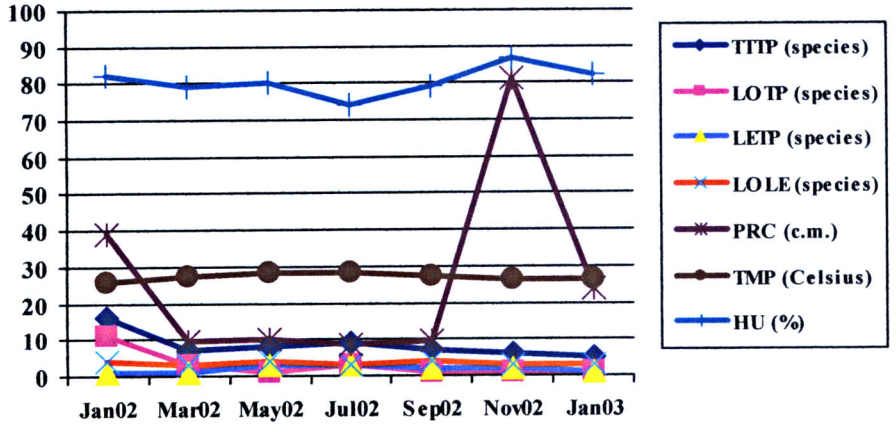


Figure 90 The relationship between anuran tadpoles and climate factors in Khao Luang National Park.

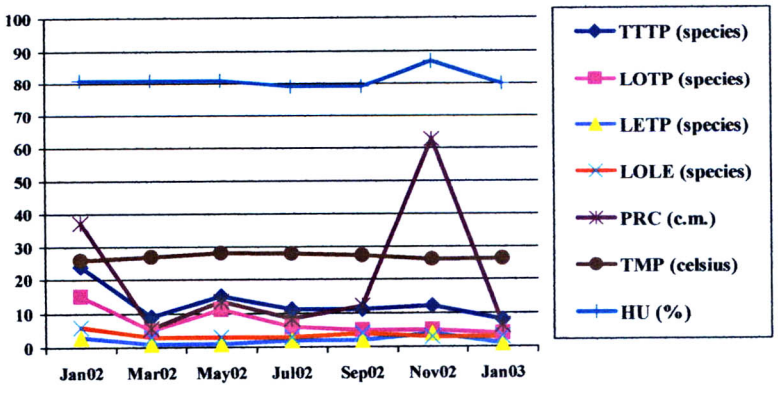


Figure 91 The relationship between anuran tadpoles and climate factors in Hala-Bala Wildlife Sanctuary.

Considering the relationship between the species of tadpoles and climate factors of all three study areas, it was found that there were no relationship between tadpole's species and relative humidity as well as the tadpole's species and temperature because of both these two factors were quite constant, while the tadpole's species were correlated with precipitation.

Comparing separately for lotic tadpole and lentic tadpoles, it was found that the tadpole's species in lotic system had changed in the same direction of total tadpole, while tadpole's species in lentic system had constant value. This finding showed the group of mostly changed tadpole possibly is tadpoles in lotic system.

Figure 88 shows the relationship of all factors in the area of Khong-Nakha Wildlife Sanctuary. The precipitation was increased in March – November 2002 and the tadpole's species were constant. It might be the reason of water in that period was plenty which was not suitable for laying eggs even inappropriate for living. On the other hand, in January 2002 was found numerous of tadpole's species that might be occurred from decreasing on amount and intensity of current in which it was more appropriate for laying eggs and living than in March – November 2002.

In twicw of study areas, Khao Luang National Park and Hala-Bala Wildlife Sanctuary, the amount of tadpole's species was increasingly found in January 2002 that was in the period of high rainfall amount. Tadpole's species were less found in March to July 2002, it probably was less amount of rainfall which was not proper for laying eggs and living from that less quantity of water. However, in September – November 2002 had high precipitation then the amount of water in stream had also high, thus it might be not appropriated for tadpole's living perhaps from over quantity of water and current. In November 2002, the precipitation was reduced as well as the current and amount of water also gain less. Furthermore, most of amphibians auran would breed in this period that caused high discovering of tadpole in January.

In case of tadpole's species in lentic sytem, most of them were found in communities in pools and ponds and the amount of species was constant. Considering the relationship between amount of tadpole's species and climate factors, it might be deviated due to the areas of surveying was locate away from Meteorological Station in each province, therefore, the climate might be different from the real value access.

All the reasons and characteristics of tadpoles in this study can show some differences between the taxonomic arrengement of adults and their tadpole. Some characteristics of tadpoles are the fundamentatal data to understand their behavior and the microhabitats of this animal group.

CONCLUSION

This study had been carried out between January 2002 – January 2003 in three study areas, which are Khao Luang National Park, Nakhon Si Thammarat Province, Khlong Nakha Wildlife Sanctuary, Ranong Province and Hala-Bala Wildlife Sanctuary, Narathiwat Province and rearing all tadpoles between January 2002-January 2004. 51 species 22 genera in 5 families have been found of Anuran tadpoles, as follows at Khao Luang 27 species 12 genera in 5 families, Khlong Nakha 28 species 17 genera in 5 families and 32 species 17 genera in 5 families in Hala-Bala(Only Bala) and 6 species could not to specified as existing species, which are *Leptobrachium* sp.1, *L.* sp2., *Amolops* sp.1, *A.* sp.2, *Huia* sp. and *Limnonectes* sp.

The 45 species were found in the dry period (summer season); 23 species in the wet period (rainy season); 16 species were found in both wet and dry periods (detailed in Table6). For the finding detail all tadpoles in each month have been shown in Appendix Table 2-4.

Table 6 Anuran tadpoles have been found in each season

Species	Seasons	
	Rainy	Summer
1. *Brachytarsophrys carinense*	x	x
2. *Megophrys nasuta*	-	x
3. *Xenophrys longipes*	-	x
4. *Xenophrys aceras*	-	x
5. *Leptobrachium* sp.1 (White-eyes)	x	-
6. *Leptobrachium* sp.2 (Red and Yellow-eyes)	x	x
7. *Leptobrachium hendricksoni*	x	x
8. *Leptolalax heteropus*	-	x
9. *Ansonia malayana*	-	x
10. *Bufo asper*	x	x
11. *Bufo quadriporcatus*	x	x
12. *Bufo parvus*	x	-
13. *Bufo melanostictus*	x	x
14. *Bufo macrotis*	-	x
15. *Pedostibes hosii*	-	x
16. *Amolops larutensis*	x	x
17. *Amolops* sp.1	-	x
18. *Amolops* sp.2	x	-
19. *Huia* sp.	-	x
20. *Ferjervarya limnocharis*	x	x
21. *Limnonectes* sp.	-	x
22. *Limnonectes blythii*	-	x
23. *Limnonectes macrognathus*	-	x
24. *Limnonectes kuhlii*	-	x
25. *Rana alticola*	x	x
26. *Rana chalconata*	x	x

Table 7 (Cont'd)

Species	Seasons	
	Rainy	Summer
27. *Rana hosii*	-	x
28. *Rana signata*	-	x
29. *Rana nigrovittata*	-	x
30. *Rana cubitalis*	-	x
31. *Rana erythraea*	x	x
32. *Taylorana hascheana*	-	x
33. *Hoplobatrachus rugulosus*	x	x
34. *Occidozyga lima*	-	x
35. *Occidozyga martensii*	x	-
36. *Rhacophorus pardalis*	-	x
37. *Rhacophorus nigropalmatus*	-	x
38. *Rhacophorus reinwardtii*	-	x
39. *Rhacophorus prominanus*	x	x
40. *Rhacophorus bipunctatus*	x	x
41. *Polypedates leucomystax*	x	x
42. *Polypedates macrotis*	x	x
43. *Nyctixalus pictus*	-	x
44. *Microhyla ornata*	-	x
45. *Microhyla borneensis*	x	-
46. *Microhyla heymonsi*	x	x
47. *Microhyla berdmorei*	-	x
48. *Microhyla butleri*	-	x
49. *Microhyla inornata*	-	x
50. *Kaloula pulchra*	-	x
51. *Chaperina fusca*	x	-

Remark: x = Present

For microhabitat can be divided into 2 systems that are "Lotic and Lentic". Each microhabitat is as follows;

Lotic or Srteam

1. Torrents
2. Riffle water
3. Shingle areas
4. Open pools
5. Side pools
6. Potholes on rock banks
7. Pools of intermittent streams

Lentic or Non-Stream

1. Communities in Pools or Ponds
2. Rain pools
3. Buttress tanks

For behavior, tadpoles are alert during the daytime and nighttime but most of them are increasingly alert at nighttime, both swimming and feeding. Some have obvious daytime activities that are *Megophrys nasuta, Polypedates leucomystax, MIcrohyla heymonsi* and *Kaloula pulchra.*

The character of mouthpartss

The character of mouthparts can be divided into 4 groups which are Dorsal mouth, Ventral mouth, Anterovertral mouth and Terminal mouth. These characters can be explained as follows:

Dorsal mouth

This mouth was found in *Megophrys* , *Brachytarsophrys*, *Xenophrys* and *Microhyla*(*Microhyla heymonsi* and *M. borneensis*).

Ventral Mouth

The ventral mouth was found in *Amolops* in Ranidae, *Ansonia*, *Bufo (Bufo asper)* in Bufonidae and *Leptolalax* in Megophryidae.

Anteroventral

This mouth was found in many groups of anuran tadpoles which are;Ranidae (except *Amolops* and *Occidozyga*), Rhacopholidae, *Leptobrachium* in Megophryidae and Bufonidae, except *B. asper* and *Ansonia malayana.*

Terminal Mouth

Terminal mouthes have been found in most of the Microhylidae and *Occidozyga* in Ranidae.

All tadpoles were divided by their characters of mouthparts, microhabitats and feeding behavior as the table 7.

Table 7 The relationship of external morphology, behavior and microhabitat

Species	System		Living[3]			Oral Apparatus[4]			
	Lotic [1]	Lentic [2]	S	M	B	D	AV	V	T
1. *Brachytarsophrys carinense*	3,4	-	X	-	-	X	-	-	-
2. *Megophrys nasuta*	3, 4	-	X	-	-	X	-	-	-
3. *Xenophrys longipes*	3, 4	-	X	-	-	X	-	-	-
4. *Xenophrys aceras*	4	-	X	-	-	X	-	-	-
5. *Leptobrachium* sp.1 (White-eyes)	4, 5, 7	-	-	-	X	-	X	-	-
6. *Leptobrachium* sp.2 (Red and Yellow-eyes)	4, 5, 7	-	-	-	X	-	X	-	-
7. *Leptobrachium hendricksoni*	4, 5, 7	-	-	-	X	-	X	-	-
8. *Leptolalax heteropus*	3	-	-	-	X	-	-	X	-
9. *Ansonia malayana*	2	-	-	-	X	-	-	X	-
10. *Bufo asper*	2	-	-	-	X	-	-	X	-
11. *Bufo quadriporcatus*	4 - 7	-	-	-	X	-	X	-	-
12. *Bufo parvus*	4 – 7	-	-	-	X	-	X	-	-
13. *Bufo melanostictus*	-	1, 2	-	-	X	-	X	-	-
14. *Bufo macrotis*	4 – 7	-	-	-	X	-	X	-	-
15. *Pedostibes hosii*	4, 5	-	-	-	X	-	X	-	-
16. *Amolops larutensi*	1	-	-	-	X	-	-	X	-
17. *Amolops* sp.1	1	-	-	-	X	-	-	X	-
18. *Amolops* sp.2	1	-	-	-	X	-	-	X	-
19. *Huia* sp.	2	-	-	-	X	-	-	X	-
20. *Fejervaya limnocharis*	3 – 7	1, 2	-	-	X	-	X	-	-
21. *Limnonectes* sp.	5	-	-	-	X	-	X	-	-
22. *Limnonectes blythii*	5	-	-	-	X	-	X	-	-
23. *Limnonectes macrognathus*	5	-	-	-	X	-	X	-	-
24. *Limnonectes kuhlii*	5, 7	-	-	-	X	-	X	-	-
25. *Rana alticola*	3, 4, 5, 7	-	-	-	X	-	X	-	-
26. *Rana chalconata*	3 – 7	-	-	-	X	-	X	-	-
27. *Rana hosii*	4	-	-	-	X	-	X	-	-
28. *Rana signata*	3	-	-	-	X	-	X	-	-
29. *Rana nigrovittata*	3 – 7	2	-	-	X	-	X	-	-
30. *Rana cubitalis*	4	-	-	-	X	-	X	-	-
31. *Rana erythraea*	-	1	-	-	X	-	X	-	-
32. *Taylorana hascheana*	5	-	-	-	X	-	X	-	-
33. *Hoplobatrachus rugulosus*	-	1, 2	-	-	X	-	X	-	-
34. *Occidozyga lima*	-	1	-	-	X	-	-	-	X
35. *Occidozyga martensii*	-	1	-	-	X	-	-	-	X

Table 8 (Cont'd)

Species	System		Living[3]			Oral Apparatus[4]			
	Lotic[1]	Lentic[2]	S	M	B	D	AV	V	T
36. *Rhacophorus pardali*	-	2	-	-	X	-	X	-	-
37. *Rhacophorus nigropalmatus*	6	2	-	-	X	-	X	-	-
38. *Rhacophorus reinwardtii*	6	-	-	-	X	-	X	-	-
39. *Rhacophorus prominanus*	6	-	-	-	X	-	X	-	-
40. *Rhacophorus bipunctatus*	7	-	-	-	X	-	X	-	-
41. *Polypedates leucomystax*	3 – 7	1, 2	-	-	X	-	X	-	-
42. *Polypedates macrotis*	6	-	-	-	X	-	X	-	-
43. *Nyctixalus pictus*	-	3	-	-	X	-	X	-	-
44. *Microhyla ornate*	5, 6, 7	1, 2	X	X	-	-	-	-	X
45. *Microhyla borneensis*	6	-	X	-	-	-	-	-	X
46. *Microhyla heymonsi*	5, 7	1, 2	X	-	-	-	-	-	X
47. *Microhyla berdmorei*	5	-	X	X	-	-	-	-	X
48. *Microhyla butleri*	6	-	X	X	-	-	-	-	X
49. *Microhyla inornata*	6	-	X	X	-	-	-	-	X
50. *Kaloula pulchra*	-	1	X	X	-	-	-	-	X
51. *Chaperina fusca*	6	-	X	X	-	-	-	-	X

[1] 1=Torrents 2=Riffle
3=Shingle area 4=Open pool
5=Side Pool 6=Pothole
7=Pool of Intermittent

[2] 1=Communities in Pools or Ponds
2=Rain Pools
3=Butress Tank

[3] S= Surface water M= Mid-water B= Bottom

[4] D= Dorsal mouth AV= Anteroventral mouth
V= Ventral mouth T= Terminal mouth

RECOMMENDATION FOR FUTURE WORK

In this study, there are many differences between the species and in the shape of tadpoles when compared to other studies. Thus future researchers, who are interested to studying tadpole, should concentrate on these followings matters:

1. Surveys in other locations

   In further research, the unstudied-areas should be investigated because it probably has some species that were not found in this study.

2. Exploit up-dates and recognize references

   The reference documents and recognized texts should be updated to classify species and genus identification because it would be confusing for the next researchers who will take these results for references in their own study.

3. Specify stage of tadpoles

   Studies should specify the stage of tadpoles that are used for explanation in the results because the characteristics of tadpole are different in each stage.

4. Apply characteristics of tadpoles after stage 46

   The application on characteristics of tadpoles should be used after stage 46 in which they are mature enough, because some species can change with up to4 types of color and marks on the bodies.

5. Specify place of collection

   It should specify the places where tadpoles are collected for characteristics explanation, in the field or in an aquarium to avoid any mistakes in identification especially colors that found to bedifferent between in the fieid and in aquarium.

6. Watch out for disease

   During study, care shouldbe taken to avoid disease which can affect tadpoles and infect others with that disease anddausethe death os samples..

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APPENDIX

Appendix Table 1 Measurement Body of Anuran tadpoles on Stage 37 and 40

Species	Stage	N[1]	Measurement (mm.) ±SD[8]					LTRF[7]
			TTL[2]	MSL[3]	SEL[4]	IOL[5]	INL[6]	
1. *Brachytarsophrys carinense*	37	2	48, 50±1.4	15, 16±0.7	15, 15±0	5, 5±0	25, 26±0.7	-
	40	2	48, 50±1.4	15, 16±0.7	15, 16±0.7	5, 5±0	26, 26±0	-
2. *Megophrys nasuta*	37	2	34, 35±0.7	1, 1±0	1, 1±0	3, 3.06±0.0	2, 2.04±0.0	
	40	1	37	1	1	3.1	2.0	
3. *Xenophrys longipes*	37	2	34, 34±0	2, 2±0	1, 1±0	5, 5±0	5, 5±0	-
	40	1	34	2	1	5	5	-
4. *Xenophrys aceras*	37	2	48, 50±1.4	3.80, 4±0.1	2, 2±0	6, 6±0	6, 6±0	
	40	1	50	4.1	2	6	6	
5. *Leptobrachium* sp. (White-eyes)	37	2	45, 52±4.9	2, 3±0.7	4, 6±1.4	7, 8±0.7	6, 7±0.7	6(2-6)/5(1-4)
	40	1	60	3	7	8	7	9(2-9)/7(1-6)
6. *Leptobrachium* spl. (Red, Yellow-eyes)	37	2	50, 80±21.2	4, 7±2.1	4, 7±2.1	8, 10±1.4	4, 6±1.4	6(1-6)/6(2-5) 7(2-7)/6(2-5)
	40	1	75	7	7	10	5	6(1-6)/6(2-5)
7. *Leptobrachium hendricksoni*	37	1	55	3	3	7	4	7(2-7)/7(1-6)
	40	2	54, 55±0.7	3, 3±0	3, 3±0	3, 8±3.5	4, 4±0	7(2-7)/7(1-6) 8(2-8)/8(1-5)
8. *Leptolalax heteropus*	37	1	54	0.96	1.98	3.93	1.03	3(2-3)
9. *Ansonia malayana*	37	2	15, 16.5±1.0	3, 3±0	1,1 ±0	1, 1±0	0.5, 0.5±0	2/3
	40	1	18	3	1.1	1.3	0.6	2/3

Appendix Table 1. (Cont'd)

Species	Stage	N[1]	Measurement (mm.) ±SD[8]					LTRF[7]
			TTL[2]	MSL[3]	SEL[4]	IOL[5]	INL[6]	
10. *Bufo asper*	37	2	11, 11.5±0.3	1, 1±0	0.5, 0.5±0	1, 1±0	0.5, 0.5±0	2/3
11. *Bufo divergens*	37	3	19, 20, 20±0.5	2, 2, 2±0	0.9, 1, 1±0.0	2, 2, 2±0	1.7, 1.7, 1.8±0.0	2(2)/3
	40	5	19, 20, 21, 21, 21±0.8	2, 2, 2, 2, 2±0	1, 1, 1, 1, 1±0	2, 2, 2, 2, 2.1±0.0	1.7, 1.8, 1.8, 1.8, 1.8±0.0	2(2)/3
12. *Bufo parvus*	37	3	17, 19, 19±1.1	0.9, 1, 1±0.0	0.9, 1, 1±0.0	1.8, 2, 2±0.1	1.3, 1.6, 1.6±0.1	2(2)/3
	40	3	19, 20, 20±0.5	1, 1, 1±0	1, 1, 1±0	2, 2, 2±0	1.6, 1.6, 1.6±0	2(2)/3
13. *Bufo melanastictus*	37	5	15, 17, 17, 18, 20±1.8	0.7, 0.8, 0.8, 0.9, 1±3.2	0.4, 0.4, 0.4, 0.5, 0.5±0.5	1.6, 1.9, 2, 2, 2±0.1	0.9, 1, 1, 1, 1±0.0	2(2)/3
	40	5	15, 19, 19, 20, 21±2.2	0.8, 1, 1, 1, 1±0.0	0.4, 0.5, 0.5, 0.5, 0.5±0.0	1.6, 2, 2, 2, 2±0.1	0.9, 1, 1, 1, 1±0.0	2(2)/3
14. *Bufo macrotis*	37	1	20	0.9	1.9	2.5	1.2	2(2)/3
	40	2	20, 21±0.7	0.9, 0.9±0.0	1.9, 1.9±0.0	2.5, 2.65±0.0	1.2, 1.33±0.0	2(2)/3
15. *Pedostibes hosii*	37	3	19, 20, 20±0.5	1.5, 1.5, 1.5±0	1, 1, 1±0	2, 2, 2±0	1.7, 1.7, 1.7±0	2(2)/3

Appendix Table 1. (Cont'd)

Species	Stage	N[1]	Measurement (mm.) ±SD[8]					LTRF[7]
			TTL[2]	MSL[3]	SEL[4]	IOL[5]	INL[6]	
16. *Amolops larutensis*	37	6	59, 59, 60, 60, 60, 61±0.7	3.3, 3.3, 3.4, 3.4, 3.4, 3.4±0.0	5, 5, 5, 5, 5, 5±0	8, 8, 8, 8, 8, 8±0	5.4, 5.4, 5.4, 5.4, 5.4, 5.4±0	8(4-8)/5(1) 9(5-9)/5(1)
	40	3	60, 60, 61±0.5	3.4, 3.4, 3.4±0	5, 5, 5±0	8, 8, 8±0	5.4, 5.4, 5.4±0	8(4-8)/5(1) 9(5-9)/5(1)
17. *Amolops* sp.	37	3	45, 46, 46±0.5	3, 3, 3±0	2.9, 3, 3±0.0	3, 3, 3±0	5.9, 6, 6±0.0	7(4-7)/3(1)
	40	2	45, 47±1.4	2.9, 3±0.07	3, 3±0	3,3±0	5,9,6±0.0	7(4-7)/3(1)
18. *Amolops* sp1.	40	1	70	4	4	8	2.7	9(5-9)/5(1)
19. *Huia siam*	37	1	30	0.8	1.7	3.6	1.8	5(3-5)/7(1)
	40	1	35	1	2	4	2	5(3-5)/8(1)
20. *Fejervaya limnocharis*	37	3	25, 29, 30±2.6	1.1, 1.3, 1.3±0.1	1.7, 2, 2±0.1	1.6, 2, 2±0.2	0.8, 1, 1±0.1	2(2)/3(1) 2(2)/3
	40	4	30, 30, 32, 35±2.3	1.3, 1.3, 1.4, 1.5±0.0	2, 2, 2, 2.2±0.1	2, 2, 2, 2.2±0.1	1, 1, 1, 1.1±0.0	2(2)/3(1)
21. *Limnonectes* sp.	26	3	29, 30, 30±0.5	2, 2, 2±0	2, 2, 2±0	3, 3, 3±0	2, 2, 2±0	
22. *Limnonectes blythii*	37	1	32	0.6	1.3	2.2	2.2	1/3(1-2)
	40	2	34, 35±0.7	0.8, 0.8±0.0	1.74, 1.7±0.0	2.7, 2.7±0.0	2.7, 2.7±0.0	1/3(1-2)
23. *Limnonectes macrognathus*	37	5	25, 25, 26, 27, 29±1.6	0.9, 0.9, 0.9, 0.9, 0.99±0.012	1.9, 1.9, 1.9, 1.9, 1.97±0.015	2.8, 2.8, 2.8, 2.8, 2.86±0.012	1.4, 1.4, 1.4, 1.4, 1.4±0.0	1/3(1)
	40	2	29, 30±0.7	0.9, 0.9±0	1.9, 1.9±0.0	2.8, 2.8±0.0	1.4, 1.4±0.0	1/3(1)

Appendix Table 1. (Cont'd)

Species	Stage	N[1]	Measurement (mm.) ±SD[8]					LTRF[7]
			TTL[2]	MSL[3]	SEL[4]	IOL[5]	INL[6]	
24. *Limnonectes kuhlii*	37	1	45	2.0	3.8	5.0	2.3	1(2)/3(1)
	40	2	53, 60±4.9	2.3, 2.5±0.1	4.2, 4.4±0.1	5.3, 5.6±0.2	2.6, 2.8±0.1	1(2)/3(1)
25. *Rana alticola*	37	5	70, 85, 85, 100, 105±13.8	1.5, 1.5, 1.8,1.8,2, 2±0.2	3.1, 3.5, 3.5, 4, 4±0.3	9, 10, 10, 11, 11±0.8	5, 5, 5, 6, 6±0.5	7(2-7)/6(1) 8(2-8)/7(1)
	40	5	87, 90, 102, 114, 120±14.4	1.8, 1.8, 2, 2, 2±0.1	3.5, 3.6, 4, 4, 4±0.2	10, 10, 11, 11, 11±0.5	5, 5, 6, 6, 6±0.5	8(2-8)/7(1)
26. *Rana chalconata*	37	5	25, 28, 30, 34, 35±4.1	0.2, 0.4, 0.8, 1, 1±0.2	2.3, 2.5, 2.8, 3, 3±0.3	2.3, 2.5, 2.7, 3, 3±0.3	2, 2.3, 2.3, 2.8, 2.8±0.3	4(2-4)/3 4(2-4)/3(1) 5(2-5)/3(1)
	40	5	25, 29, 32, 34, 35±0.4	0.2, 0.4, 0.8, 1, 1±0.2	2.3, 2.5, 2.8, 3, 3±0.3	2.3, 2.5, 2.8, 3, 3±0.3	2, 2.3, 2.6, 2.7, 2.8±0.3	4(2-4)/3(1) 5(2-5)/3(1)
27. *Rana hosii*	37	2	47, 48±0.7	1.3, 1.3±0.0	2.6, 2.6±0.01	3.6, 3.7±0.0	1.8, 1.8±0.04	5(2-5)/4(1)
	40	3	48, 49, 5±1.5	1.5, 1.5, 1.5±0.0	3.0, 3.0, 3.0±0.0	3.9, 4.03, 4.1±0.0	1.9, 2.0, 2.0±0.0	5(2-5)/4(1)
28. *Rana signata*	37	1	25	1.1	2.3	5.5	3.6	7(2-7)/4(1)
	40	2	38, 40±1.4	1.3, 1.5±0.1	2.7, 3.1±0.2	5.7, 5.9±0.1	3.9, 4.0±0.0	7(2-7)/4(1)

Appendix Table1. (Cont'd)

Species	Stage	N[1]	Measurement (mm.) ±SD[8]					LTRF[7]
			TTL[2]	MSL[3]	SEL[4]	IOL[5]	INL[6]	
29. *Rana nigrovittata*	37	5	35, 35, 37, 38, 38±1.5	3.1, 3.1, 3.1, 3.1, 3.1±0.0	3.1, 3.1, 3.1, 3.1, 3.1±0.0	3.3, 3.3, 3.4, 3.4, 3.4±0.0	2.5, 2.5, 2.7, 2.7, 2.7±0.1	2(2)/3(1)
	40	7	36, 37, 37, 38, 39, 40, 40±1.8	3.14, 3.14, 3.1, 3.1, 3.2, 3.2, 3.21±0.0	3.14, 3.15, 3.1, 3.1, 3.2, 3.2, 3.2±0.0	3.40,3.48, 3.4,3.4, 3.5,3.5, 3.5±0.05	2.5, 2.7, 2.7, 2.7, 2.9, 3.0, 3.0±0.3	2(2)/3(1)
30. *Rana cubitalis*	37	1	40	4.0	2.6	2.0	3.9	2(2)/3(1)
	40	2	35, 38±2.1	3.6, 3.9±0.1	2.2, 2.5±0.2	1.7, 1.8±0.1	3.5, 3.7±0.1	2(2)/3(1)
31. *Rana erythraes*	37	3	35, 35, 42±4.0	4.0, 4.0, 5.3±0.7	1.9, 1.9, 2.7±0.4	1.5, 1.5, 1.8±0.1	2.9, 2.9, 3.5±0.3	1/2(1)
	40	6	35, 42, 46, 47, 49, 50±5.5	4.0, 5.3, 6.2, 6.5, 6.7, 6.8 ±1.0	1.9, 2.6, 3.1, 3.2, 3.3,3.3±0.5	1.5,1.6, 1.9,1.9, 2.0, 2.0±0.2	2.9,3.5,3.8,3.8 6,4.0,4.07±0.4 01	1/2(1)
32. *Taylorana hascheana*	37	1	20	1.5	0.7	0.3	0.6	-
33. *Hoplobatrachus rugulosa*	37	2	50, 60±7.0	5.8, 6.0±0.1	1.8, 2.0±0.1	4.8, 5.0±0.1	4.8, 4.9±0.1	5(3-5)/5(1-3)
	40	1	60	6.0	2	5.0	4.9	5(3-5)/5(1-3)
34. Occidozyga lima	40	1	37	3.4	1.8	1.3	1.4	
35. *Occidozyga martensii*	37	1	25	3.0	1.4	0.9	0.9	
36. *Rhacophorus pardalis*	40	1	38	4.5	2.2	1.4	2.5	6(3-6)/3

Appendix Table1. (Cont 'd)

Species	Stage	N[1]	Measurement (mm.) ±SD[8]					LTRF[7]
			TTL[2]	MSL[3]	SEL[4]	IOL[5]	INL[6]	
37. *Rhacophorus nigropalmatus*	37	2	42, 45±2.1	1.7, 1.8±0.0	1.7, 1.8±0.0	4.9, 6.0±0.7	2.4, 3.0±0.3	6(3-6)/3(1)
	40	1	45	1.8	1.8	6.0	3.0	Reduced
38. *Rhacophorus reinwardtii*	37	1	38	1.0	2.0	4.0	1.9	7(2-7)/3(1)
	40	1	40	1.1	2.2	4.1	2.1	7(2-7)/3(1)
39. *Rhacophorus prominanus*	37	5	30, 30, 30, 31, 31±0.548	1.31, 1.32, 1.32,1.34, 1.34±0.013	1.98, 1.99, 1.99, 2.01, 2.01±0.013	3.9,3.9, 3.9,3.9, 3.9±0.0	2.6, 2.6, 2.6, 2.6, 2.6±0.0	5(2-5)/3
	40	5	31, 31, 31, 32, 32±0.5	1.3, 1.3, 1.3, 1.3, 1.3±0.0	2, 2.0, 2.0, 2.0, 2.0±0.0	3.9,3.9, 3.9, 4, 4.0±0.0	2.6, 2.6, 2.6, 2.6, 2.6±0.0	5(2-5)/3 6(2-6)/3
40. *Rhacophorus bipunction*	37	2	35, 37±1.4	1.01, 1.0±0.0	2.0, 2.0±0.0	4.2, 4.3±0.0	2.1, 2.2±0.0	6(2-6)/3(1)
	40	1	37	1.0	2.0	4.3	2.2	6(2-6)/3(1)
41. *Polypedates leucomystax*	37	3	40, 43, 48±4.041	1.0, 1.1, 1.2±0.0	4.0, 4.3, 4.8±0.3	6.0, 6.2, 6.7±0.3	2.0, 2.0, 2.2±0.1	4(2-4)/3(1)
	40	3	45, 52, 55±5.1	1.1, 1.9, 2.2±0.5	4.5, 7.8, 9.1±0.3	6.4,9.9, 12.±0.3	2.1, 3.3, 4.0±0.9	4(2-4)/3(1)
42. *Polypedates macrotis*	37	2	35, 37±1.414	1.5, 1.7±0.2	1.5, 1.7±0.2	5.5, 5.7±0.1	2.7, 2.8±0.0	5(2-5)/3(1)
	40	3	39, 40, 40±0.5	1.9, 2.0, 2.0±0.0	1.9, 2.0,2.06±0.0	5.9, 6.0, 6.0±0.0	2.9, 3.0, 3.0±0.0	5(2-5)/3(1) 6(2-6)/3(1)
43. *Nyctixalus pictus*	40	1	40	2.03	2.03	5.01	2.52	5(3-5)/3

Appendix Table1. (Cont'd)

Species	Stage	N[1]	Measurement (mm.) ±SD[8]					LTRF[7]
			TTL[2]	MSL[3]	SEL[4]	IOL[5]	INL[6]	
44. *Microhyla ornata*	40	3	25, 27, 27±1.1	1.1, 1.2, 1.2±0.0	1.1, 1.2, 1.2±0.0	6.8, 7.0, 7.0±0.1	3.3, 3.5, 3.5±0.1	-
45. Microhyla borneensis	37	2	17, 18±0.7	1.0, 1.1±0.0	1.0, 1.1±0.0	3.2, 3.2±0.0	1.0, 1.0±0.0	-
	40	3	18, 19, 19±0.5	1.1, 1.1, 1.1±0.0	1.1, 1.1, 1.1±0.0	3.2, 3.2, 3.2±0.0	1.0, 1.0, 1.0±0.0	-
46. *Microhyla heymonsi*	37	2	13, 14±0.7	2.0, 2.1±0.0	0.7, 0.7±0.0	0.9, 1.0±0.0	0.9, 1.0±0.0	
	40	3	14, 15, 15±0.5	2.1, 2.2, 2.2±0.0	0.7, 0.7, 0.7±0.0	1.0, 1.1, 1.1±0.0	1.0, 1.1, 1.1±0.0	
47. *Microhyla berdmorei*	37	1	20	1.0	1.0	5.0	1.0	-
	40	1	23	1.0	1.0	5.0	1.1	-
48. *Microhyla butleri*	40	1	19	1.2	1.2	5.2	1.2	-
49. *Microhyla inornata*	37	1	19.	1.8	1.8	5.1	1.7	
50. *Kaloula pulchra*	37	3	18, 18, 18.5±0.2	1.7, 1.8, 1.8±0.0	1.7, 1.8, 1.8±0.0	5.4, 5.4, 5.4±0.0	0.6, 0.6, 0.7±0.0	
	40	2	19, 19.5±0.3	1.8, 1.8±0.0	1.8, 1.8±0.0	5.4, 5.5±0.0	0.7, 0.7±0.0	
51. *Chaperina fusca*	37	2	20, 21±0.707	0.9, 0.9±0.0	0.9, 0.9±0.0	4.9, 5.0±0.0	2.4, 2.5±0.0	
	40	1	21	0.9	0.9	5.0	2.5	-

[1] N=Number of Tadpole
[2] TTL=Total length
[3] MSL=Mouth-snout length
[4] SEL=Snout-eye length
[5] IOL=Interorbital length
[6] INL=Internarial length
[7] LTRF=Lateral tooth rows formula
[8] SD=Standard Deviation

Appendix Table 2 The details of tadpoles survey in Khlong Nakha Wildlife Sanctuary

Tadpole's Species	Places and Duration						
	Khlong Nakha Wildlife Sanctuary						
	Jan. 2002	Mar. 2002	May 2002	Jul. 2002	Sep. 2002	Nov. 2002	Jan. 2003
Brachytarsophrys carinense[1]	-	-	-	-	-	-	-
Megophrys nasuta[1]	-	-	-	-	-	-	-
Xenophrys longipes[1]	*	-	-	-	-	-	-
Xenophrys aceras[1]	*	-	-	-	-	-	-
Leptobrachium sp.1 [1] (White-eyes)	-	-	-	-	-	-	-
Leptobrachium sp.2 (Red and Yellow-eyes)[1]	-	-	-	-	-	-	*
Leptobrachium hendricksoni[1]	-	-	-	-	-	-	-
Leptolalax heteropus [1]	-	-	-	-	-	-	-
Ansonia malayana [1]	*	-	-	-	-	-	-
Bufo asper[1]	*	-	-	-	-	-	-
Bufo quadriporcatus[1]	-	-	-	-	-	-	-
Bufo parvus[1]	*	-	*	-	-	-	-
Bufo melanostictus[2]	-	-	-	*	*	*	-
Bufo macrotis[1]	*	-	-	-	-	-	-
Pedostibes hosii[1]	-	-	-	-	-	-	-
Amolops larutensis [1]	-	-	-	-	-	-	-
Amolops sp.1 [1]	*	-	-	-	-	-	-
Amolops sp.2 [1]	-	-	-	-	-	-	-
Huia sp.[1]	*	-	-	-	-	-	-
Fejervaya limnocharis [3]	*	*	*	*	*	*	*
Limnonectes sp.[1]	-	-	-	-	-	-	-
Limnonectes blythii[1]	*	-	-	-	-	-	-
Limnonectes macrognathus[1]	-	-	-	-	-	-	-
Limnonectes kuhlii[1]	*	-	-	-	-	-	-
Rana alticola[1]	*	*	*	*	*	*	*
Rana chalconata[1]	*	*	*	*	*	*	*
Rana hosii[1]	*	-	-	-	-	-	-
Rana signata[1]	-	-	-	-	-	-	-
Rana nigrovittata [1]	-	*	-	-	-	-	-
Rana cubitalis[1]	*	-	-	-	-	-	-
Rana erythraea [2]	*	*	*	*	*	*	*
Taylorana hascheana [1]	-	-	-	*	-	-	-
Hoplobatrachus rugulosus[2]	-	-	-	-	-	*	-
Occidozyga lima [2]	-	-	-	-	-	-	-
Occidozyga martensii [2]	-	-	-	*	-	-	-
Rhacophorus pardalis[2]	-	-	-	-	-	-	-

Appendix Table 2 (Cont'd)

Tadpole's Species	Places and Duration						
	Khlong Nakha Wildlife Sanctuary						
	Jan. 2002	Mar. 2002	May 2002	Jul. 2002	Sep. 2002	Nov. 2002	Jan. 2003
Rhacophorus nigropalmatus[2]	-	-	-	-	-	-	-
Rhacophorus reinwardti[1]	-	-	-	-	-	-	-
Rhacophorus prominanus[1]	-	-	-	-	-	-	-
Rhacophorus bipunctatus[1]	-	-	-	-	*	-	-
Polypedates leucomystax[3]	*	*	*	*	*	*	*
Polypedates macrotis[1]	-	-	-	-	-	-	-
Nyctixalus pictus[2]	-	-	-	-	-	-	-
Microhyla ornate[3]	*	-	-	-	-	-	-
Microhyla borneensis[1]	-	-	-	-	-	-	-
Microhyla heymonsi[3]	*	*	*	*	*	*	*
Microhyla berdmorei[1]	-	-	-	-	-	-	-
Microhyla butleri[1]	-	-	-	-	-	-	-
Microhyla inornata[1]	-	-	-	-	-	-	-
Kaloula pulchra[2]	-	-	-	-	-	*	-
Chaperina fusca[1]	-	-	-	-	-	*	-
Total Tadpoles	19	7	7	9	7	10	7
Total Lotic Tadpoles	14	2	3	3	2	3	3
Total Lentic Tadpoles	1	1	1	3	2	4	1
Lotic and Lectic Tadpoles	4	4	3	3	3	3	3

Remarks:
* = found in the survey
- = unfound in the survey
1 = Lotic tadpoles
2 = Lentic tadpoles
3 = Lotic and Lentic tadpoles

Appendix Table 3 The details of tadpoles survey in Khao Luang National Park,

Tadpole's Species	Places and Duration						
	Khao Luang National Park						
	Jan. 2002	Mar. 2002	May 2002	Jul. 2002	Sep. 2002	Nov. 2002	Jan. 2003
Brachytarsophrys carinense[1]	-	*	-	*	-	-	-
Megophrys nasuta[1]	-	-	-	-	-	-	-
Xenophrys longipes[1]	-	-	-	-	-	-	-
Xenophrys aceras[1]	*	-	-	-	-	-	-
Leptobrachium sp.1 [1] (White-eyes)	-	-	-	*	-	-	-
Leptobrachium sp.2 (Red and Yellow-eyes)[1]	*	*	-	*	-	-	-
Leptobrachium hendricksoni[1]	-	-	-	-	-	-	-
Leptolalax heteropus [1]	-	-	-	-	-	-	-
Ansonia malayana [1]	-	-	-	-	-	-	-
Bufo asper[1]	-	*	-	-	-	-	-
Bufo quadriporcatus[1]	-	-	-	-	-	-	-
Bufo parvus[1]	-	-	-	*	-	-	-
Bufo melanostictus[2]	-	-	-	*	*	*	-
Bufo macrotis[1]	*	-	-	-	-	-	-
Pedostibes hosii[1]	-	-	-	-	-	-	-
Amolops larutensis [1]	-	-	-	-	-	-	-
Amolops sp.1 [1]	-	-	-	-	-	-	-
Amolops sp.2 [1]	-	-	-	-	-	-	-
Huia sp.[1]	-	-	-	-	-	-	-
Fejervaya limnocharis [3]	*	*	*	*	*	*	*
Limnonectes sp.[1]	-	-	-	-	-	-	-
Limnonectes blythii[1]	*	-	-	-	-	-	-
Limnonectes macrognathus[1]	*	-	-	-	-	-	-
Limnonectes kuhlii[1]	*	-	-	-	-	-	-
Rana alticola[1]	*	-	-	-	-	-	-
Rana chalconata[1]	*	*	*	*	*	*	*
Rana hosii[1]	*	-	-	-	-	-	-
Rana signata[1]	-	-	-	-	-	-	-
Rana nigrovittata [1]	-	*	*	-	*	-	-
Rana cubitalis[1]	*	-	-	-	-	-	-
Rana erythraea [2]	*	*	*	*	*	*	*
Taylorana hascheana [1]	-	-	-	-	-	-	-
Hoplobatrachus rugulosus[2]	-	-	-	-	-	*	-
Occidozyga lima [2]	-	-	*	-	-	-	-
Occidozyga martensii [2]	-	-	-	*	-	-	-
Rhacophorus pardalsi[2]	-	-	-	-	-	-	-

Appendix Table 3 (Cont'd)

Tadpole's Species	Places and Duration						
	Khao Luang National Park						
	Jan. 2002	Mar. 2002	May 2002	Jul. 2002	Sep. 2002	Nov. 2002	Jan. 2003
Rhacophorus nigropalmatus[2]	-	-	-	-	-	-	-
Rhacophorus reinwardti[1]	-	-	-	-	-	-	-
Rhacophorus prominanus[1]	-	-	-	-	-	-	-
Rhacophorus bipunctatus[1]	-	-	-	-	-	-	-
Polypedates leucomystax[3]	*	*	*	*	*	*	*
Polypedates macrotis[1]	-	-	-	-	-	-	-
Nyctixalus pictus[2]	-	-	-	-	-	-	-
Microhyla ornate[3]	*	-	-	-	-	-	-
Microhyla borneensis[1]	-	-	-	-	-	-	-
Microhyla heymonsi[3]	*	*	*	*	*	*	*
Microhyla berdmorei[1]	*	-	-	-	-	-	-
Microhyla butleri[1]	*	-	-	-	-	-	-
Microhyla inornata[1]	-	-	-	-	-	-	-
Kaloula pulchra[2]	-	-	*	-	-	-	-
Chaperina fusca[1]	-	-	-	-	-	-	-
Total Tadpoles	17	8	8	11	7	6	5
Total Lotic Tadpoles	12	4	1	5	1	1	1
Total Lentic Tadpoles	1	1	3	3	2	2	1
Lotic and Lectic Tadpoles	4	3	4	3	4	3	3

Remarks: * = found in the survey
- = unfound in the survey
1 = Lotic tadpoles
2 = Lentic tadpoles
3 = Lotic and Lentic tadpoles

Appendix Table 4 The details of tadpoles survey in Hala-Bala (Only Bala) Wildlife Sanctuary

Tadpole's Species	Places and Duration						
	Hala-Bala Wildlife Sanctuary						
	Jan. 2002	Mar. 2002	May 2002	Jul. 2002	Sep. 2002	Nov. 2002	Jan. 2003
Brachytarsophrys carinense[1]	-	-	-	-	-	-	-
Megophrys nasuta[1]	*	-	-	-	-	-	-
Xenophrys longipes[1]	-	-	-	-	-	-	-
Xenophrys aceras[1]	-	-	-	-	-	-	-
Leptobrachium sp.1 [1] (White-eyes)	-	-	-	-	-	-	-
Leptobrachium sp.2 (Red and Yellow-eyes)[1]	-	-	-	-	-	-	-
Leptobrachium hendricksoni[1]	*	*	*	*	*	*	*
Leptolalax heteropus [1]	-	-	*	-	-	-	-
Ansonia malayana [1]	*	-	-	-	-	-	-
Bufo asper[1]	*	-	-	-	-	-	-
Bufo quadriporcatus[1]	*	*	*	*	*	*	*
Bufo parvus[1]	-	-	-	-	-	-	-
Bufo melanostictus[2]	-	-	-	*	*	*	-
Bufo macrotis[1]	-	-	-	-	-	-	-
Pedostibes hosii[1]	-	-	*	-	-	-	-
Amolops larutensis [1]	*	*	*	*	*	*	*
Amolops sp.1 [1]	-	-	-	-	-	-	-
Amolops sp.2 [1]	-	-	-	*	-	-	-
Huia sp.[1]	-	-	-	-	-	-	-
Fejervaya limnocharis [3]	*	*	*	*	*	*	*
Limnonectes sp.[1]	*	-	-	-	-	-	-
Limnonectes blythii[1]	-	-	-	-	-	-	-
Limnonectes macrognathus[1]	-	-	-	-	-	-	-
Limnonectes kuhlii[1]	*	-	-	-	-	-	-
Rana alticola[1]	-	-	-	-	-	-	-
Rana chalconata[1]	*	*	*	*	*	*	*
Rana hosii[1]	-	-	*	-	-	-	-
Rana signata[1]	-	-	*	-	-	-	-
Rana nigrovittata [1]	*	-	-	-	*	-	-
Rana cubitalis[1]	-	-	-	-	-	-	-
Rana erythraea [2]	*	*	*	*	*	*	*
Taylorana hascheana [1]	-	-	*	-	-	-	-
Hoplobatrachus rugulosus[2]	-	-	-	-	-	*	-
Occidozyga lima [2]	-	-	-	-	-	-	-
Occidozyga martensii [2]	-	-	-	-	-	-	-
Rhacophorus pardalis[2]	*	-	-	-	-	-	-

Appendix Table 4 (Cont'd)

Tadpole's Species	Places and Duration						
	Hala-Bala Wildlife Sanctuary						
	Jan. 2002	Mar. 2002	May 2002	Jul. 2002	Sep. 2002	Nov. 2002	Jan. 2003
Rhacophorus nigropalmatus[2]	*	-	-	-	-	-	-
Rhacophorus reinwardti[1]	*	-	-	-	-	-	-
Rhacophorus prominanus[1]	*	*	*	-	-	*	-
Rhacophorus bipunctatus[1]	-	-	-	-	-	-	-
Polypedates leucomystax[3]	*	*	*	*	*	*	*
Polypedates macrotis[1]	*	-	-	*	-	-	-
Nyctixalus pictus[2]	*	-	-	-	-	-	-
Microhyla ornate[3]	*	-	-	-	-	-	-
Microhyla borneensis[1]	*	-	*	-	*	-	-
Microhyla heymonsi[3]	*	*	*	*	*	*	*
Microhyla berdmorei[1]	-	-	-	-	-	-	-
Microhyla butleri[1]	*	-	-	-	-	-	-
Microhyla inornata[1]	*	-	-	-	-	-	-
Kaloula pulchra[2]	-	-	-	-	-	*	-
Chaperina fusca[1]	-	-	-	-	-	-	-
Total Tadpoles	24	9	15	11	11	12	8
Total Lotic Tadpoles	15	5	11	6	5	5	4
Total Lentic Tadpoles	3	1	1	2	2	4	1
Lotic and Lectic Tadpoles	6	3	3	3	4	3	3

Remarks:
* = found in the survey
- = unfound in the survey
1 = Lotic tadpoles
2 = Lentic tadpoles
3 = Lotic and Lentic tadpoles

The Permit of Tadpoles' collecting

ที่ ทส (กวภ) 0938/ ๕๖

กรมอุทยานแห่งชาติ สัตว์ป่า และพันธุ์พืช
61 ถ.พหลโยธิน จตุจักร
กรุงเทพฯ 10900

๑๙ มีนาคม 2546

เรื่อง ขออนุญาตเข้าไปทำการศึกษาหรือวิจัยทางวิชาการในพื้นที่ป่าไม้

เรียน คุณจารุจินต์ นภีตะภัฏ

อ้างถึง แบบคำขออนุญาตฯ ลงวันที่ 7 สิงหาคม 2545

สิ่งที่ส่งมาด้วย แบบ กปม. (ว)-04

ตามหนังสือที่อ้างถึง ท่านได้ขออนุญาตเข้าทำการศึกษาวิจัยในพื้นที่ป่าไม้ เรื่อง "สัณฐานวิทยาที่ใช้ในการแยกชนิดลูกอ๊อดบางชนิด ในอันดับ Anuran ของภาคใต้ของประเทศไทย" รายละเอียดตามที่แจ้งแล้ว นั้น

ฝ่ายเลขานุการคณะกรรมการวิชาการด้านป่าไม้ ขอเรียนว่า กรมอุทยานแห่งชาติ สัตว์ป่าและพันธุ์พืช ได้พิจารณาแล้ว อนุญาตให้เข้าดำเนินการในพื้นที่ดังกล่าวได้ ตั้งแต่ มีนาคม 2546 ถึง มกราคม 2547 โดยให้ปฏิบัติตามรายละเอียดในแบบ กปม. (ว)-04 ในสิ่งที่ส่งมาด้วย

จึงเรียนมาเพื่อโปรดทราบ และแจ้งให้คณะผู้วิจัยทราบด้วย

ขอแสดงความนับถือ

(นายพิทยา เพชรมาก)
นักวิชาการป่าไม้ 8 ว.
กรรมการและผู้ช่วยเลขานุการ
คณะกรรมการวิชาการด้านป่าไม้

ฝ่ายเลขานุการคณะกรรมการวิชาการด้านป่าไม้
โทร. 5614292-3 ต่อ 408,409