

## Mouth Part Structures and Distribution of Some Tadpoles from Thailand

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**ABSTRACT.**- The survey of some tadpole species in Thailand was conducted between December 1998 to March 2004. The 44 species of tadpoles were found from many parts of Thailand. The species are following: *Brachytarsophrys carinensis* (Boulenger, 1889), *Leptobranchium hendricksoni* Taylor, 1962, *Leptolalax gracilis* (Gunther, 1872), *Leptolalax pelodytoides* (Boulenger, 1893), *Megophrys parva* (Boulenger, 1893), *Ansonia malayana* Inger, 1960, *Bufo macrotis* Boulenger, 1887, *Bufo parvus* Boulenger, 1887, *Amolops marmoratus* (Gunther, 1859), *Amolops* sp., *Fejervarya cancrivora* (Gravenhorst, 1829), *Fejervarya limnocharis* (Gravenhorst, 1829), *Hoplobatrachus rugulosus* (Wiegman, 1835), *Limnonectes kuhlii* (Duméril and Bibron, 1841), *Limnonectes blythii* (Boulenger, 1920), *Occidozyga lima* (Gravenhorst, 1829), *Occidozyga martensii* (Peters, 1867), *Paa fasciculispina* (Inger, 1970), *Rana alticola* Boulenger, 1882, *Rana chalconota* (Schlegel, 1837), *Rana erythraea* (Schlegel, 1837), *Rana livida* (Blyth, 1856), *Rana nigrovittata* (Blyth, 1855), *Chirixalus hansenae* Cochran, 1827, *Chirixalus vittatus* (Boulenger, 1887), *Polypedates leucomystax* (Gravenhorst, 1829), *Rhacophorus bipunctatus* Ahl, 1927, *Rhacophorus* sp., *Theloderma asperum* (Boulenger, 1886), *Calluella guttulata* (Blyth, 1855), *Glyphoglossus molossus* Gunther, 1868, *Kalophrynus interlineatus* (Blyth, 1855), *Kaloula pulchra* Gray, 1831, *Microhyla berdmorei* (Blyth, 1856), *Microhyla butleri* Boulenger, 1900, *Microhyla heymsi* Vogt, 1911, *Microhyla ornata* (Duméril and Bibron, 1841), *Microhyla pulchra* (Hallowell, 1861), *Micryletta inornata* (Boulenger, 1890). Two of them, *Leptobranchium* sp. and *Rhacophorus* sp. have been studied for more details about mouth part, morphology to identify species.

**KEY WORDS.**- Tadpole, Mouth Part Structure, Feeding behavior, Thailand.

## INTRODUCTION

The life cycle of amphibians are composed of two periods as for instance larval (tadpole) and adult. Most amphibians lay eggs in the water and

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afterwards their eggs develop to tadpoles. In the tadpoles period, they have a mouth part characters and feeding behaviors that are different from adult. Both of these characters important to identify tadpole species. Expect to mouth part structure of each species because it can be use as taxonomic characters.

Most of amphibian researches of Thailand and other countries in south-east Asia are related with the Taxonomy. Example Taylor (1962) studied and identified amphibian of Thailand by collected amphibian samples from 71 Provinces between 1957-1958 and 1959-1960 and conducted the key and described amphibian of Thailand. Inger (1966) studied the systematics and zoogeography of Borneo amphibian and conducted the keys to tadpole families and species on the base of mouthpart structure and other morphology. Smith (1916a, 1917) described the character of 21 tadpoles species. Heyer (1971) studied and described morphological of 19 tadpole species in 4 families from the Sakaerat Experimental and Environmental Station in Nakhon Ratchasima Province of Thailand. Berry (1975) studied amphibians diversity of Peninsular Malaysia. Matsui et.al. (1996) surveyed the amphibian fauna in each regions of Thailand and in 1999 studied Megophryidae in genus *Leptobrachium* from Thailand and described the new species by information from adult morphology and used tadpole character supporting. Leong and Chou (1999) studied diversity and development of Singapore tadpole. Tu et.al. (1999) reported specific gravity and mechanism for its control in tadpoles of three anuran species from different water strata and the office of environmental policy and planning (2000) reported that Thailand have 123 amphibian species that was in great numbers when compared with other countries area. In fact we can study anuran diversity from tadpoles distribution that are easy than from adult. So that some time we can fine the new species record and novel species. In this research we followed the three objectives as (1) Study mouth part structure and feeding behavior of tadpole, (2) Use mouth part structure of tadpole to taxonomic character for tadpole classification and (3) Use tadpoles' distribution data of each region for fundamental information of Thailand.

## MATERIAL AND METHOD

Field surveys and study period spanned between December 1998 to March 2000. Normally, field trips were on a weekly in average. We checked anuran distribution area from documents and collected tadpole samples from that land. Furthermore catch from many other area that was easy for survey. Lapped tadpole samples by dip-nets. Before catch them must had observed their activity, ecology of their habitat (a) lotic system-flowing water: eg. Stream banks, waterfalls, forest streams, shingle areas and riffle; (b) Lentic system non-flowing water: eg. Rain pools, side pools of streams, trail-side ditches, puddles, ponds; (c) Phytothelmata: eg. Tree-holes, log cavities, buttress reservoirs, pitcher and plant cups. Transferred tadpole samples from natural area to laboratory room and feed them and observed their feeding behavior together. Selected tadpoles which have perfectly hind limb. This state, tadpole mouth part structures are completely then check denticle structure by stereomicroscope and took tadpole mouth photograph. Grew up left over tadpoles to adult for checked their species these again. Finally, take a remained tadpoles and frog back to their natural habitat research ending.

## RESULTS

Samples of tadpoles from Thailand that are collected between December 1998 to March 2004 had 44 species total from 5 families as for instance (1) Family Megophryidae: *Brachytarsophrys carinensis* (Boulenger, 1889), *Leptobrachium hendricksoni* Taylor, 1962, *Leptolalax gracilis* (Gunther, 1872), *Leptolalax pelodytoides* (Boulenger, 1893), *Megophrys parva* (Boulenger, 1893). (2) Family Bufonidae: *Ansonia malayana* Inger, 1960, *Bufo macrotis* Boulenger, 1887, *Bufo parvus* Boulenger, 1887. (3) Family Ranidae: *Amolops marmoratus* (Gunther, 1859), *Amolops* sp., *Fejervarya cancrivora* (Gravenhorst, 1829), *Fejervarya limnocharis* (Gravenhorst, 1829), *Hoplobatrachus rugulosus* (Wiegman, 1835), *Limnonectes kuhlii* (Dumuril and Bignon, 1841), *Limnonectes blythii* (Boulenger, 1920), *Occidozyga lima* (Gravenhorst, 1829), *Occidozyga martensii* (Peters, 1867), *Paa fasciculispina* (Inger,

1970), *Rana alticola* Boulenger, 1882, *Rana chalconota* (Schlegel, 1837), *Rana erythraea* (Schlegel, 1837), *Rana livida* (Blyth, 1856), *Rana nigrovittata* (Blyth, 1855). (4) Family Rhacophoridae: *Chirixalus hansenae* Cochran, 1827, *Chirixalus vittatus* (Boulenger, 1887), *Polypedates leucomystax* (Gravenhorst, 1829), *Rhacophorus bipunctatus* Ahl, 1927, *Rhacophorus* sp., *Theلودerma asperum* (Boulenger, 1886). (5) Family Microhylidae: *Calluella guttulata* (Blyth, 1855), *Glyphoglossus molossus* Gunther, 1868, *Kalophrynus interlineatus* (Blyth, 1855), *Kaloula pulchra* Gray, 1831, *Microhyla berdmorei* (Blyth, 1856), *Microhyla butleri* Boulenger, 1900, *Microhyla heymonsi* Vogt, 1911, *Microhyla ornata* (Dumeril and Bibron, 1841), *Microhyla pulchra* (Hallowell, 1861), *Micryletta inornata* (Boulenger, 1890). The distributions of all tadpoles are given as:

**Table 1** Tadpole distribution in some Provinces of Northern Thailand

Province	Species
Chiang Rai	<i>Fejervarya limnocharis</i> , <i>Limnonectes kuhlii</i> , <i>Rana nigrovittata</i> , <i>Polypedates leucomystax</i> , <i>Microhyla heymonsi</i> , <i>Microhyla ornata</i>
Chiang Mai	<i>Leptobranchium smithi</i> , <i>Leptolalax pelodytoides</i> , <i>Megophrys parva</i> , <i>Amolops marmoratus</i> , <i>Fejervarya limnocharis</i> , <i>Limnonectes kuhlii</i> , <i>Microhyla berdmorei</i> , <i>Microhyla heymonsi</i> , <i>Microhyla ornata</i>
Lampang	<i>Microhyla berdmorei</i>
Phrae	<i>Fejervarya limnocharis</i> , <i>Occidozyga lima</i> , <i>Microhyla ornata</i>

**Table 2** Tadpole distribution in some Provinces of Eastern Thailand

Province	Species
Chachoengsao	<i>Megophrys parva</i> , <i>Bufo melanostictus</i> , <i>Fejervarya limnocharis</i> , <i>Hoplobatrachus rugulosus</i> , <i>Occidozyga lima</i> , <i>Occidozyga martensii</i> , <i>Rana nigrovittata</i> , <i>Chirixalus vittatus</i> , <i>Polypedates leucomystax</i> , <i>Calluella guttulata</i> , <i>Microhyla berdmorei</i> , <i>Microhyla butleri</i> , <i>Microhyla heymonsi</i> , <i>Microhyla ornata</i> , <i>Microhyla pulchra</i>
Chanthaburi	<i>Megophrys parva</i> , <i>Paa fasciculispina</i> , <i>Rana nigrovittata</i>
Trat	<i>Paa fasciculispina</i> , <i>Rana nigrovittata</i>
Prachin Buri	<i>Limnonectes kuhlii</i> , <i>Rana nigrovittata</i> , <i>Kaloula pulchra</i> , <i>Microhyla heymonsi</i>

**Table 3** Tadpole distribution in some Provinces of Western Thailand

Province	Species
Kanchanaburi	<i>Bachytarsophrys carinensis</i> , <i>Leptobranchium smithi</i> , <i>Leptobranchium</i> sp., <i>Leptolalax gracilis</i> , <i>Megophrys parva</i> , <i>Ansonia malayana</i> , <i>Bufo macrotis</i> , <i>Bufo melanostictus</i> , <i>Bufo parvus</i> , <i>Amolops marmoratus</i> , <i>Fejervarya limnocharis</i> , <i>Limnonectes kuhlii</i> , <i>Occidozyga martensii</i> , <i>Rana alticola</i> , <i>Rana hosii</i> , <i>Polypedates leucomystax</i> , <i>Rhacophorus bipunctatus</i> , <i>Glyphoglossus molossus</i> , <i>Kaloula pulchra</i> , <i>Microhyla butleri</i> , <i>Microhyla heymonsi</i> , <i>Microhyla ornata</i> , <i>Microhyla pulchra</i> , <i>Micryletta inornata</i> ,
Phetchaburi	<i>Brachytarsophrys carinensis</i> , <i>Leptobranchium smithi</i> , <i>Megophrys parva</i> , <i>Bufo melanostictus</i> , <i>Bufo parvus</i> , <i>Amolops</i> sp., <i>Rana alticola</i> , <i>Polypedates leucomystax</i>
Uthai Thani	<i>Polypedates leucomystax</i>
Prachuap Khiri Khan	<i>Rana alticola</i>

**Table 4** Tadpole distribution in some Provinces of Central Thailand

Province	Species
Nakhon Nayok	<i>Limnonectes kuhlii</i> , <i>Rana nigrovittata</i> , <i>Polypedates leucomystax</i> , <i>Kaloula pulchra</i> , <i>Microhyla heymonsi</i> , <i>Microhyla ornata</i>
Bangkok	<i>Bufo melanostictus</i> , <i>Fejervarya limnocharis</i> , <i>Rana erythraea</i> , <i>Polypedates leucomystax</i> , <i>Kaloula pulchra</i> , <i>Microhyla heymonsi</i> , <i>Microhyla ornata</i>
Samut Prakan	<i>Fejervarya cancrivora</i> , <i>Fejervarya limnocharis</i>
Nakhon Pathom	<i>Fejervarya limnocharis</i>

**Table 5** Tadpole distribution in some Provinces of Northeastern Thailand

Province	Species
Loei	<i>Leptobranchium smithi</i> , <i>Leptolalax pelodytoides</i> , <i>Megophrys parva</i> , <i>Bufo melanostictus</i> , <i>Bufo parvus</i> , <i>Fejervarya limnocharis</i> , <i>Hoplobatrachus rugulosus</i> , <i>Limnonectes gyldenstolpei</i> , <i>Limnonectes kuhlii</i> , <i>Occidozyga martensii</i> , <i>Rana erythraea</i> , <i>Rana livida</i> , <i>Rana nigrovittata</i> , <i>Chirixalus hansenae</i> , <i>Chirixalus vittatus</i> , <i>Polypedates leucomystax</i> , <i>Rhacophorus bipunctatus</i> , <i>Theloderma asperum</i> , <i>Glyphoglossus molossus</i> , <i>Kalophrynus interlineatus</i> , <i>Microhyla berdmorei</i> , <i>Microhyla butleri</i> , <i>Microhyla heymonsi</i> , <i>Microhyla ornata</i> , <i>Micryletta inornata</i>
Phetchabun	<i>Megophrys parva</i> , <i>Rana nigrovittata</i>
Udon Thani	<i>Occidozyga lima</i>
Nong Khai	<i>Bufo melanostictus</i> , <i>Fejervarya limnocharis</i> , <i>Occidozyga lima</i> , <i>Occidozyga martensii</i> , <i>Chirixalus hansenae</i> , <i>Chirixalus vittatus</i> , <i>Polypedates leucomystax</i> , <i>Microhyla butleri</i> , <i>Microhyla heymonsi</i> , <i>Microhyla ornata</i>

**Table 5** Continued.

Province	Species
Khon Kaen	<i>Bufo melanostictus</i> , <i>Fejervarya limnocharis</i> , <i>Hoplobatrachus rugulosus</i> , <i>Limnonectes gyldenstolpei</i> , <i>Occidozyga lima</i> , <i>Occidozyga martensii</i> , <i>Rana erythraea</i> , <i>Polypedates leucomystax</i> , <i>Glyphoglossus molossus</i> , <i>Microhyla butleri</i> , <i>Microhyla heymonsi</i> , <i>Microhyla ornata</i>
Nakhon Ratchasima	<i>Bufo melanostictus</i> , <i>Fejervarya limnocharis</i> , <i>Rana nigrovittata</i> , <i>Polypedates leucomystax</i> , <i>Glyphoglossus molossus</i> , <i>Kaloula pulchra</i> , <i>Microhyla butleri</i> , <i>Microhyla heymonsi</i> , <i>Microhyla ornata</i> , <i>Microhyla pulchra</i>
Chaiyaphum	<i>Limnonectes gyldenstolpei</i> , <i>Glyphoglossus molossus</i> , <i>Microhyla heymonsi</i> , <i>Microhyla ornata</i>
Ubon Ratchathani	<i>Fejervarya limnocharis</i> , <i>Occidozyga lima</i> , <i>Occidozyga martensii</i> , <i>Rana nigrovittata</i> , <i>Polypedates leucomystax</i> , <i>Rhacophorus sp.</i> , <i>Microhyla butleri</i> , <i>Microhyla heymonsi</i> , <i>Microhyla ornata</i>
Surin	<i>Bufo melanostictus</i> , <i>Hoplobatrachus rugulosus</i> , <i>Rana erythraea</i> , <i>Glyphoglossus molossus</i> , <i>Microhyla heymonsi</i> , <i>Microhyla pulchra</i>
Sri Sa Ket	<i>Bufo melanostictus</i> , <i>Bufo parvus</i> , <i>Hoplobatrachus rugulosus</i> , <i>Limnonectes gyldenstolpei</i> , <i>Limnonectes kuhlii</i> , <i>Occidozyga martensii</i> , <i>Rana nigrovittata</i> , <i>Polypedates leucomystax</i> , <i>Rhacophorus sp.</i> , <i>Kaloula pulchra</i> , <i>Microhyla butleri</i> , <i>Microhyla heymonsi</i> , <i>Microhyla ornata</i>

**Table 6** Tadpole distribution in some Provinces of Southern Thailand

Province	Species
Phangnga	<i>Leptobranchium smithi</i> , <i>Bufo melanostictus</i> , <i>Rana alticola</i> , <i>Rana chalconota</i> , <i>Polypedates leucomystax</i> , <i>Microhyla heymonsi</i> , <i>Microhyla pulchra</i>
Nakhon Si Thammarat	<i>Leptobranchium smithi</i> , <i>Bufo melanostictus</i> , <i>Fejervarya limnocharis</i> , <i>Rana chalconota</i> , <i>Polypedates leucomystax</i> , <i>Microhyla berdmorei</i> , <i>Microhyla heymonsi</i> , <i>Microhyla ornata</i> , <i>Micryletta inornata</i>
Krabi	<i>Leptobranchium smithi</i> , <i>Bufo parvus</i> , <i>Limnonectes blythii</i> , <i>Occidozyga martensii</i> , <i>Rana chalconota</i> , <i>Rana nigrovittata</i> , <i>Polypedates leucomystax</i> , <i>Kaloula pulchra</i> , <i>Microhyla berdmorei</i> , <i>Microhyla butleri</i> , <i>Microhyla heymonsi</i>
Trang	<i>Polypedates leucomystax</i>
Yala	<i>Rana alticola</i>
Phatthalung	<i>Bufo melanostictus</i> , <i>Occidozyga lima</i> , <i>Kaloula pulchra</i> , <i>Microhyla ornata</i>
Surat Thani	<i>Amolops</i> sp., <i>Limnonectes blythii</i> , <i>Occidozyga martensii</i> , <i>Rana alticola</i> , <i>Rana chalconota</i> , <i>Rana nigrovittata</i> , <i>Polypedates leucomystax</i>
Songkhla	<i>Leptobranchium hendricksoni</i> , <i>Bufo parvus</i> , <i>Bufo melanostictus</i> , <i>Bufo marcrois</i> , <i>Fejervarya limnocharis</i> , <i>Rana erythraea</i> , <i>Rana chalconota</i> , <i>Polypedates leucomystax</i> , <i>Microhyla heymonsi</i>

The localities of all tadpole species are following data:

#### Family Megophryidae

##### *Brachytarsophrys carinensis* (Boulenger, 1889)-

**Kanchanaburi:** The preparation area to Thong Pha Phum National Park, Thong Pha Phum District (January, March and May); Phetchaburi: Kaeng Krachan National Park

(December).

##### *Leptobranchium smithi* Matsui, Nabhitabhata and

**Panha, 1999- Chiang Mai:** Taad Mok Waterfall, Doi Sutep-Pui National Park (December); Loei: Phu Luang Wildlife Sanctuary (March, April, November, December); Kanchanaburi: Chock Kadin Waterfall, Thong Pha Phum District (January, May, November); Phetchaburi: Kaeng Krachan National Park (January, December); Phangnga: Wung Kiang Khu Waterfall, Khao Lak Lum Lu National Park and Lum Pee Waterfall, Khao Jum Pee National Park, Thai Muang (January, December); Krabi: Huay To, Khao Phanom Bencha National Park (December); Nakhon Sri Thammarat: Karome Waterfall, Khao Luang National Park (December).

##### *Leptobranchium hendricksoni* Taylor, 1962-

**Songkhla:** Bouriphat Waterfall and Ton Nga Chang Waterfall, Rattaphum District (August).

##### *Leptobranchium* sp.- Kanchanaburi:

Huay Na m Dib, The preparation area to Thong Pha Phum National Park, Thong Pha Phum District (January to June, November).

##### *Leptolalax gracilis* (Gunther, 1872)-Kanchanaburi:

Huay Nam Dib in preparation area to Thong Pha Phum National Park, Thong Pha Phum District (March to May).

##### *Leptolalax pelodytoides* (Boulenger, 1893)- Chiang

**Mai:** Doi Chiang Dao Wildlife Research Center, Chiang Dao District (December); Loei: Phu Luang Wildlife Sanctuary (March, April, May, June, September, October, November, December).

##### *Megophrys parva* (Boulenger, 1893) - Chiang Mai:

Sop-huay Paatung-Nahlow Doi Chiang Dao Wildlife research center, Chiang Dao District (January, December); Loei: Phu Luang Wildlife Sanctuary (March, April, September, October, November, December); Phetchabun: Nam Nao National Park (April); Chachoengsao: Khao Ang Rui Ni

Wildlife Sanctuary (December); Chanthaburi: Charng-Say waterfall, Khao Khitchakut Sub-District (November, December); Kanchanaburi: The preparation area to Thong Pha Phum National Park, Thong Pha Phum District (January, May); Phetchaburi: Kaeng Krachan National Park (December).

#### Family Bufonidae

**Ansonia malayana Inger, 1960- Kanchanaburi:** Huay Nam Dib and Ban Ephu Waterfall, Thong Pha Phum District (May to June).

**Bufo macrotis Boulenger, 1887- Kanchanaburi:** Thong Pha Phum (May); Songkhla: Ton Nga Chang Waterfall and Dike Dam in Khao Bhandad Wildlife Sanctuary, Rattaphum District (August).

**Bufo melanostictus Schneider, 1799- Loei:** Phu Luang Wildlife Sanctuary (March, April); Nong Khai: Bung Khong Long (August, September); Khon Kaen: Phu Wiang National Park (September); Surin: Muang District (May); Si Sa Ket: Huay Sa La Wildlife Sanctuary, Phu Sing District (March), Phu Chong-Na Yoi National Park (October); Nakhon Ratchasima: Khao Yai National Park (November); Chachoengsao: Khao Ang Rui Ni Wildlife Sanctuary (January, February); Bangkok: (Jan-Apr); Kanchanaburi: Thong Pha Phum District (February); Phetchaburi: Kaeng Krachan National Park (December); Phangnga: Khao Lak Lum Lu National Park, Thai Muang District (September to December); Nakhon Si Thammarat: Khao Nan National Park, Nob Phi Tum District, (December); Phatthalung: Kuan Niang District (September, October); Songkhla: Bouriphat Waterfall, Rattaphum District (March, August).

**Bufo parvus Boulenger, 1887- Loei:** Phu Kradung National Park (May); Si Sa Ket: Phu Sing District (March); Kanchanaburi: Thong Pha Phum District (March); Phetchaburi: Kaeng Krachan National Park (December);

Songkhla: Bouriphat Waterfall, Rattaphum District (August); Krabi: Sakae Waterfall and Ban Sran, Khao Phanom Bencha National Park (December).

#### Family Ranidae

**Amolops marmoratus (Gunther, 1859) - Chiang Mai:** Doi Inthanon National Park (December); Kanchanaburi: Ban Ephu and Chockkadin Waterfall, Thong Pha Phum District (January to June, November).

**Amolops sp.- Phetchaburi:** Kaeng Krachan National Park (December); Surat Thani: Khao Sok National Park (December).

**Fejervarya cancrivora (Gravenhorst, 1829)- Samut Prakan:** Bang Bo (September).

**Fejervarya limnocharis (Gravenhorst, 1829)- Chiang Rai:** Huay Mae Jai, Wiang Pa Pao (September, October); Chiang Mai: Hang Dong District (September); Phrae: (October); Loei: Phu Luang Wildlife Sanctuary (May, June), Phu Kradung National Park (May); Nong Khai: Bung Khong Long (August, September); Khon Kaen: Phu Wiang National Park (September); Ubon Ratchathani: Yod Dom Wildlife Sanctuary (October); Nakhon Ratchasima: Sakaerat Ecological Research Station (May); Chachoengsao: Khao Ang Rui Ni Wildlife Sanctuary (January, February); Samut Prakan: Khlong Dan (September); Bangkok: (May); Nakhon Prathom: Muang District (April); Kanchanaburi: Thong Pha Phum, (April, May, June, November); Nakhon Si Thammarat: Karom Waterfall, Khao Luang National Park (December), Krung Ching Waterfall, Khao Luang National Park (December), Khao Nan National Park (December); Songkhla: Ton Nga Chang Waterfall and Dike Dam in Khao Bhandad Wildlife Sanctuary, Rattaphum (August).

**Hoplobatrachus rugulosus (Wiegman, 1835)- Loei:** Phu Kradung National Park (May); Khon Kaen: Phu Wiang National Park (Septem

ber), Phu Wiang District (May); Surin: Muang District (April, May); Si Sa Ket: Phu Sing District; Chachoengsao: Khao Ang Rui Ni Wildlife Sanctuary.

***Limnonectes gyldenstolpei* (Anderson, 1916)- Loei:**

Phu Luang Wildlife Sanctuary (November, December); Khon Kaen: Phu Wiang National Park (September); Chaiyaphum: Thung Kamung, Phu Khieu Wildlife Sanctuary (November); Sri Sa Ket: Phu Chong-Na Yoi National Park (October); Ubon Ratchathani: Phu Chong-Na Yoi National Park, Na Chaloui District (October).

***Limnonectes kuhlii* (Dum\_ril and Bibron, 1841)-**

**Chiang Rai:** Huay Mae Jai, Wiang Pa Pao District (September, October); Chiang Mai: Mae Sa Waterfall, Wang Booah Tong Jed Si aterfall (September); Loei: Phu Luang Wildlife Sanctuary (March, April, May, June, July, August, September, October, November, December); Si Sa Ket: Huay Sa La National Park, Phu Sing District (March); Nakhon Nayok: Khao Yai National Park (April, November); Prachin Buri: Khao Yai National Park (April, November); Kanchanaburi: Thong Pha Phum District (January to April, November).

***Limnonectes blythii* (Boulenger, 1920)- Krabi:**

Sakae Waterfall: Huay To, Khao Phanom Bencha National Park (December); Surat Thani: Khao Sok National Park (December).

***Occidozyga lima* (Gravenhorst, 1829)- Phrae:**

Long District (September); Udon Thani: Ban Phu (September); Nong Khai: Bung Khong Long (August, September); Khon Kaen: Phu Wiang National Park (May, September); Ubon Ratchathani: Yod Dom Wildlife Sanctuary (October); Chachoengsao: Khao Ang Rui Ni Wildlife Sanctuary; Phatthalung: Khuan Niang District (October).

***Occidozyga martensii* (Peters, 1867)- Loei:**

Phu Luang Wildlife Sanctuary (May), Phu Kradung National Park (May); Nong Khai:

Bung Khong Long (August, September); Khon Kaen: Phu Wiang National Park (September); Sri Sa Ket: Phu Chong-Na Yoi National Park (October); Ubon Ratchathani: Phu Chong-Na Yoi National Park (October), Yod Dom Wildlife Sanctuary, Ubon Ratchathani Province (October); Chachoengsao: Khao Ang Rui Ni Wildlife Sanctuary (April), Muang District (April); Kanchanaburi: Thong Pha Phum, (June); Krabi: Khao Pra-Bang Kram Wildlife Sanctuary (December); Surat Thani: Khao Sok National Park (December).

***Paa fasciculispina* Inger, 1970- Chanthaburi:**

Chang Say Waterfall, Khao Kitchakut Sub-District (November, December); Trat: Huay Satau, Bo Rai District (January).

***Rana alticola* Boulenger, 1882- Phetchaburi:**

Kaeng Krachan National Park (December); Kanchanaburi: Thong Pha Phum District (January, May); Prachuap Khiri Khan: Pa La-U Waterfall, Hua Hin District (December); Phangnga: Khao Lak Lum Ru National Park, Thai Muang District (January, September to October), Khao Jum Pee National Park, Thai Muang District (December); Yala: Khlongtie Kabang, Muang District (March); Surat Thani: Khao Sok National Park (December).

***Rana chalconota* (Schlegel, 1837)- Phangnga:**

Kanin Waterfall, Thai Muang District (December); Songkhla: Dike Dam in Khao Bhandad Wildlife Sanctuary (August), Bouriphat Waterfall, Rattaphum District (August); Nakhon Si Thammarat: Karome Waterfall, Khao Luang National Park (December); Krabi: Sakae Waterfall: Ban Sran, Khao Phanom Bencha National Park (December), Huay To, Khao Phanom Bencha National Park (December), Khao Pra-Bang Kram Wildlife Sanctuary (December); Surat Thani: Khao Sok National Park (December).

***Rana erythraea* (Schlegel, 1837)- Loei:**

Phu Luang

Wildlife Sanctuary (no month data); Khon Kaen: Phu Wiang National Park (September); Surin: Muang District (May); Bangkok: (June); Songkhla: Rattaphum District (August).

***Rana hosii Boulenger, 1891- Kanchanaburi:*** Huay Nam Dib in preparation area to Thong Pha Phum National Park, Thong Pha Phum District (January to July).

***Rana livida (Blyth, 1856)- Loei:*** Phu Luang Wildlife Sanctuary (May, June, July, August, September, October).

***Rana nigrovittata (Blyth, 1855)- Chiang Rai:*** Huay Mae Jai, Wiang Pa Pao District (September, October); Loei: Phu Luang Wildlife Sanctuary (March, April, May, June); Phetchabun: Nam Nao National Park (April); Nakhon Nayok: Khao Yai National Park (April, September), Na Dee District (no month data); Prachin Buri: Khao Yai National Park (April, September); Nakhon Ratchasima: Sakaerat (May); Sri Sa Ket: Phu Chong-Na Yoi National Park (October); Ubon Ratchathani: Phu Chong-Na Yoi National Park (October); Chantaburi: Cha Say Waterfall, Khao Kitchakut Sub-District (November, December); Chachoengsao: Khao Ang Rui Ni Wildlife Sanctuary; Trat: Huay Satau, Bo Rai District (January, December); Krabi: Sakae Waterfall, Khao Phanom Bencha National Park (December), Ban Sran, Khao Phanom Bencha National Park (December), Huay To Khao Phanom Bencha National Park (December); Surat Thani: Khao Sok National Park (December).

#### Family Rhacophoridae

***Chirixalus hansenae Cochran, 1827- Loei:*** Phu Luang Wildlife Sanctuary (September, October, November, December); Nong Khai: Bung Khong Long (August, September).

***Chirixalus vittatus (Boulenger, 1887): Loei:*** Phu Luang Wildlife Sanctuary (September, October); Nong Khai: Bung Khong Long

(August, September); Chachoengsao: Khao Ang Rui Ni Wildlife Sanctuary (no month data).

#### ***Polypedates leucomystax (Gravenhorst, 1829)-***

**Chiang Rai:** Huay Mae Jai, Wiang Pa Pao District (September, October); Loei: Phu Luang Wildlife Sanctuary (March, April, May, June, July, August, September, October), Phu Kradung National Park (January); Nong Khai: Bung Khong Long (August, September); Khon Kaen: Phu Wiang National Park (September), Phu Wiang District, (January); Nakhon Ratchasima: Sakaerat Ecological Research Station (May); Surin: Muang District (April, May); Si Sa Ket: Huay Sa La Wildlife Sanctuary, Phu Sing District (March), Phu Chong-Na Yoi National Park (October); Ubon Ratchathani: Phu Chong-Na Yoi National Park (October), Yod Dom Wildlife Sanctuary (October); Nakhon Nayok: Nang Rong Waterfall and Wang Muang Waterfall (April, June); Chachoengsao: Khao Ang Rui Ni Wildlife Sanctuary (January, February); Uthai Thani: Huay Ka Kaeng Wildlife Sanctuary (May); Bangkok: (January); Kanchanaburi: Thong Pha Phum District (April, May, June); Phetchaburi: Kaeng Krachan National Park (December); Phangnga: Khao Lak Lum Lu National Park, Thai Muang District (September, October and December); Trang: Kantang District (March); Songkhla: Dike Dam in Khao Bhandad Wildlife Sanctuary, Rattaphum District (August); Nakhon Si Thammarat: Yod Leung Stream, Khao Luang National Park (December); Krabi: Sakae Waterfall, Khao Phanom Bencha National Park (December); Surat Thani: Khao Sok National Park (December).

***Rhacophorus bipunctatus Ahl, 1927- Loei:*** Phu Luang Wildlife Sanctuary (May, June); Kanchanaburi: Huay Nam Dib, preparation area to Thong Pha Phum National Park,



Thong Pha Phum District, Province (April, May, June).

**Rhacophorus sp.- Sri Sa Ket:** Phu Chong-Na Yoi National Park (September, October); Ubon Ratchathani: Phu Chong-Na Yoi National Park (September, October).

**Theloderma asperum (Boulenger, 1886)- Loei:** Phu Luang Wildlife Sanctuary (March, April).

**Family Microhylidae**

**Calluella guttulata (Blyth, 1855)- Chachoengsao:** Khao Ang Rui Ni Wildlife Sanctuary (no month data).

**Glyphoglossus molossus Gunther, 1868- Loei:** Phu Luang Wildlife Sanctuary (May, June, July, August, September, October), Phu Kradung National Park (May); Chaiyaphum: Thung Kamung, Phu Khieu Wildlife Sanctuary (November); Khon Kaen: Phu Wiang District (May); Nakhon Ratchasima; Sakaerat Ecological Research Station (May); Surin: Muang District (May); Kanchanaburi: Thong Pha Phum District (May).

**Kalophrynus interlineatus (Blyth, 1855)- Loei:** Phu Luang Wildlife Sanctuary (March, April, July, August, September, October).

**Kaloula pulchra Gray, 1831- Nakhon Ratchasima:** Sakaerat Ecological Research Station (May); Si Sa Ket: Huay Sa La Wildlife Sanctuary, Phu Sing District (March); Nakhon Nayok: Khao Yai National Park (April); Prachin Buri: Khao Yai National Park (April); Bangkok (no month data); Kanchanaburi: Thong Pha Phum District (March, April); Phatthalung: Kuan Niang District, (September, October); Krabi: Ban Sran, Khao Phanom Bencha National Park (December).

**Microhyla berdmorei (Blyth, 1856)- Chiang Mai:** Tad Mok Waterfall, Doi Sutep-Pui National Park (December), Doi Chiang Dao Wildlife Research Center, Chiang Dao District (December); Lampang: Naum Mae Fa, Chae Hom District (May); Loei: Phu

Luang Wildlife Sanctuary (March, April, May, June, November, December); Chachoengsao: Khao Ang Rui Ni Wildlife Sanctuary (no month data); Nakhon Si Thammarat: Khao Nan National Park (December and April); Krabi: Sakae Waterfall: Ban Sran, Khao Phanom Bencha National Park (December), Khao Pra-Baŋg Kram Wildlife Sanctuary (December).

**Microhyla butleri Boulenger, 1900- Loei:** Phu Luang Wildlife Sanctuary (September, October); Nong Khai: Bung Khong Long (August, September); Khon Kaen: Phu Wiang National Park (September); Sri Sa Ket: Phu Chong-Na Yoi National Park (October); Ubon Ratchathani: Phu Chong Na Yoi National Park (October), Yod Dom Wildlife Sanctuary (October); Nakhon Ratchasima: Sakaerat Ecological Research Station (May); Chachoengsao: Khao Ang Rui Ni Wildlife Sanctuary (no month data); Kanchanaburi: Thong Pha Phum (April, May, June); Krabi: Sakae Waterfall, Khao Phanom Bencha National Park (December).

**Microhyla heymonsi Vogt, 1911- Chiang Rai:** Huay Mae Jai, Wiang Pa Pao District (October); Chiang Mai: Mae Glang waterfall (September); Phrae: Huay Mae Lang, Long District (October); Loei: Phu Luang Wildlife Sanctuary (March, April, May, June, July, August, September, October, November, December Phu Kradung National Park (May); Nong Khai: Bung Khong Long (August, September); Khon Kaen: Phu Wiang National Park (September), Phu Wiang District (May); Chaiyaphum: Thung Kamung, Phu Khieu Wildlife Sanctuary (November); Nakhon Ratchasima: Sakaerat Ecological Research Station (May); Sri Sa Ket: Phu Chong-Na Yoi National Park (October); Ubon Ratchathani: Phu Chong-Na Yoi National Park (October), Yod Dom Wildlife Sanctuary (October); Chachoengsao: Khao Ang Rui Ni Wildlife

actually at the floor. Their mouth at the ventral side or higher nearly to head terminal. In tadpoles mouth have 3 function consist of papilla, denticle and beak or at least with beak that are consist of the first group feeded by chip off in pieces or eaten sediment on water floor such as *Rana nigrovittata*, *Rana chalconota* and *Fejervarya cancrivora*. The second groups feeded by predation and eaten remain plants and animals such as *Polypedates leucomystax leucomystax*, *Hoplobatrachus rugulosus*, *Rana erytraea*. The third group consists of two feeding behavioral type together that are trimming and predating example *Bufo melanostictus*, *Bufo macrotis*, *Bufo parvus* and *Fejervarya limnocharis*. The last group consists of tadpoles that are eaten by pumping and predating such as *Occidozyga lima* and *O. martensii*.

5. Tadpoles that are actually resided at the base in lotic water, their mouth at the ventral side or higher to head terminal or with ventral disc. Mouth part structure consists of papilla denticle and beak. One group feeded by scraping and eating sediment on water floor such as *Leptobranchium smithi*, *Leptobranchium* sp., *Leptobranchium hendricksoni*, *Ansonia malayana* and other one group consisted of *Rhacophorus bipunctatus*, *Leptolalax gracilis* and *Leptolalax pelodytoides* they are predator and scaventure.

## DISCUSSION

Importance structures for classify tadpole species such as mouth location, shape of lips, denticle formula, beak and papilla form, Numbers and consecutive order of bud rows around their mouth and some special structure. These are very strong character for instance color, body skill, size and body shape can be change following environment. In the matter of some tadpoles have denticle in mouth cavity their denticle formula important for identification other hand some tadpole which haven't denticle their beek and lips are necessary. Denticle formula is strong character even though mouth part of some tadpole from 34 species have more than one formula example *Rana alticola* have 2 denticle formula that is II:5+5/1+1:VIII

or II:5+5/1+1:VI, *Bufo parvus* undaunted I:1+1/III or II/III, *Leptobranchium* sp. consist of I:5+5/6+6:I, I:7+7/6+6:I, I:6+6/6+6:I, or I:7+7/5+5:I, *Leptolalax gracilis* such as I:2+2 or 2+2/2+2 and denticle formula of *Polypedates leucomystax* may be I:3+3/III or I:3+3/1+1:II. About denticle formula variation, Porter (1972) and Inger (1966) said that denticle formula have been change ensuing age, size, body length however its have stabled when tadpole have completely behind limbs. There are to be in line with this result to exempt some species which are little change. Nevertheless some species have prominent outside morphological so can be identify them with out denticle formula investigation example *Rana alticola*; prominent character are big size, body dark their tail marked with three orange spots to place in a row from tail base.

Several species have been identified by external morphology that is easy way for instant some species very difficult to specified such as *Bufo parvus*, *Bufo melanostictus*, *Bufo macrotis* these three species have very close morphology and some denticle formula is I:1+1/III so that we can classified them by using Number of small bud on their papilla and gap between denticle row. Mouth part structure of 34 species relation to feeding behavior and their habitat are in agreement with other report. Character of *Microhyla pulchra*, *Microhyla ornata*, *Kaloula pulchra*, *Rana nigrovittata* and *Bufo parvus* are the same as Smith (1916b). Ferther more mouth part structure and denticle formula of *Limnonectes kuhlii*, *Hoplobatrachus rugulosus*, *Glyphoglossus molossus* likewise morphology of *Fejervarya limnocharis*, *Rana erythraea* and *Polypedates leucomystax* similar to Smith (1917). In addition *Micryletta inornata* attribute like Heyer (1971). These reports has demonstrated basically characteristic of 16 tadpoles from Thailand. Only 5 species such as *Limnonectes kuhlii*, *Polypedates leucomystax*, *Microhyla butleri*, *Glyphoglossus molossus* and *Fejervarya limnocharis* have been elucidated about mouth part character. These reports are in agreement with this study. In addition Smith (1971) has reported character of *Megalophrys pelodytoides* with is the same to *Leptolalax pelodytoides* but den-

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ticle formula and papilla are different namely.

Megalophrys pelodytoides denticle formula is II:4+4/3+3:I but *Leptolalax pelodytoides* is I:4+4/2+2:I. Megalophrys hasseltii has been reported by Smith (1917) should be *Leptobranchium smithi* because its mouth different from *Leptobranchium hasseltii* that had been collected sample from Vietnam and Java. Recently it is specified to *Leptobranchium smithi* by Matsui et al. (1999), They are reported about denticle formula of this species. It have variated from I:4+4/4+4:I to I:6+6/5+5:I but a result from this study to find out that denticle formula is I:5+5/5+5:I however other character are similiary. *Leptobranchium hendricksoni* feature from western Malaysia by Berry (1963) similar to Songkla sample. Mouth part structure of *Rana chalconota* and *Rana nigrovittata* from Borneo reported by Inger (1966) and collection of Thailand by Smith (1916a) are agreement with this study but denticle formula of *Rana alticola* and *Leptolalax pelodytoides* by Smith (1916a, 1917) are different because Smith reported denticle formula of *Rana alticola* is I:8+8/VIII and **Leptolalax pelodytoides** is II:4+4/3+3:I but we found that is II:5+5/1+1:VI and I:4+4/2+2:I

Feeding behavior of 34 species are different following to their habitat but have been related with mouth part structure like Wassersug and Hoff (1979), Pough et al. (1998) report. Exploring and collecting tadpole specimens from many area in Thailand include 15 months, 34 species have been collected. To be specific at the preparation area to national Park in Thong Pha Phum, Khanchanaburi Province only have found at least 25 species. From all specimens have only one new record that is *Leptolalax gracilis* and we found more than Matsui et al. (1996) report 11 species. So the studying amphibian distribution by tadpole survey better than study in adult form. Many species have distributed in Malaysia and Borneo (Inger, 1966) such as *Leptolalax gracilis* or *Leptobranchium gracile* Gunther in Malaysia (Berry, 1975) as for Megalophrys parva have been found on western, eastern and northern of Thailand but distri-

bution of *Brachytarsophrys carinensis* more limit even though they have similar habitat. *Leptobranchium smithi* distributed on western and northern of Thailand may be found in Union of Burma too thus *Leptobranchium* sp. found in Khanchanaburi then to dispersed on northern because above area from Khanchanaburi have connected forest. *Leptobranchium hendricksoni* distributed on southern and no dispersed to above moreover one interesting species from northern is *Leptolalax pelodytoides*. It has outside morphology similar to *Leptolalax gracilis* but denticle formula different. Inger (1966) and Berry (1975) reported *Leptolalax gracilis* distributed in Borneo and Malaysia that is difficult to spread in to western of Thailand but some time they are from Union of Burma. The majority of tadpole can be found generally expansive area but some species lived in some where such as *Limnonectes kuhlii*, *Rana alticola*, *Rana chalconota*, *Rana hosii*, *Ansonia malayana*, *Amolops marmoratus*, *Paa fasciculispina*.

## CONCLUSION

We found 34 species of tadpoles from many parts of Thailand in this studying. There are Megalophrys parva (Boulenger, 1893), *Brachytarsophrys carinensis* (Boulenger, 1889), *Leptobranchium smithi* Matsui, Nabhitabhata and Panha, 1999, *Leptobranchium* sp., *Leptobranchium hendricksoni* Taylor, 1962, *Leptolalax pelodytoides* (Boulenger, 1893), *Leptolalax gracilis* (Gunther, 1872) *Bufo parvus* Boulenger, 1887, *B. melanostictus* Schneider, 1799, *Bufo macrotis* Boulenger, 1887, *Ansonia malayana* Inger, 1960, *Occidozyga lima* (Gravenhorst, 1829), *O. martensii* (Peters, 1867), *Fejervarya cancrivora* (Gravenhorst, 1829), *Fejervarya limnocharis* (Gravenhorst, 1829), *Limnonectes kuhlii* (Dumuril and Bibron, 1841), *Hoplobatrachus rugulosus* (Wiegman, 1835), *Paa fasciculispina* Inger, 1970, *Rana nigrovittata* (Blyth, 1855), *Rana erythraea* (Schlegel, 1837), *Rana alticola* Boulenger, 1882, *Rana chalconota* (Schlegel, 1837), *Rana hosii* Boulenger, 1891, *Amolops marmoratus* (Gunther, 1859), *Polypedates leucomystax* (Gravenhorst, 1829),

*Rhacophorus bipunctatus* Ahl, 1927, *Microhyla pulchra* (Hallowell, 1861), *Microhyla ornata* (Dumeril and Bibron, 1841), *Microhyla heymonsi* Vogt, 1911, *Microhyla berdmorei* (Blyth, 1856), *Microhyla butleri* Boulenger, 1900, *Micryletta inornata* (Boulenger, 1890), *Kaloula pulchra* Gray, 1831, *Glyphoglossus molossus* Gunther, 1868. The microhabitats and feeding behavior of tadpoles were divided into 5 types. About the species accounts, we found one *Leptobrachium* sp. from Huay Nam Dib, the preparation area to Thong Pha Phum National Park, Thong Pha Phum District, Kanchanaburi Province (January to June, November). The mouth part of it is differed from other species in Thailand. In this paper we would like to identify as genus. For the further study have been studied by the first author.

## ACKNOWLEDGMENTS

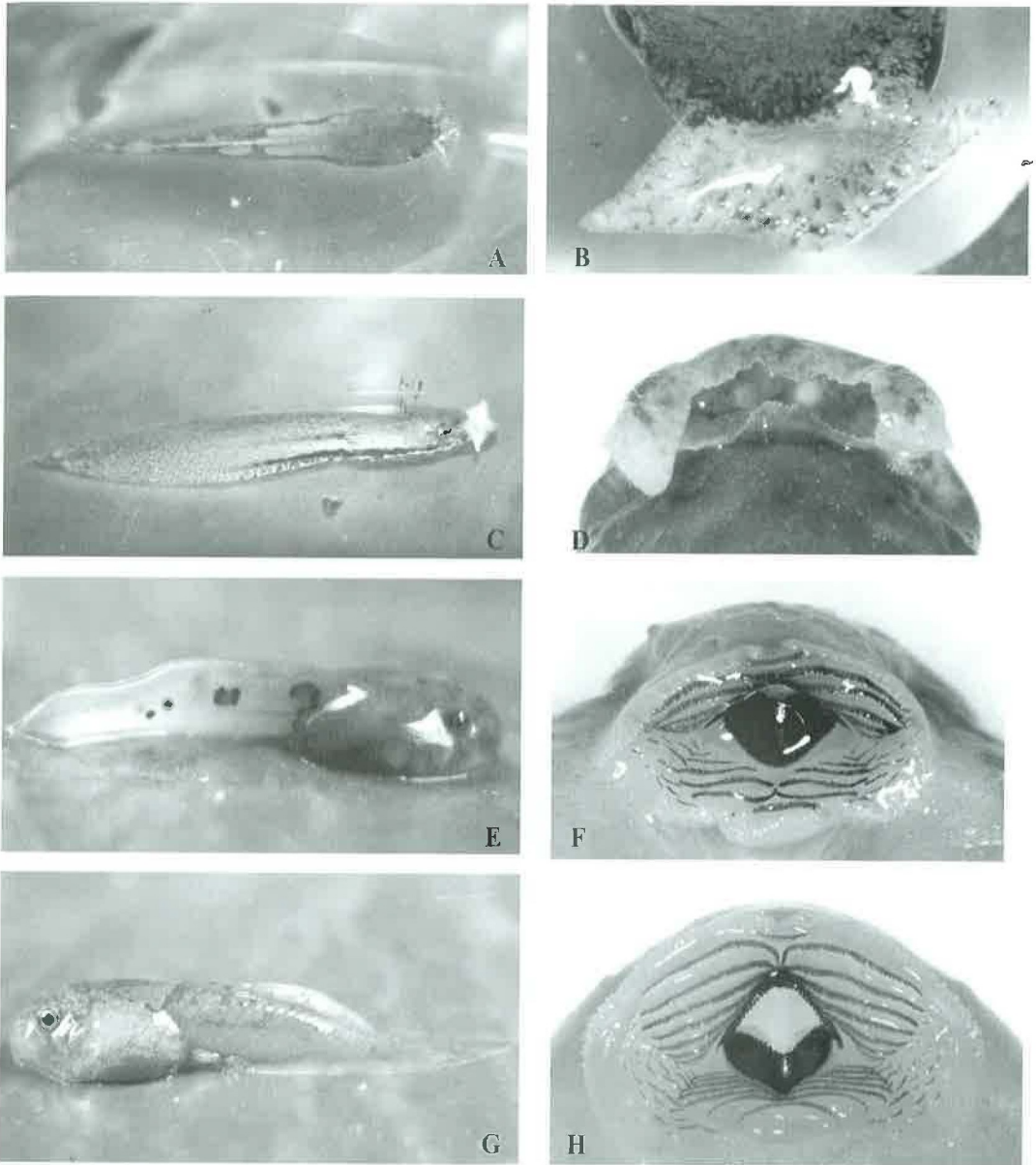
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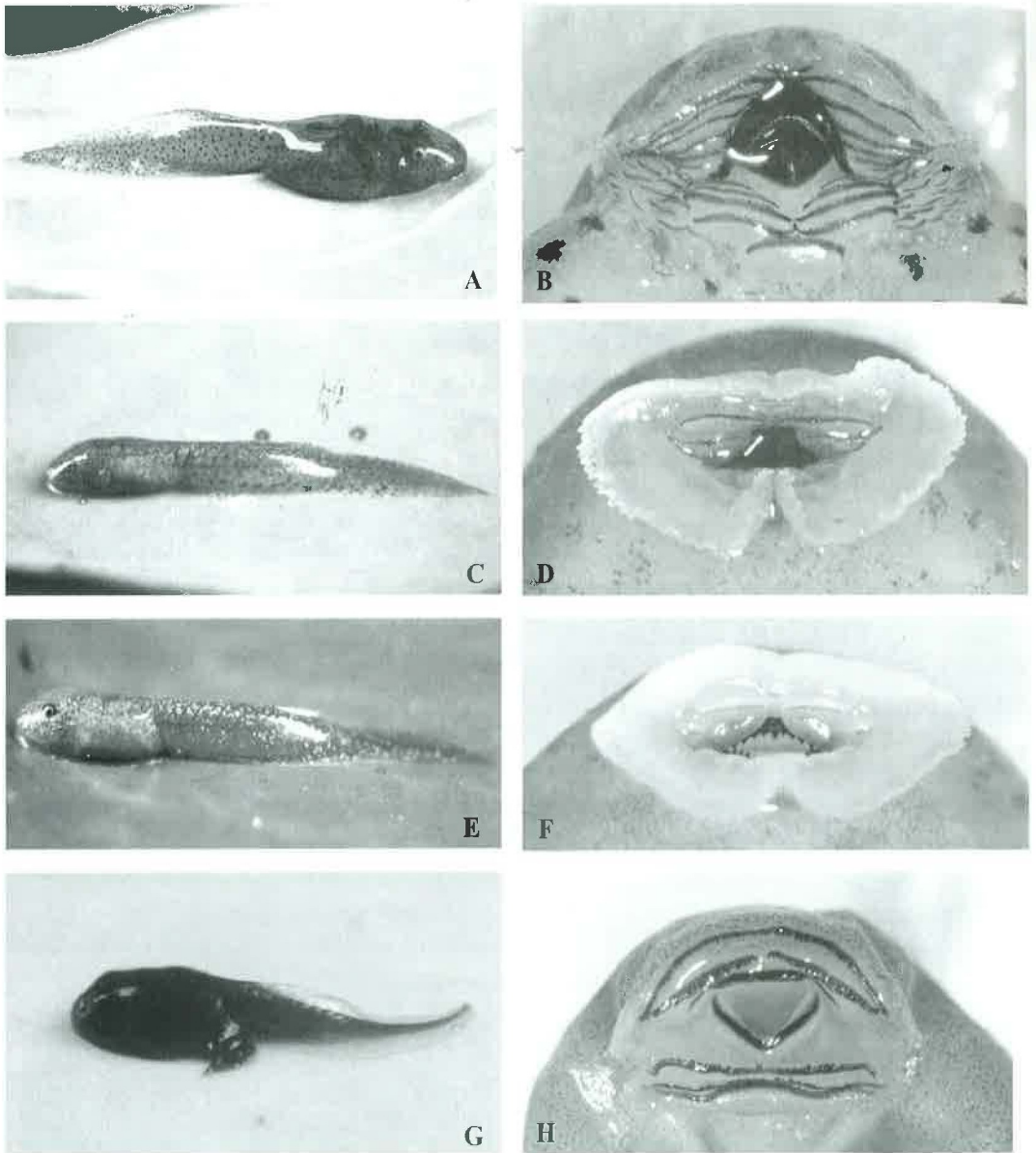
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APPENDIX

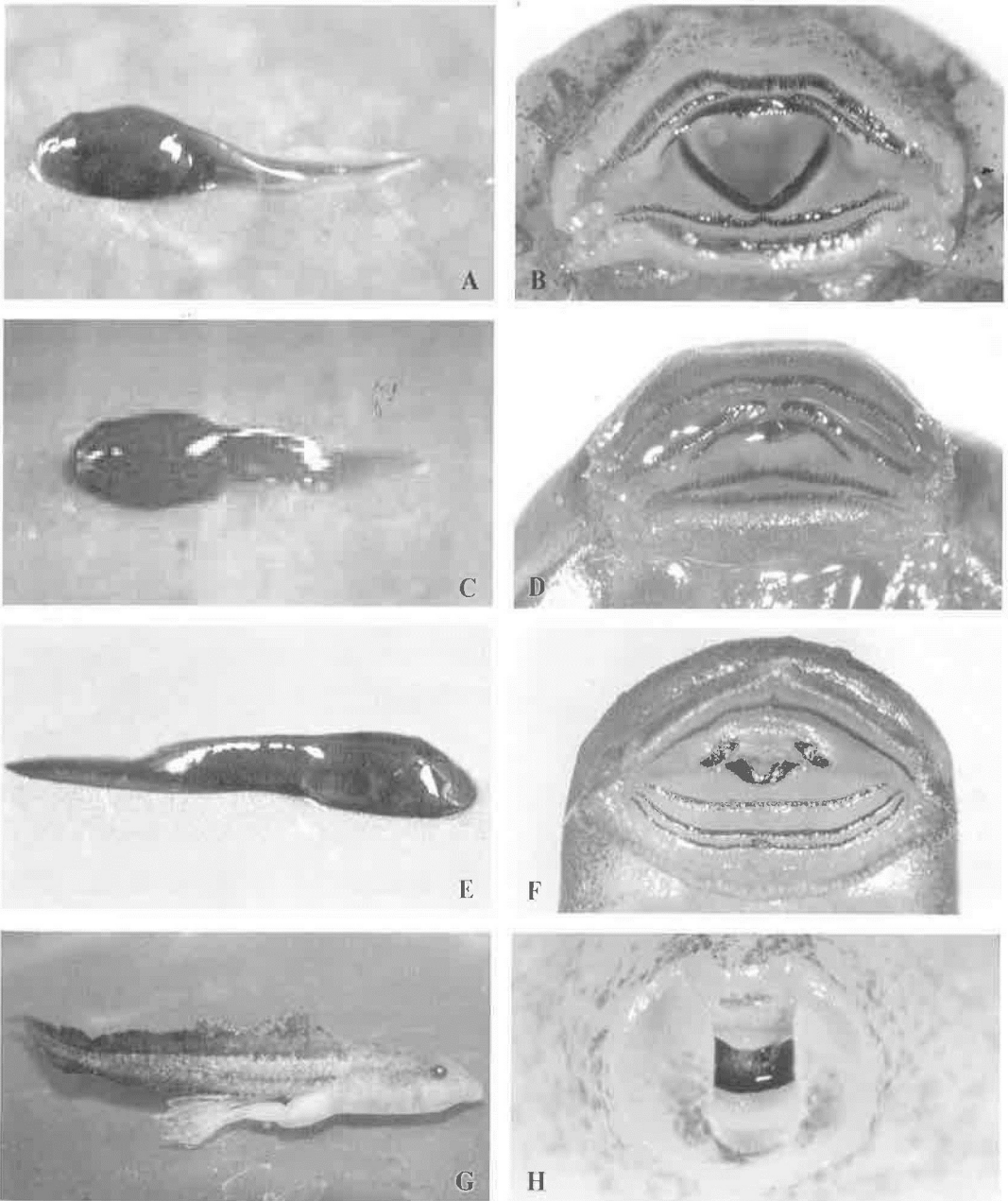


**Figure 1** Showing tadpoles and mouth parts: A and B (*Megophrys parva*), C and D (*Brachytasophrys carinensis*), E and F (*Leptobrachium smithi*) mouth part and denticle formular  $I5+5/5+5:I$ , G and H (*Leptobrachium* sp.) mouth part and denticle formula  $I:5+5/6+6:I$ ,  $I:7+7/6+6:I$ ,  $I:6+6/6+6:I$  and  $I:7+7/5+5:I$ .

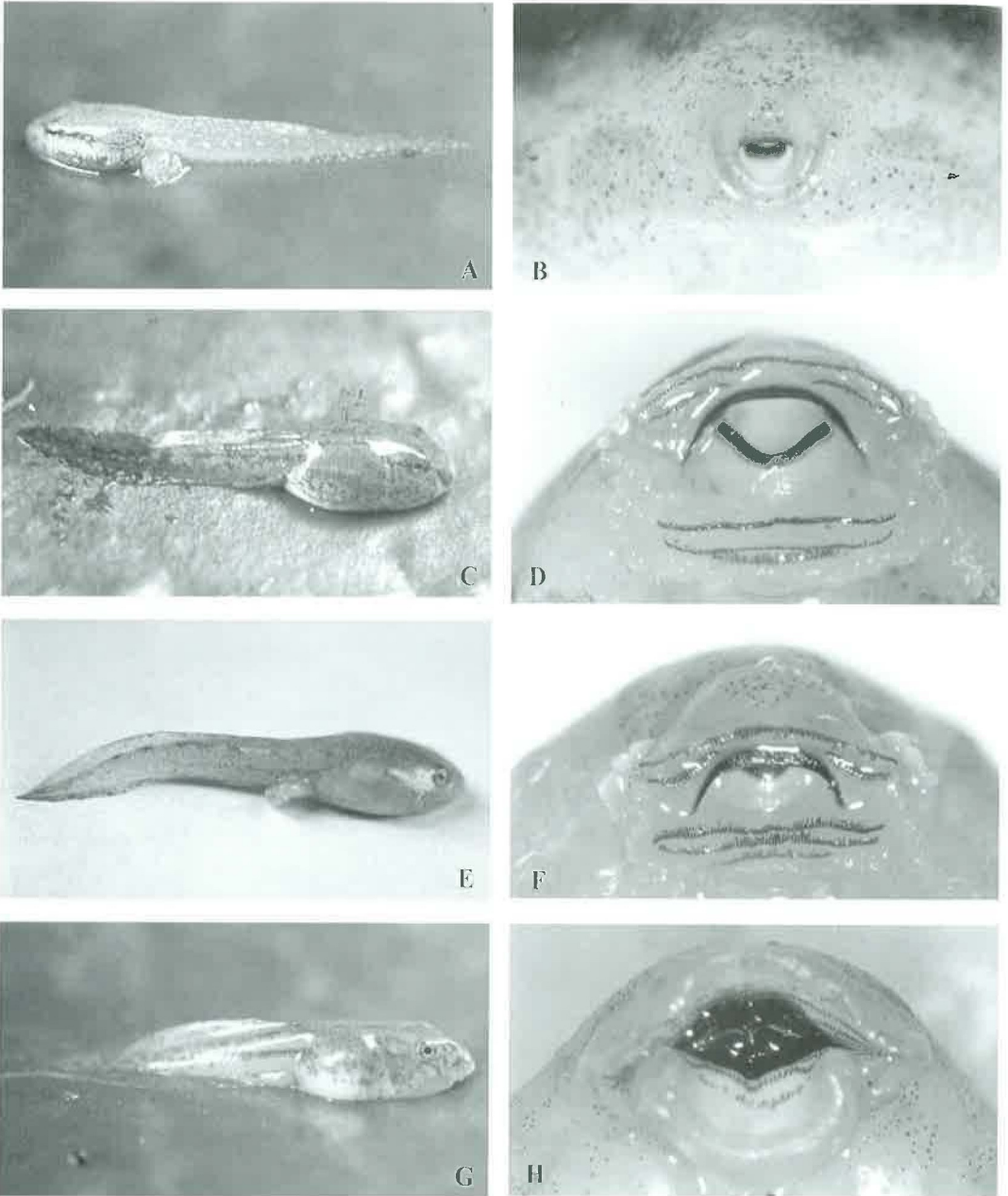


**Figure 2** Showing tadpoles and mouth parts: A and B (*Leptobrachium hendricksoni*), C and D (*Leptolalax pelodytoides*), E and F (*Leptolalax gracilis*), G and H (*Bufo parvus*)

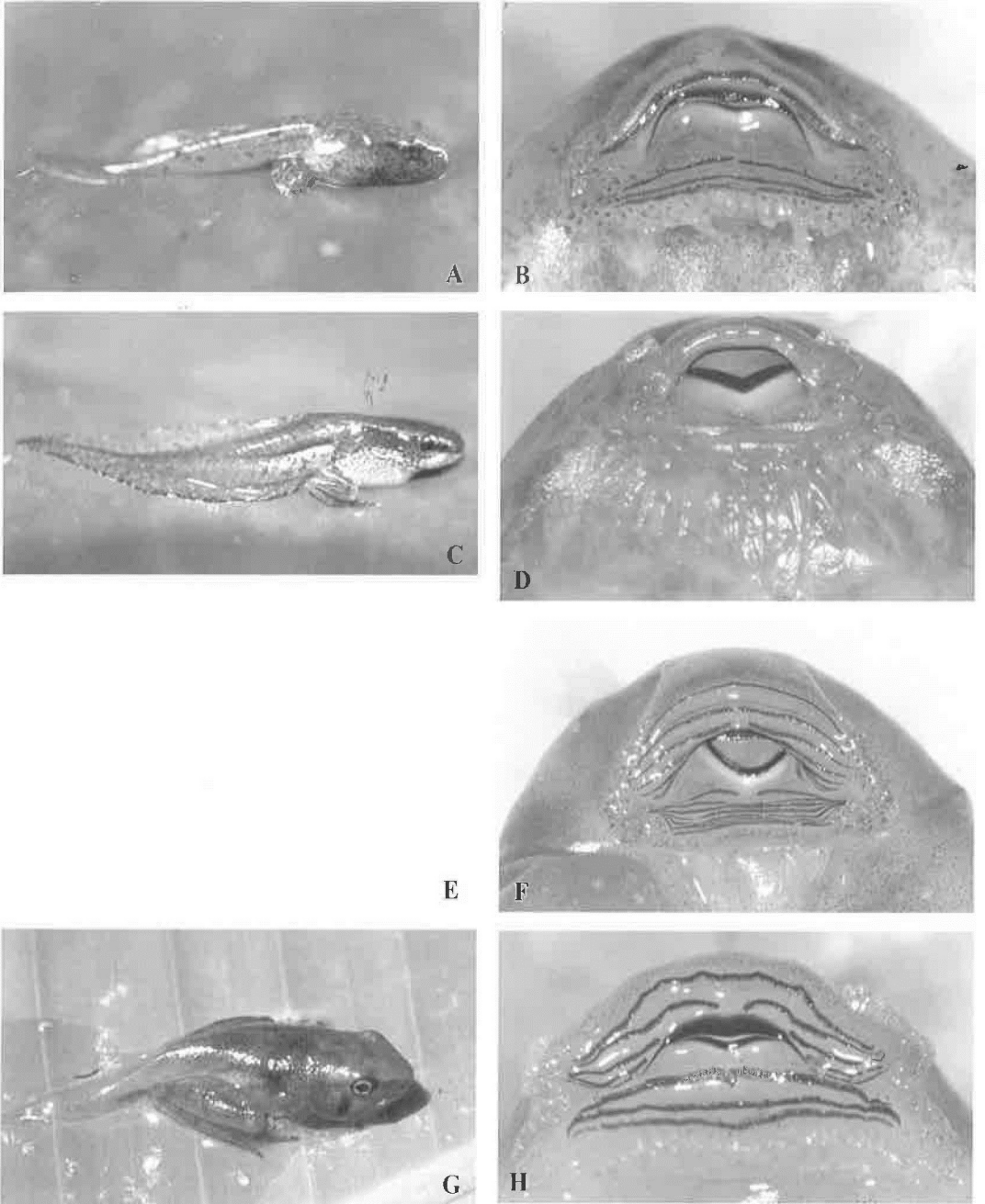




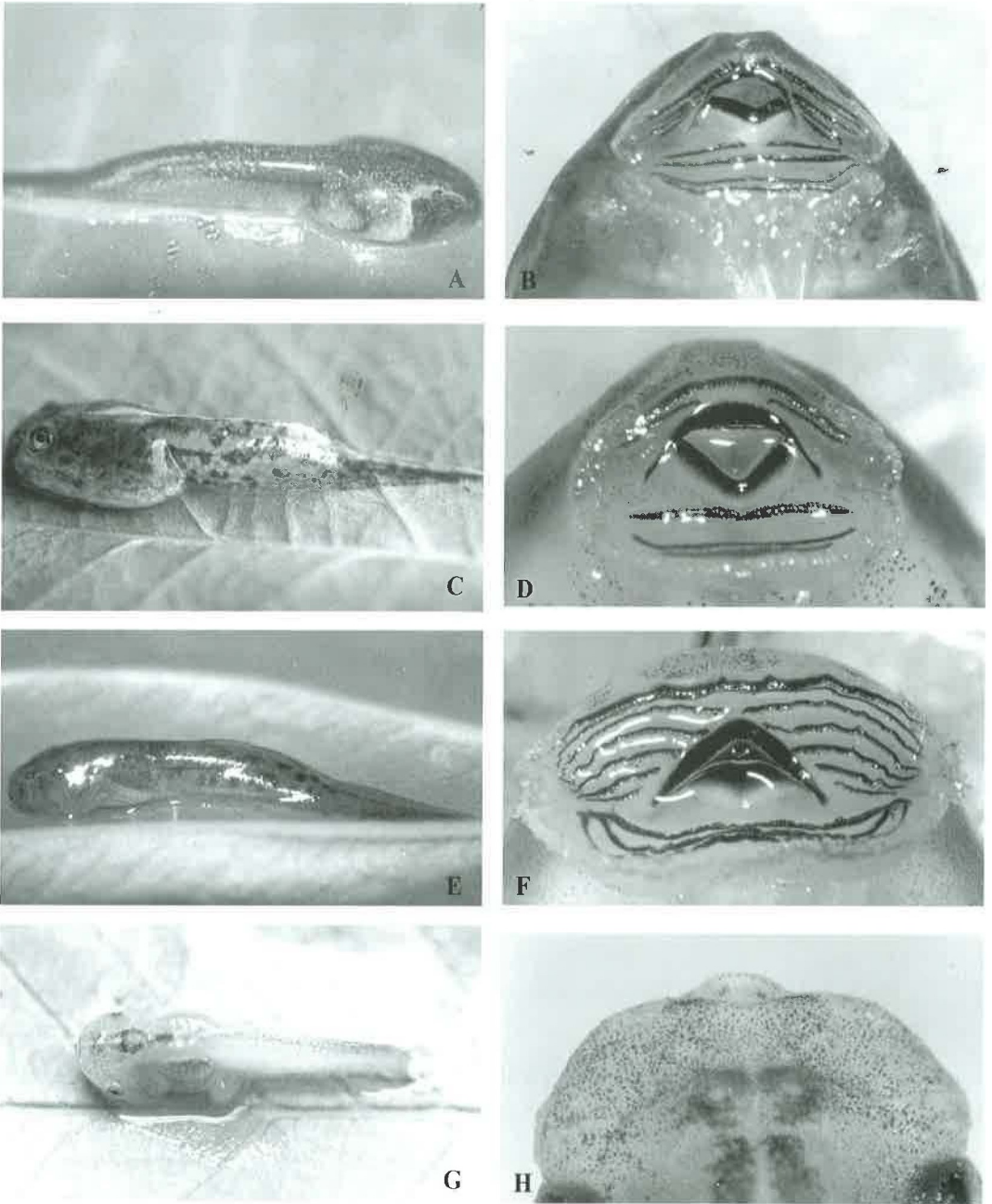
**Figure 3** Showing tadpoles and mouth parts: A and B (*Bufo melanostictus*), C and D (*Bufo macrotis*), E and F (*Ansonia malayana*), G and H (*Occidozyga lima*)



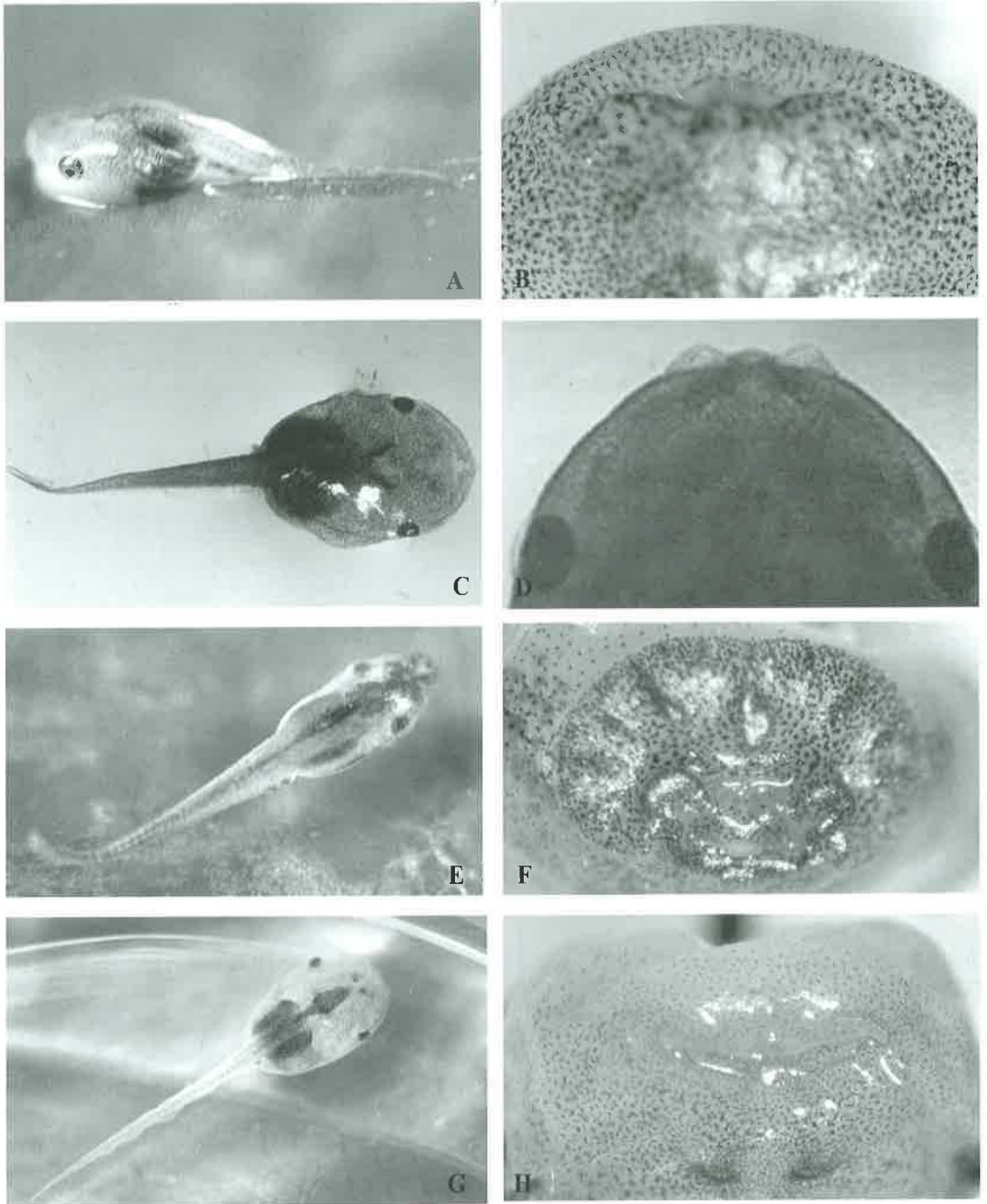
**Figure 4** Showing tadpoles and mouth parts: A and B (*Occidozyga martensii*), C and D (*Fejervarya limnocharis*), E and F (*Limnonectes kuhlii*), G and H (*Hoplobatrachus rugulosus*)



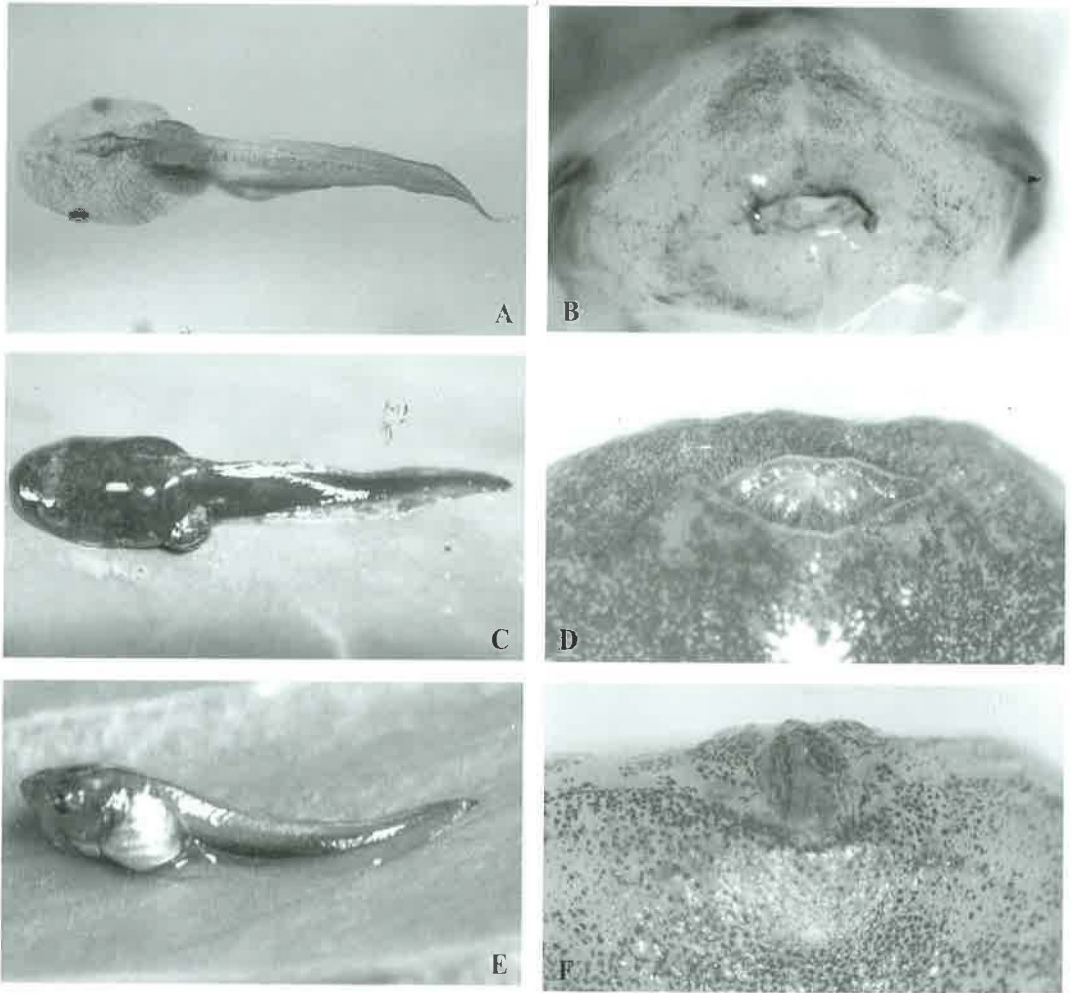
**Figure 5** Showing tadpoles and mouth parts: A and B (*Rana nigrovittata*), C and D (*Rana erythraea*), E and F (*Rana alticola*), G and H (*Rana chalconota*)



**Figure 6** Showing tadpoles and mouth parts: A and B (*Rana hosii*), C and D (*Fejervarya cancrivora*), E and F (*Paa fasciculispina*), G and H (*Microhyla pulchra*)



**Figure 7** Showing tadpoles and mouth parts: A and B (*Microhyla ornata*), C and D (*Micryletta inornata*), E and F (*Microhyla heymonsi*), G and H (*Microhyla berdmorei*)



**Figure 8** Showing tadpoles and mouth parts: A and B (*Microhyla butleri*), C and D (*Kaloula pulchra*), E and F (*Glyphoglossus molossus*)

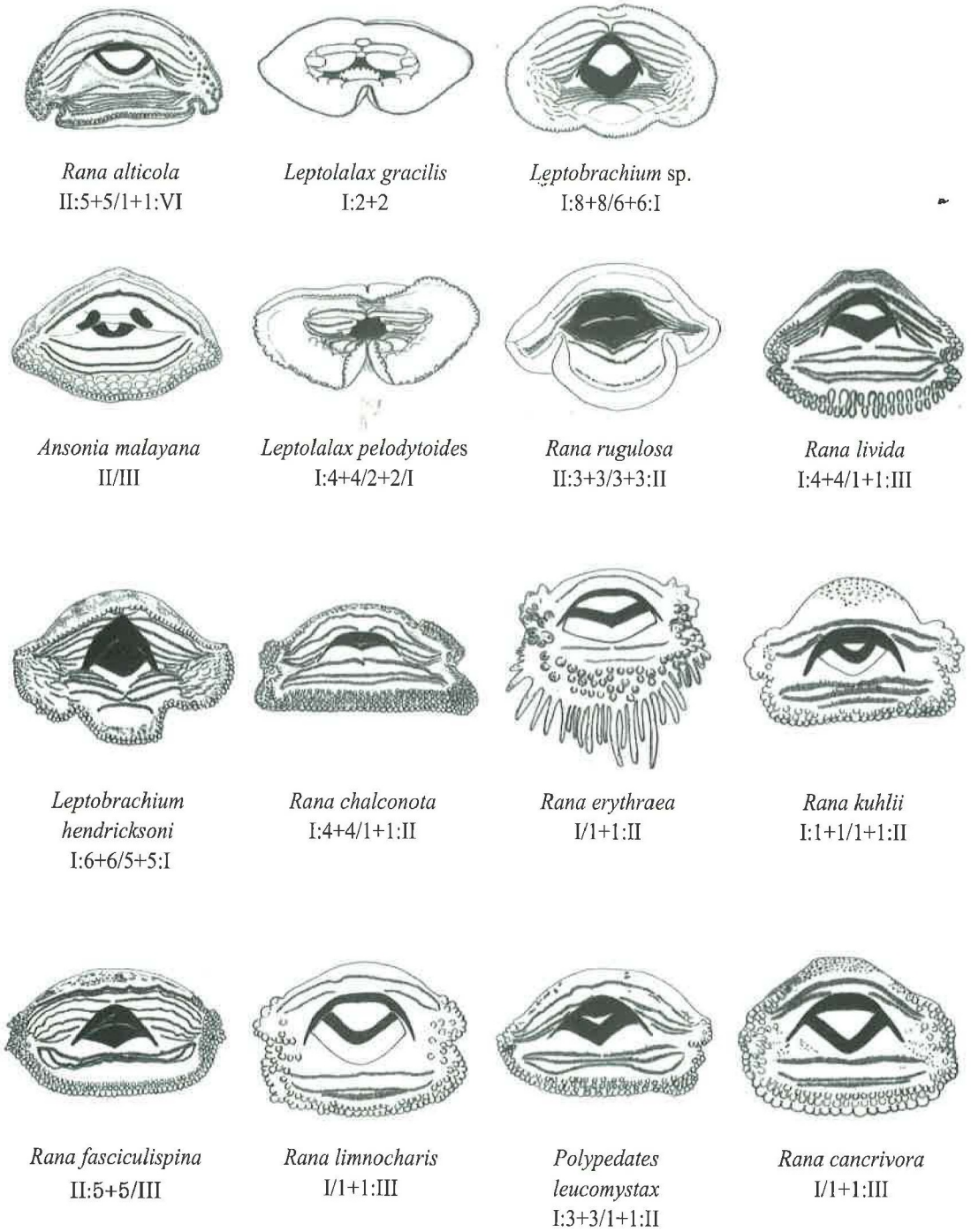
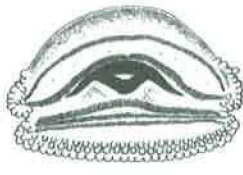


Figure 9 Mouth part and denticle formula of some tadpoles: Part I.



*Bufo macrotis*  
I/1+1:III



*Bufo parvus*  
I/1+1:III



*Bufo melanostictus*  
I/1+1:III



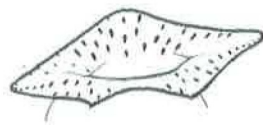
*Leptobrachium smithi*  
I:5+5/5+5:I



*Rhacophorus bipunctatus*  
I:5+5/III



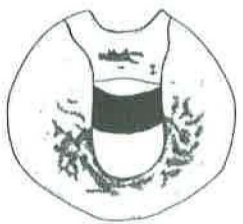
*Microhyla heymonsi*



*Megophrys parva*



*Occidozyga martensii*



*Occidozyga lima*

**Figure 9** Mouth part and denticle formula of some tadpoles: Part II.