

**Article VIII.—NOTES ON AMPHIBIANS FROM FUKIEN,  
HAINAN, AND OTHER PARTS OF CHINA<sup>1</sup>,<sup>2</sup>**

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<sup>1</sup>Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 109.

<sup>2</sup>This paper went to press in June, 1930. It has been possible to incorporate only a few of the papers received since that date.

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### INTRODUCTION

This is primarily an advance report on the amphibians collected in China by the Central Asiatic Expeditions<sup>1</sup> of The American Museum of Natural History, but an effort has been made to include, in addition, all the Chinese material contained in the collections of the American Museum.

In 1927, Karl P. Schmidt published 'Notes on Chinese Amphibians' which dealt with a large part of the material treated here and, in fact, his report has been entirely incorporated in the present one.

This paper is chiefly concerned with amphibians which I collected in Fukien and on the island Hainan. Many additional ones were secured during my trips through Anhwei, Hunan, Shansi, Chihli, and Inner Mongolia. Wang Fa-hsiang, a native collector whom I personally trained, obtained valuable material in Chihli and

<sup>1</sup>Formerly called "Third Asiatic Expedition."

Shantung, while other members of the Expeditions, chief among them Walter Granger, are responsible for additional specimens of interest. I will not enumerate the sources of that part of the collection already included and accounted for by Schmidt.

Special emphasis has been placed on life histories and an effort made to bring together all the important field observations on Chinese amphibians found in the literature. It is hoped that one result of this paper will be the stimulation of interest in field work among students of biology in China.

I am deeply indebted to Dr. Roy Chapman Andrews for the opportunity of serving four years on the field staff of his Central Asiatic Expeditions. Dr. G. K. Noble not only read the entire manuscript but offered much friendly advice for which I am grateful. Mr. Karl P. Schmidt also read the manuscript and made many valuable suggestions.

#### LIST OF FORMS CONSIDERED INVALID

The species listed in the left-hand column below have been found by me to differ in no essentials from certain well-known forms as indicated. Forms previously relegated to synonymy by others are not included here.

<i>Tylotriton asperrimus</i> Unterstein	= <i>Tylotriton verrucosus</i> Anderson
<i>Molge labiatum</i> Unterstein	= <i>Pachytriton brevipes</i> (Sauvage)
<i>Osteosternum amoyense</i> Wu	= <i>Ocidozyga lima</i> (Gravenhorst)
<i>Rana courtoisi</i> Angel	= <i>Rana spinosa</i> David
<i>Rana duboisreymondi</i> Vogt	= <i>Rana spinosa</i> David
<i>Rana caldwelli</i> Schmidt	= <i>Rana adenopleura</i> Boulenger
<i>Rana melli</i> Vogt	= <i>Rana andersonii</i> Boulenger
<i>Polypedates feyi</i> Chen	= <i>Polypedates dennysi</i> (Blanford)

#### LIST OF LARVÆ DESCRIBED

The following larval forms are described for the first time:

*Hynobius chinensis*  
*Hyla chinensis*  
*Hyla sanchiangensis*  
*Hyla simplex*  
*Rana adenopleura*  
*Rana asiatica*  
*Rana guentheri*  
*Rana latouchii*  
*Rana montivaga*  
*Rana nigromaculata mongolia*  
*Rana nigromaculata reinhardtii*  
*Rana plancyi*



*Polypedates dennysi*  
*Polypedates oxycephalus*  
*Philautus doriæ*  
*Kaloula borealis*

Among the above, there is doubt about the identity of the *Rana montivaga* tadpole only, but two larvæ, though described in full and figured, have not been named. One is a ranid, recorded as *Rana* (species?), the other a polypedatid, recorded as *Polypedates* species?

Three tadpoles, though not formally described in detail, are reported for the first time. They proved to be so similar to known forms that a description is unnecessary. They are:

*Megophrys kuatunensis*  
*Bufo bankorensis*  
*Polypedates leucomystax megacephalus*

*Rana japonica*, *Rana spinosa*, and *Staurois ricketti* tadpoles are re-described for reasons explained under each, and two larvæ are doubtfully referred to *Bufo raddei*.

#### LOCALITIES OF SPECIAL IMPORTANCE

Approximately 175 Chinese geographical names are to be found in the following pages. These group themselves roughly into (a) places of medium to small size, where many specimens have been collected; (b) large cities found on all maps; and (c) minor localities of no great importance in either a general or special sense. The following list is intended to allocate all of group (a) but, as anyone can imagine, the classification of so many places is no simple matter and slips have doubtless been made. Group (b) localities are too readily found to take up space here, while the situations of those in (c) are designated where they occur in the text.

- CH'UNGAN CITY.....see page 410 and map, page 611.  
 CH'UNGAN HSIEN.....see page 410 and map, page 611.  
 FUTSING or FUCHING HSIEN.....see page 411 and map, page 611.  
 HOK'OU or HOKOW.....on the plateau of northeastern Kiangsi, west and a little south of Kwangsin. See map, page 611.  
 KIENNING.....a fu city on the northern branch of the upper Min River, Fukien. See map, page 611. Not to be confused with the hsien city of the same name some distance west of Yenping near the Kiangsi boundary.  
 KIUKIANG.....on the Yangtze River in extreme northern Kiangsi. The mountains immediately to the south are known as the Lushan and it is there that Kuling is situated.

- KOWLOON.....on the mainland just opposite Hongkong Island directly to the north.
- KUATUN.....see page 410 and map, page 611.
- LIKIANG.....in northwestern Yunnan, near the Yangtze River; altitude 8200 feet on H. R. Davis' map of Yunnan.
- LILONG.....in Kwangtung, immediately north of the area under British control surrounding Hongkong Island.
- LOFAOSHAN.....a range of mountains sixty miles east of Canton and seventy north of Hongkong, reaching an altitude of 4000 feet or a little more.
- MT. OMEI.....a precipitous mountain in Szechwan immediately west of Kiating, attaining an altitude of 11,000 feet. Also called Omi or Omei Shan.
- NINGKWO.....a fu city at low altitude in southeastern Anhwei.
- NODOA.....in northern central Hainan, near the foothills of the island's southern highland.
- PINGHSIANG OR PINGSIANG.....in extreme western Kiangsi, at about 27° 41' N. latitude.
- SAN CHIANG.....a mountain village in northwestern Fukien. See page 411 and map, page 611.
- SHUICHOW.....a fu city in Kwangtung about 120 miles north of Canton.
- SUIFU.....a fu city in southern Szechwan, at the junction of the Min and Yangtze Rivers. The altitude is given as 800 feet on H. R. Davis' map of Yunnan.
- TALIFU.....in northwestern Yunnan. The altitude is given as 6700 feet on H. R. Davis' map of Yunnan.
- TENGYUEH OR MOMIEN.....in extreme western Yunnan. The altitude is given as 5365 feet on H. R. Davis' map of Yunnan.
- WANHSIEN.....on the Yangtze River in extreme eastern Szechwan, at an altitude of 600 feet.
- WHAMPOA.....twelve miles southeast of Canton, on an island in the Chu Kiang or Pearl River.
- WUHU.....on the Yangtze River in eastern Anhwei.
- WUTINGCHOW DISTRICT.....Wuting is a chow city about forty miles northwest of Yunnanfu at an altitude of 6000 feet (H. R. Davis' map of Yunnan). The area under its jurisdiction is Wutingchow District or Hsien. For the sake of uniformity with Schmidt, I have in this case used the word, District, instead of its Chinese equivalent, Hsien.
- YENPING.....see page 411 and map, page 611.
- YUANKIANG.....in southeastern Yunnan, on the Yuan Kiang or Red River. The altitude is given as 1500 feet on H. R. Davis' map of Yunnan and its distance from Yunnanfu as about 110 miles.

The question of the proper Romanization of Chinese geographical names is no simple matter because scholars of various nationalities translate the sounds in different ways, and because much similarity often exists between the names of places even within one province. A good example of the possibility of error arising from this latter cause is the case of Lianghokou or Lianghokow, Szechwan (see page 429). Finding four towns of this name (it is immaterial whether the final letter is u or w) on the map of the province, I went to some trouble to determine which one of these was referred to, only to find out that the place in question was still a fifth Lianghokou in the same province! When such repetition occurs, it does not always mean that the real names are duplicated but rather that different Chinese names are spelled with the same English letters.

In general, I have used the spelling of the Postal Map of China, which may be bought for a small sum at any large Chinese post office. For reasons too involved to enumerate here, this standard has not always been followed but, in an effort to avoid confusion, I have designated the position of every locality, some of the largest and best known cities excepted.

The present tendency is to omit the suffixes fu, ting, chow, and hsien, as their only purpose is the indication of grades of political importance among cities. If added, these final syllables are, nevertheless, often useful in helping one to distinguish between localities in the same province that happen to be spelled alike, and their retention for this reason is sometimes justified.

Anglicized Chinese monosyllables, when put together as names, may be written as a single word, separated by spaces, joined by hyphens, or even capitalized, but, in general, it is best to do the simplest thing, i. e., write each name as one, unbroken word without spacing, hyphens or more than one capital letter. For example, the capital of Shansi is variously seen as Tai Yuan, Tai-yuan, Taiyuanfu, etc., but it is printed as Taiyuan on the Postal Map.

According to the rules of writing Chinese sounds in English, many syllables are separated in the middle by an apostrophe, which merely indicates a soft or aspirated pronunciation. It is not easy to retain such a mark and only the most literally minded attempt to do so in geographical names. On many special maps of small areas, the apostrophe is used throughout in an effort to be more accurate, but frequently it is dropped entirely, and I fail to find a single one in the list of names taken from the Postal Map. Edward Stanford has not used

it in his 'Complete Atlas of China,' which happens to be by far the most useful one procurable.

A word of caution should be added: no one has an ear so acute that he or she can write down with any degree of accuracy Chinese monosyllables when first heard. It is essential that some method be devised by which every sound may be properly written according to the rules of a standard system, preferably the Anglicized form as found in either Wade's or Hirth's syllabary of Chinese sounds (Hirth, 1907). In general, Chinese characters, rather than some local pronunciation, should form the basis of Romanization.

#### HAINAN

The island of Hainan occupies a position of especial significance for those interested in the Chinese fauna. Lying almost wholly south of latitude 20° N., it is the southernmost extension of China. In the same latitude as northern Indo-China and northern Luzon, its faunal relations are primarily Oriental and its fauna is as tropical in character as that of any other corner of China. It may be divided into two regions; a northern, open plain and a southern, rugged highland, mountainous and partly forested. Five Finger Mountain forms the center of the highest section and reaches an altitude of 6300 feet.

The following is a paraphrase of Moninger's (1919) description of the Hainan climate:

During the summer season the thermometer ranges steadily from 80° to 90° F., the heat is very intense and the humidity great. Through the winter months, the temperature occasionally drops to 45° but rarely below and never that low unless the sky is cloudy. Frost is practically unknown [at lower altitudes]. From the first of October the weather is generally fair until January, with an occasional day of rain. Several weeks of January and February are very damp for the air is constantly saturated with a fine mist but no rain falls. In March and April, when the monsoons blow, the air is very dry.

#### SUMMARY OF CONTRIBUTIONS TO THE HERPETOLOGY OF HAINAN<sup>1</sup>

Swinhoe (1870) published the first list of Hainan amphibians, enumerating three species as follows:

*Rana esculenta*  
*Rana gracilis*  
*Hyla chinensis*

No specimen of the first was preserved, so obviously he must have mistaken some common Hainan *Rana* for the Chinese representative of the

<sup>1</sup>This list is complementary to Schmidt's similar one dealing with the reptiles of Hainan and contained in the introduction of his paper published in 1927.

European green frog, *Rana nigromaculata*. *R. gracilis* is a synonym of *limnocharis* and his *Hyla* may safely be taken as *simplex*.

In 1888, Boettger reported upon a collection made in Hainan by Otto Herz. A list of his six species follows:

*Oxyglossus lima*  
*Rana gracilis*  
*Rana macrodactyla*  
*Rana tigrina*  
*Rhacophorus maculatus*  
*Bufo melanostictus*

*Oxyglossus* is now *Oaxidozyga*, while *R. tigrina* is the equivalent of *R. rugulosa* and *R. maculatus* a synonym of *Polypedates leucomystax leucomystax*.

Boettger (1894) made an addition to the list from the collection of Bernhard Schmacker, *Rana guentheri*.

Cope's 1895 report on Hainan material included but one species of amphibian which he called "*Hyla arborea* var.," after noting its distinctive characteristics. He undoubtedly had a specimen of *H. simplex* before him, because it is the only *Hyla* certainly known on Hainan, where it is abundant.

Mr. John Whitehead was the first to secure representatives of the mountain fauna of Hainan but his trip was costly because he died in the interior of the island. Boulenger (1899) identified the collection which contained three new species designated by asterisks in the following list:

*Rana graminea*\*  
*Rana andersonii*  
*Staurois hainanensis*\*  
*Rhacophorus leucomystax*  
*Rhacophorus oxycephalus*\*  
*Bufo melanostictus*

*R. andersonii*, in addition to the three new forms, constitutes a new record for the island.

Barbour described *Microhyla hainanensis* in 1908, a species now relegated to the synonymy under *M. pulchra*. His description, nevertheless, is the first Hainan record of *pulchra*.

In 1913, Vogt listed nine amphibians comprising a collection made on Hainan by Schoede and presented to the Berlin Museum. *Microhyla ornata* and *M. butleri* were thus reported from Hainan for the first time, the latter, however, as a new species, *M. boulengeri*, which has only recently been considered synonymous with *M. butleri* (Parker, 1928). Vogt ended his paper with a list of eighteen forms then known to

occur on Hainan. From this list, for reasons already stated, *Microhyla hainanensis* must be deleted and *Hyla simplex* substituted for *H. arborea* and *H. chinensis* together. I do not know on what authority *Microhyla fissipes* was included but the point is immaterial because Parker (1928) considers it identical with *M. ornata*.

Mell's 1922 paper on the fauna of southern China includes quotations of Hainan records. He has duplicated Vogt's list in almost every detail, so the remarks already applied to that are appropriate for Mell's nominal list.

During my sojourn on Hainan, Malcom Smith made a collecting trip there, securing nineteen forms, two of them undescribed and six others also new for Hainan. His additions to the fauna are listed below, each new species marked with an asterisk:

<i>Oxyglossus laevis martensi</i>	<i>Rana taipehensis</i>
<i>Rana kuhlii</i>	<i>Microhyla achatina</i>
<i>Rana nasica</i>	<i>Microhyla butleri</i>
<i>Rana spinulosa*</i>	<i>Micrixalus torrentis*</i>

The important point to be noted here is that *M. heymonsi* must be substituted for *M. achatina* because the latter is now regarded as confined to Java (Parker, 1928).

The present paper includes seventeen species from Hainan, none of them new to science but a few of special interest. A complete list follows:

<i>Bufo melanostictus</i>	<i>Polypedates leucomystax leucomystax</i>
<i>Hyla simplex</i>	<i>Polypedates oxycephalus</i>
<i>Oeidozyga laevis martensi</i>	<i>Polypedates species?*</i>
<i>Oeidozyga lima</i>	<i>Philautus doriae*</i>
<i>Rana guentheri</i>	<i>Philautus vittatus*</i>
<i>Rana limnocharis</i>	<i>Kalophrynus pleurostigma*</i>
<i>Rana macrodactyla</i>	<i>Microhyla butleri</i>
<i>Rana taipehensis</i>	<i>Microhyla ornata</i>
	<i>Microhyla pulchra</i>

The four marked species are additions to the fauna but one of them, unfortunately, has not been definitely identified and cannot be included in a final list of Hainan amphibians. The large series of *H. simplex* clears up in a most satisfactory way the long confused question of the tree toads found on the island. The introduction of two new genera to the fauna, *Philautus* and *Kalophrynus* is worthy of note and one of them, *P. vittatus*, well illustrates a point brought out below, i.e., even in the lowlands, common forms frequently escape the notice of first-class collectors.

The twenty-five amphibians definitely known to occur on Hainan are listed below. I have arranged two columns: one for a brief state-

ment of the range, the other for the probable habitat preference of each form.

	RANGE	HABITAT PREFERENCE
(1) <i>Bufo melanostictus</i>	From India and southern China southward through the Malay Archipelago to the Philippines	Open plains and plateaus
(2) <i>Hyla simplex</i>	Annam and Tonkin	Vegetation of lowlands
(3) <i>Oæidozyga lævis martensi</i>	Peninsula of southeastern Asia <sup>1</sup>	Quiet water of open, level or hilly country
(4) <i>Oæidozyga lima</i>	Northeastern India and southern China to and including the Malay Archipelago	Quiet water of open, level or hilly country
(5) <i>Rana andersonii</i>	Southern and central China, Upper Burma, and Tonkin	Mountain streams
(6) <i>Rana graminea</i>	Southeastern China, Annam, and Tonkin	Mountain streams
(7) <i>Rana guentheri</i>	Southern and central China, Annam, and Tonkin	Quiet water of plains and plateaus
(8) <i>Rana kuhlii</i>	Loo Choo Islands, Formosa, southern and central China through the Malay Archipelago	Quiet water of mountains
(9) <i>Rana limnocharis</i>	India, Japan, and central China through the Malay Archipelago to the Philippines	Quiet water and grassland from sea-level to at least 7000 ft.
(10) <i>Rana macrodactyla</i>	Extreme southern China, Tonkin, Burma, and Siam into the Malay Peninsula	Streams and wet areas of open country at low altitudes
(11) <i>Rana nasica</i>	Tonkin and Hainan	Mountains
(12) <i>Rana rugulosa</i>	Central and southern China, Burma, and Formosa through much of the peninsula of southeastern Asia <sup>1</sup>	More permanent quiet water of plains and plateaus

<sup>1</sup>The region from Upper Burma and northern Indo-China to and including the entire Malay Peninsula will be thus designated.

	RANGE	HABITAT PREFERENCE
(13) <i>Rana spinulosa</i>	Known only from Hainan	Mountain streams
(14) <i>Rana taipehensis</i>	Formosa, extreme southeastern China, (Tonkin?), and Annam	Grass and streams from low to moderate altitudes
(15) <i>Staurois hainanensis</i>	Known only from Hainan	Cascades
(16) <i>Micrixalus torrentis</i>	Known only from Hainan	Mountain streams
(17) <i>Polypedates leucomystax leucomystax</i>	Peninsula of southeastern Asia <sup>1</sup> through the Malay Archipelago to the Philippines	Vegetation of level as well as mountainous country
(18) <i>Polypedates oxycephalus</i>	Known only from Hainan	Cascades
(19) <i>Philautus doriæ</i>	Burma and Siam	Vegetation of low, level country
(20) <i>Philautus vittatus</i>	Upper Burma, Siam, and Cochin China	Vegetation of low, level country
(21) <i>Kalophrynus pleurostigma</i>	Southern China and Burma southward through the Malay Archipelago	Open country near streams at low and moderate altitudes
(22) <i>Microhyla butleri</i>	Central and southeastern China southward into the Malay Peninsula	Grassland of plains, plateaus, and mountains to moderate altitudes
(23) <i>Microhyla heymonsi</i>	Formosa and southern China through the peninsula of southeastern Asia <sup>1</sup> to Sumatra	Open country at low altitudes as well as high mountains
(24) <i>Microhyla ornata</i>	India through Burma, central China, and Formosa southward into the Malay Peninsula	Open plains, plateaus, and low mountains
(25) <i>Microhyla pulchra</i>	Extreme southeastern China, Tonkin, Siam, and Cochin China	Plains, plateaus, and low mountains

<sup>1</sup>The region from Upper Burma and northern Indo-China to and including the entire Malay Peninsula will be thus designated.



Although the amphibian fauna of Hainan has been analyzed and discussed by Smith and others, the above table brings together data never before correlated and should enable us to arrive at conclusions of some finality. I have purposely omitted reference to conventionalized formulæ relegating the various species to zoögeographic regions or areas because I believe that better results can be obtained by adhering to the simplest possible method of presentation. The ranges as given are intended to be correct even in detail but I have only indicated the habitat preferences in a general way, distinguishing readily secured, open country forms of wide and general distribution from the more elusive mountain inhabitants whose ranges are often very erratic.

Careful examination of the above table brings certain facts to light as follows:

1.—Nineteen of these Hainan frogs are already known to be widely distributed in southeastern Asia (Nos. 1, 3-10, 12, 14, 17, 19-25). Nearly all of this number of species are lowland and open country types readily collected and generally abundant.

2.—The four forms not known to occur off the island are mountain-stream inhabitants secured only with great difficulty, a fact that may entirely account for their apparent absence elsewhere (Nos. 13, 15-16, 18). It is more than probable that these will turn up when the higher regions of the adjacent mainland are thoroughly explored.

3.—There are but two remaining forms: *R. nasica*, also a mountain species, the range of which is but partly known; and *H. simplex*, the single representative of the north and central Asiatic fauna that extends over much of Europe.

It may be concluded, then, that the lowland amphibian fauna of Hainan is exactly what it would be were the island still connected with the adjacent mainland, while the mountain fauna is more distinctive, a condition that undoubtedly is largely accounted for by our incomplete knowledge of the amphibians inhabiting the mountains of the opposite mainland. In addition, it is safe to state that more than twenty-five species exist on Hainan.

#### FUKIEN AND ITS THREE PRINCIPAL LOCALITIES

Fukien is one of China's "Eighteen Provinces." Located on the southeastern coast, it is bounded by the Formosan Strait on the east, Chekiang on the north, Kiangsi on the west, and Kwangtung on the south. It is roughly quadrangular in shape and set obliquely, the north-western corner being a little east of the southeastern. With the exception of the four corners, it lies wholly within the area bounded by the 24th and 28th parallels of north latitude, and the 116th and 120th meridians of east longitude. The area is 46,332 square miles.

In southeastern China, from southern Anhwei southward through Chekiang, Kiangsi (the flat country of the Poyang Lake region excepted), Fukien, and much of Kwangtung, endless chains of steep, rugged mountains rise to an altitude of from three to more than seven thousand feet. Their general trend is from northeast to southwest, or parallel to the coast, and the wildest and highest ranges follow inland provincial boundaries, while along the sea lower chains are found.

Obviously, an area lying just north of the tropic of Cancer, having great altitudinal differences resulting from ranges extending more or less north and south, and an extensive coast line, would possess a rich and interesting fauna and flora. Fukien is just such an area that has proved nowise disappointing, harboring, as it does, no less than 118 forms of reptiles and amphibians together. This count does not take marine species into consideration.

To the Chinese, the name Fukien is almost synonymous with the word mountain. This, moreover, is a true conception. The deeply indented coast, a result of subsidence, is no less rugged and hilly than the interior, though here the low mountains are broken up by plains. Proceeding inland, the mountains increase and the plains diminish until, along the western border, high, steep ranges almost completely intercept transportation. It is here that peaks rise to more than 7000 feet and sparsely settled, primeval forests abound. These western ranges arise from a plateau about 1200 feet above sea-level.

The northern half of the province, that section with which this paper directly deals, is drained largely by the Min River system. The headwaters of this river arise along the Fukien-Kiangsi boundary and descend as several small rivers to unite at Yenping and form the Min.

The three Fukien localities of special importance, Ch'ungan Hsien, Yenping, and Futsing Hsien, are described separately below.

CH'UNGAN HSIEN.—As shown on the map, page 611, Ch'ungan City, Kuatun, and San Chiang are all included in this area. Ch'ungan City is situated on an open, highly cultivated plateau inhabited by few interesting amphibia. After crossing this thickly settled region, one soon enters the Kuatun mountains extending along its western border where possibly the highest peaks of the province are found. Kuatun itself is little more than a series of houses stretched along a valley that comes to an end just below the summit of Kuatun Mountain (Plate XIX, fig. 1), locally reputed to reach a greater altitude than any of the neighboring mountains. This valley is bowl-shaped and partly cultivated at its upper end, but lower down it is narrow, steep-sided, and

forested. San Chiang, a typical mountain village, is situated some 1200 to 1500 feet lower in a wide valley through which an interprovincial highway extends. The pass into Kiangsi, a few miles above San Chiang, is called T'ung Mu Kuan. The San Chiang-Kuatun region, then, is rugged and well forested as shown in the photographs of plates XVIII-XXI. I have no exact data on the altitudes of this region but the figures already given and those on the map, page 611, are the most reliable ones available.

Kuatun is famous as the collecting ground of both Abbé Armand David and Mr. J. D. LaTouche. Mr. Outram Bangs of the Museum of Comparative Zoölogy, Cambridge, Massachusetts, has supplied me with a list of twenty-seven birds having Kuatun as their common type locality, while no less than fifteen mammals and seven reptiles have been described from there.<sup>1</sup> The same is true of the following amphibians (those recently described by me are not included):

*Rana latouchii*  
*Rana ricketti* .  
*Megophrys boettgeri*

This by no means exhausts the Kuatun new-species list but gives some idea of the scientific importance of this remote village.

In this paper, I have, as a rule, used Ch'ungan Hsien to designate specimens from the "hsien" or district controlled politically by Ch'ungan City. This term, then, is inclusive of several localities, Ch'ungan City, Kuatun, San Chiang, etc., but, in nearly every case, specific details are added in the text to indicate the exact origin of the material.

YENPING.—This city, situated where the main branches unite to form the Min River, has been visited by botanists as well as zoölogists. Caldwell, Sowerby, and Andrews collected here with good results. The water front of the town is only some 500 feet above sea-level but the precipitous, forested mountains six to ten miles west of the city reach a height of 4200 feet or more. Thus, specimens from a great range in altitude may be taken. (See map, page 611.)

FUTSING<sup>2</sup> HSIEN.—In this area, low, intensely cultivated plains and rugged mountains are mixed in about equal proportions. The latter scarcely exceed 3000 feet in altitude and are for the most part quite bare. One range in which I worked is still clothed in forests and it was there that the cascade and swift-stream amphibians were taken. I made my headquarters in Ling Shih Szu, a large but delapidated monastery at the

<sup>1</sup>The more inclusive term Ch'ungan Hsien is given by me (Pope, 1929) as the type locality of seven additional new reptiles, all the types of which were taken in the mountains about Kuatun and San Chiang.

<sup>2</sup>Hokkiang or Hokchiang is the local and Foochow equivalent of Futsing.

base of the mountains. Futsing Hsien is on the coast just southeast of Foochow. (See map, page 611.)

SUMMARY OF CONTRIBUTIONS TO THE HERPETOLOGY OF FUKIEN

Our knowledge of the amphibia of this province begins with Steindachner's 1869 report on the collection made by the 'Novara.' Two species were recorded from Amoy as follows:

*Bufo melanostictus*  
*Hyla chinensis*

David's records of the three species listed below do not strictly belong here but are, nevertheless, worthy of mention, dealing as they do with specimens from extreme eastern Kiangsi near the Fukien boundary:

*Triton orientalis*  
*Cynops chinensis*  
*Rana latrans* or *spinosa*

The first is generally known as *Triturus orientalis*, while the second is now referred to the subsequently described *Pachytriton brevipes*.

In 1882, Boulenger described a new species from Amoy:

*Rana guentheri*

La Touche visited Kuantun in 1896 and 1898. Boulenger (1899) reported on his interesting collection from there as follows:

*Rana kuhli*  
*Rana boulengeri*  
*Rana japonica*  
*Rana latouchii*\*  
*Rana andersoni*  
*Rana ricketti*\*  
*Rhacophorus leucomystax*  
*Rhacophorus dennysi*  
*Bufo vulgaris*  
*Leptobrachium boettgeri*\*

The three species described as new are marked with asterisks. *R. boulengeri* is a synonym for *R. spinosa*, while the genus *Leptobrachium* is now united with *Megophrys*. The toads called *B. vulgaris* are undoubtedly identical to the *B. bankorensis* of the present paper, and *R. leucomystax* to *P. l. megacephalus*. Boulenger was much gratified to see the three *R. dennysi* from Kuantun because, since its description in 1881 from an indefinite locality, he had received one from Foochow and was consequently able to base a new account on all five specimens then known.

The following species<sup>1</sup> secured at Foochow by Kreyenberg are included in Wolterstorff's 1906 extensive report on Chinese collections:

*Rana esculenta chinensis*  
*Rana japonica*  
*Rana limnocharis*  
*Microhyla ornata*  
*Hyla chinensis*

*R. e. chinensis* is certainly Schmidt's *R. nigromaculata reinhardtii*. The first, third, and fourth are additions to the fauna.

Only after many years had passed was the knowledge of the Amphibia of Fukien increased by Annandale's 1917 record of *Rana rugulosa* from the province.

Boulenger reported *Rana longicrus* from Ching Fung Lin, Fukien, in his Monograph (1920), a record referred to *R. japonica* in the present paper.

A great revival of interest was initiated when Stejneger listed the Chinese material in the National Museum (1925). The following six among a total of eighteen forms recorded from Fukien were additions to the fauna:

*Pachytriton brevipes*  
*Microhyla sowerbyi*  
*Microhyla heymonsi*  
*Rana plancyi*  
*Rana adenopleura*  
*Oxydozyga lima*

As explained in the 'Annotated List of Species,' *M. butleri* should be substituted for *M. sowerbyi*, described as new, and *R. fukienensis* for *R. plancyi*. *Oxydozyga* is a synonym of *Oæidozyga*.

The next contribution, made by Schmidt in 1927, was based on the fine collections of Caldwell, Andrews, and Heller, and although it consisted of as many as thirteen species, it included no additions to the fauna.

In 1929, Wu recorded *Oæidozyga lima* from Amoy as the type of a new genus and species *Osteosternum amoyense*.

The present paper includes a total of thirty-two species collected by myself in Fukien, the following nine constituting new records:

<sup>1</sup>This lot of species was also enumerated in a communication from Kreyenberg in 1905 and a short article by Wolterstorff of the same date. These references, though included in the Bibliography at the end of this paper, are not quoted directly because of their comparative inaccessibility.

*Hynobius chinensis*  
*Megophrys kuatunensis*\*  
*Megophrys pelodytoides*  
*Megophrys hasseltii*  
*Hyla sanchiangensis*\*  
*Rana chunganensis*\*  
*Rana graminea*  
*Rana montivaga*  
*Rana* (species?)

The three starred forms were described by me as new in 1929. Unfortunately, one of the nine cannot be included in a final list because of its uncertain identity.

The accompanying table summarizes the distribution of Amphibia within Fukien, giving habitat preferences and general ranges in terms of provinces, countries and other major geographical divisions. An asterisk indicates a record based entirely upon material in the collection of the American Museum or upon my personal observation. A study of this table will show at once the complex nature of the Fukien amphibian fauna, consisting as it does of twenty-two oriental and nine Palearctic species. The former, after excluding *Megophrys kuatunensis*, *Bufo bankoensis*, *Rana chunganensis*, and *Polypedates leucomystax megacephalus*, species whose ranges are not known or very incompletely defined, may be divided into three groups as follows:

1.—Forms widely distributed through southern China and the peninsula of southeastern Asia including, or not, part of India and the Malay Archipelago: *Megophrys pelodytoides*, *Megophrys hasseltii*, *Bufo melanostictus*, *Oæidozyga lima*, *Rana kuhlii*, *Rana limnocharis*, *Microhyla butleri*, *Microhyla heymonsi*, and *Microhyla ornata*.

2.—Forms of moderately wide distribution in China and the peninsula of southeastern Asia: *Rana andersonii*, *Rana graminea*, *Rana guentheri*, *Rana montivaga*, and *Rana rugulosa*.

3.—Forms of limited distribution in central and southeastern China and, in two cases, Tonkin: *Megophrys boettgeri*, *Rana spinosa*, *Stauroides ricketti*, and *Polypedates dennysi*.

The ranges of three of the nine holarctic forms are not known or only poorly defined, *Hynobius chinensis*, *Hyla sanchiangensis*, *Rana japonica*, while the remaining six may be divided into two groups of equal size as follows:

1.—Those locally distributed in southeastern China and, in two cases, Formosa, but having no very close allies: *Pachytriton brevipes*, *Rana adenopleura*, and *Rana latouchii*.

2.—Those locally distributed in southern and central China and Formosa (one form excepted) but having very close allies of much wider distribution: *Hyla chinensis*, *Rana fukienensis*, and *Rana nigromaculata reinhardtii*.

Table Showing Distribution of Forms Within Fukien

	RANGE WITHIN FUKIEN				GENERAL RANGE EXCLUSIVE OF FUKIEN	HABITAT PREFERENCE IN FUKIEN
	FUTSING HSIEN	YENPING REGION	CH'UNGAN HSIEN	OTHER LOCALITIES		
(1) <i>Hynobius chinensis</i>			Rare*		Known only from Ichang, its type locality	Forest floor near top of highest ranges
(2) <i>Pachytriton brevipes</i>	Abundant*	Abundant	Abundant*		Kiangsi, Kwangtung and Yunnan <sup>1</sup>	Swift mountain streams
(3) <i>Megophrys boettgeri</i>	Abundant*	Abundant*	Abundant (Kuatun is the type locality)		Kiangsi, Chekiang, Kwangtung and Hongkong	Vicinity of shaded mountain streams
(4) <i>Megophrys kuatunensis</i>			Abundant* (Kuatun is the type locality)		(Known only from type locality)	Vicinity of shaded mountain streams at highest altitudes
(5) <i>Megophrys pelodytoides</i>	Abundant*	Abundant*	Abundant*		Tonkin, Burma, Siam, and Malay Peninsula	Vicinity of shaded mountain streams
(6) <i>Megophrys hasseltii</i>			Abundant*		Kwangtung, Burma, and Siam southward through Malay Region to Philippines	Vicinity of shaded mountain streams
(7) <i>Bufo melanostictus</i>	Abundant	Abundant*	Abundant*	Kienning,* Foochow,* Amoy	Formosa, Kwangtung, Hainan and Yunnan in China. Widely distributed through India and southward from China through Malay Region to Philippines	Open, level and hilly regions, low to medium altitudes
(8) <i>Bufo bankorensis</i>			Abundant		Formosa and Szechwan	High altitudes in mountains
(9) <i>Hyla chinensis</i>	Abundant	Abundant*	Abundant*	Foochow, Amoy	Central China and Formosa to northern Kwangtung; northern and western limit of range not well defined	Vegetation of plains and plateaus to moderate altitudes in mountains
(10) <i>Hyla sanchiangensis</i>			Abundant*		(Known only from type locality)	Vegetation of higher mountains
(11) <i>Oceidozyga lima</i>	Only moderately abundant			Amoy	Kwangtung and Hainan in China. Widely distributed southward from eastern India and China through Malay Region	Quiet water of open country at low altitudes
(12) <i>Rana adenopleura</i>		Abundant	Abundant*		Formosa	Quiet water in mountains
(13) <i>Rana andersonii</i>	Abundant*	Abundant*	Abundant	Foochow	Kwangtung, Hainan, Yunnan, Hupeh, Burma and Tonkin	Mountain streams
(14) <i>Rana chunganensis</i>			Abundant*		(Known only from type locality)	Mountain forests
(15) <i>Rana fukienensis</i>	Abundant		Abundant*	Foochow	Formosa	Quiet water of plains and plateaus
(16) <i>Rana graminea</i>		Only* moderately abundant	Abundant*		Hainan, Annam and Tonkin	Mountain streams
(17) <i>Rana guentheri</i>	Abundant*	Abundant*	Abundant*	Amoy (type locality), Kienning,* Foochow	Szechwan, Kiangsu, Kiangsi, Kwangtung, Hainan, Yunnan, Hongkong, Tonkin and Annam	Quiet water of plains and plateaus
(18) <i>Rana japonica</i>		Abundant*	Abundant	Kienning, Ching Fung Lin, Foochow	Widely distributed through central and southern China, but range is poorly defined	Grassy areas from sea-level to considerable altitudes in mountains
(19) <i>Rana kuhlii</i>		Probably* abundant	Abundant		Loo Choo Islands, Formosa, Kiangsu, Kiangsi, Yunnan, Kwangtung, Hainan, and Hongkong southward through Malay Region	Quiet waters of mountains
(20) <i>Rana latouchii</i>		Abundant*	Abundant (Kuatun is the type locality)		Formosa	Quiet water of mountains
(21) <i>Rana limnocharis</i>	Abundant	Abundant	Abundant*	Foochow, Upper Min Basin	From India through central Szechwan and Shantung to Japan and southward through Malay Region to Philippines	Quiet water and grassland from sea-level to considerable altitudes in open mountain valleys
(22) <i>Rana montivaga</i>	Probably* present but rare	Not* abundant	Abundant*		Annam	Mountain forest floor
(23) <i>Rana rugulosa</i>	Abundant*	Abundant*	Abundant*	Foochow	Yunnan, Szechwan, Hupeh, Hunan, Kiangsi, Anhwei, Kiangsu, Chekiang, Kwangtung, Hainan, Formosa, Hongkong, and southward into peninsula of southeastern Asia <sup>2</sup>	More permanent, quiet water of plains and plateaus
(24) <i>Rana nigromaculata reinhardtii</i>		Abundant	Abundant*	Foochow	<i>R. nigromaculata</i> is widely distributed in central and northern China, but the ranges of the subspecies are not well defined. This one is found as far south as northern Kwangtung	Quiet water of fields and ditches from sea level to considerable altitudes in mountains
(25) <i>Rana spinosa</i>	Abundant*	Abundant	Abundant	Foochow, Upper Min Basin	Hupeh, Kwangsi, Anhwei, Chekiang, Kwangtung, Kiangsi, Hongkong, and Tonkin	Mountain streams
(26) <i>Staurois ricketti</i>	Abundant*	Abundant	Abundant (Kuatun is the type locality)		Kwangtung and Tonkin	Shaded cascades
(27) <i>Polypedates dennysi</i>	Probably* abundant	Abundant	Abundant	Foochow, Yuchi	Hunan, Kiangsi, and Kwangsi	Generally distributed but partial to vegetation of mountain forests
(28) <i>Polypedates leucomystax megacephalus</i>		Abundant	Abundant	Foochow	Formosa, Kiangsu, Kwangtung, and Hongkong	Vegetation of plains, plateaus, and mountains to considerable altitudes
(29) <i>Microhyla butleri</i>		Abundant			Szechwan, Kwangtung, Hainan, Tonkin, Siam, Cochin China, and Malay Peninsula	Grass-grown valleys in mountains of moderate altitude
(30) <i>Microhyla heymonsi</i>	Abundant*	Abundant	Abundant*		Hainan, Formosa, Tonkin, Siam, Cochin China, Malay Peninsula Nias, and Sumatra	Open, grassy valleys of high mountains
(31) <i>Microhyla ornata</i>	Abundant	Abundant	Abundant*	Kienning, Foochow	Szechwan, Yunnan, Hunan, Kiangsi, Anhwei, Kiangsu, Chekiang, Kwangtung and Hainan in China. Exclusive of China it is found in Burma, Assam, Siam, Annam, Malay Peninsula, India and Ceylon	Grassland from sea level to considerable altitudes in mountains

<sup>1</sup>A single specimen is reported from Yunnan as stated under *P. brevipes* in the 'Annotated List of Species.' This record is open to doubt.  
<sup>2</sup>See note page 407.





An analysis of the distribution of the thirty-one forms within Fukien itself gives the following results: the three chief localities (Foochow taken together with Futsing Hsien, and Kienning with Yenping) have almost an equal number of oriental forms, the only difference being that a greater number of mountain inhabitants are recorded from Ch'ungan Hsien, a difference doubtless to be accounted for by the more thorough collecting done there. It is another matter when the Palearctic fauna is considered because Futsing Hsien has only four and Yenping five, but Ch'ungan Hsien seven forms. This illustrates the real difference between northeastern and northwestern Fukien. The rugged mountains of the northwest not only act as a barrier to the passage of northern species but afford a relatively temperate climate for them to enjoy in a latitude south of where they normally occur.

In conclusion, it may be stated that Fukien derives its fauna chiefly from the south. A few northern forms, however, penetrated the mountains of its northwestern border or followed the coast southward and became widely distributed throughout the province, while others took up their abode in the northwestern highland where they found a temperate rather than a semi-tropical climate. Conversely, southern lowland species reached different points in their northward advance along the coast, only a limited number of them having passed Yenping, however, while many of those adapted to mountain life followed the highland of the western boundary and became well established even as far north as Ch'ungan Hsien. One might describe Fukien as the meeting ground of Palearctic and oriental faunas, a term likewise applicable to northern Kwangtung as shown by Mell (1929). It would be hard to find another place possessing such a complete mixture of Amphibia representing two of the major faunistic divisions of the world.

#### METHODS AND PERIODS OF COLLECTING

Many of the large series of specimens included in this report were collected through local farmers. This method, previously employed to good advantage by Wall, Andrews, and many others, is very satisfactory when combined with constant supervision. It is, however, far more practicable with reptiles than amphibians. Frogs are easily found when breeding and, at such times, two or three persons can often secure a sufficiently large series in a few minutes. Rare reptiles may never be seen by any one individual no matter how clever at collecting that one may be and such species can only be secured through local help.

Immediately upon arrival at a new locality, I invariably called together all professional snake-catchers, fishermen, and hunters, and the like, hiring the most promising and gleaning as much information as possible from the rest. My own helpers organized idlers and ambitious boys in the hope that some of them could be permanently interested in collecting. At least one of our party always remained in camp to act as purchaser. My own time was largely spent in reconnaissance, special night studies of habits, and so forth. I collected mammals, fishes, and insects as well as reptiles and amphibians, so the hours never dragged. The fishes were for the most part taken at odd times, but I spent several months hunting mammals.

Experience soon taught me that it was wise to buy only specimens in perfect condition, and, as a result, each community soon learned what a waste of time it was to bring mutilated or partly spoiled reptiles and amphibians to camp. The practical-minded oriental farmer readily understands one's point of view and I soon learned to regard him as the most reasonable individual whose acquaintance I have been privileged to enjoy. I also learned his love of bargaining and consequently set a sliding scale of prices that varied from day to day with each species in a manner similar to that employed by the New York Stock Exchange.

The following is a summary of my important herpetological collecting centers in Fukien and the time spent in each:

Yenping	April 12,	through June 2, 1925
Ch'ungan Hsien	June 12,	through July 20, 1925
Futsing Hsien	August 24,	through October 5, 1925
Ch'ungan Hsien	April 25,	through September 3, 1926

While working in Ch'ungan Hsien, I sent a collector to Ho'kou, Kiangsi, to get the common forms there. Specimens from Ch'ungan City, Kienyang, Kianning, and Foochow were taken at odd times either by myself or one of the men directly in my employ.

#### HABITAT PREFERENCES<sup>1</sup>

This subject must be approached with great caution because a definite line can rarely be drawn that will, with any degree of certainty, serve to define and delimit habitats. So few field observations have been made on Chinese frogs that little or no help may be derived from the literature, and I have, therefore, decided not to generalize but to be as specific as possible and include only the results of my own observations.

<sup>1</sup>An abbreviated form of this section, entitled "Frog Habitats in China," was published in the Bull. of the Peking Soc. of Nat. Hist., IV, part 2. Although a few changes have been made in details and arrangement, the above is essentially the same as the original article.

In this way, I hope to form a solid foundation on which others may build by adding new data. Therefore, when I record a frog from a certain habitat I mean that it was found there by me, not that it invariably or only occurs in such an environment. In another region it might frequent an entirely different type of country.

The following points require emphasis and are added here by way of suggestion to field workers.<sup>1</sup>

Conclusions should not be drawn until repeated observations have been made on specimens occurring in numbers. If a species is seen in this or that habitat, the fact should be recorded and corroborative data searched for at once. Frogs, like other animals, will wander. Moreover, false conclusions are often drawn from single observations even when made on a specimen in normal surroundings. For example, a frog that invariably breeds in quiet, roadside pools may, after heavy rains, be found laying in swift streams because quiet pools are often temporarily connected with nearby streams. Other cases of misleading coincidence could readily be cited.

Many species are plastic in habits and consequently occur in more than one type of habitat. *Polypedates leucomystax leucomystax*, on Hainan Island, deposits its froth masses of eggs on the ground by grassy pools in open spaces, as well as on trees, or high above the ground in bushes and thickets. In Fukien, I found the closely allied form, *P. leucomystax megacephalus*, living and breeding in rockwork facing of rice-field terraces. Nevertheless, there are important points of similarity between these seemingly different habits: i.e., the eggs, always enclosed in froth, are invariably deposited adjacent to, or directly over water.

The difficulty of drawing absolute lines between certain habitats is well illustrated by the indefinite distinction between the flooded field, pond, and pool habitats. It is impossible to say when a pool becomes a pond or to tell at what point an unworked or partly-dried flooded field turns into a series of pools. For example, there are certain species that greatly prefer a really permanent body of water even though it is more than likely to be inhabited by voracious fishes of considerable size, while others would shun such a place, not only because of its fishes but for other reasons of a more complex nature. The first species would best be called pond, the second pool (or flooded field) type. Let us consider *Rana rugulosa* as an example of the former. It is obvious that such

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<sup>1</sup>I take the liberty of making these suggestions for the special benefit of those interested in living animals, because, in the past, works on the herpetology of China have not dealt with such questions.

a large frog could scarcely conceal itself in a small pool, while its size renders it comparatively safe from the attacks of fishes when in its normal or pond habitat. Turning to larvæ, it is safe to say that the spawn of *rugulosa* would fairly fill a pool in which hundreds of *Microhyla* eggs might develop unnoticed. It is needless to explain further. Anyone should realize, from the above examples, the usefulness of distinguishing between various favorite sites, in spite of the fact that such sites may not help in defining the habitats of all species of a given region.

Although the "Breeding Habitats," and "Tadpole Habitats" are generally identical, there is enough difference to warrant separate treatment of the two in the following outline. Forms marked with an asterisk occur in opposite columns. They are, in other words, the most adaptable ones.

### Adult Habitats

#### BUSH AND TREE

##### PLAIN AND PLATEAU

*Hyla immaculata*  
*Hyla chinensis*  
*Hyla simplex*  
*Polypedates dennysi*\*  
*Polypedates leucomystax leucomystax*  
*Polypedates leucomystax megacephalus*\*  
*Philautus doriae*  
*Philautus vittatus*

##### MOUNTAIN

*Hyla sanchiangensis*  
*Polypedates dennysi*\*  
*Polypedates leucomystax megacephalus*\*

Young *Hylas* are frequently found in grass rather than higher vegetation. In Fukien, *Polypedates leucomystax megacephalus* inhabited rockwork facing of terraces, as well as trees and bushes.

#### GRASS

*Rana amurensis*  
*Rana asiatica*

*Rana japonica*  
*Rana macrodactyla*  
*Rana taipehensis*

I am by no means certain just how completely some of these species are adapted to climbing in grass.

## GROUND

## PLAIN AND PLATEAU

*Bufo bufo asiaticus*\*  
*Bufo melanostictus*  
*Bufo raddei*  
*Microhyla butleri*\*  
*Microhyla ornata*\*  
*Microhyla pulchra*  
*Kaloula borealis*

## MOUNTAIN

*Hynobius chinensis*  
*Megophrys boettgeri*  
*Megophrys hasseltii*  
*Megophrys kuatunensis*  
*Megophrys pelodytoides*  
*Bufo bufo asiaticus*\*  
*Bufo bankorensis*  
*Rana montivaga*  
*Microhyla butleri*\*  
*Microhyla heymonsi*  
*Microhyla ornata*\*

The ground-inhabiting mountain forms might be further divided into those frequenting the vicinity of forest streams, such as species of *Megophrys*; those preferring the dryer sections of the forest floor, i.e., *Hynobius chinensis*, *Rana montivaga*, and, to some extent at least, *Bufo bankorensis*; and those partial to the grassy regions of open valleys, as the three forms of *Microhyla*. In Fukien, *M. heymonsi* was especially abundant in high valleys where it seemed to be entirely at home.

## FLOODED FIELDS

## PLAIN AND PLATEAU

*Rana fukienensis*<sup>1</sup>  
*Rana guentheri*  
*Rana nigromaculata nigromaculata*  
*Rana nigromaculata mongolia*  
*Rana nigromaculata reinhardtii*\*  
*Oæidozyga lima*  
*Oæidozyga lævis martensi*

## MOUNTAIN

*Rana adenopleura*  
*Rana latouchii*  
*Rana nigromaculata reinhardtii*\*

## POND

*Rana rugulosa* is a typical pond frog of plain and plateau. *Rana adenopleura* and *R. latouchii* originally might have been inhabitants of mountain ponds or pools before the coming of rice planters who furnished them with a more suitable habitat.

## POOL

*Rana kuhlii* prefers shaded mountain pools and drains to open, flooded fields. It also shuns forests.

Lowland pool forms have probably taken to a flooded field existence. As stated just above, *Rana adenopleura* and *R. latouchii* might have originally inhabited mountain ponds and pools.

<sup>1</sup>Erroneously considered by me as replacing *Rana nigromaculata reinhardtii* in eastern Fukien. See Pope, 1929, 'Frog Habitats in China,' page 12.

## MOUNTAIN STREAM

<i>Pachytriton brevipes</i>	<i>Rana spinosa</i>
<i>Rana andersonii</i>	<i>Staurois ricketti</i>
<i>Rana graminea</i>	<i>Polypedates oxycephalus</i>

Although all of these forms are well adapted to life in flowing water, probably no two of them are alike in their ability to survive in a swift stream after its emergence onto plain or plateau. Their habits are worthy of special study.

## Larval Habitats

## QUIET WATER

## PLAIN AND PLATEAU

*Bufo bufo asiaticus\**  
*Bufo melanostictus*  
*Bufo raddei*  
*Hyla chinensis*  
*Hyla simplex*  
*Oæidozyga lima*  
*Rana asiatica*  
*Rana fukienensis*  
*Rana guentheri*  
*Rana japonica\**  
*Rana limnocharis\**  
*Rana macrodactyla*  
*Rana nigromaculata nigromaculata\**  
*Rana nigromaculata mongolia*  
*Rana nigromaculata reinhardtii*  
*Rana rugulosa*  
*Polypedates dennysi\**  
*Polypedates leucomystax leucomystax*  
*Polypedates leucomystax megacephalus\**  
*Polypedates species?*  
*Philautus dorix*  
*Philautus vittatus*

## MOUNTAIN

*Hynobius chinensis*  
*Bufo bufo asiaticus\**  
*Bufo bankorensis*  
*Hyla sanchiangensis*  
*Rana adenopleura*  
*Rana japonica\**  
*Rana kuhlii*  
*Rana latouchii*  
*Rana limnocharis\**  
*Rana nigromaculata nigromaculata\**  
*Polypedates dennysi\**  
*Polypedates leucomystax megacephalus\**

The tadpole of *Hyla immaculata*, though undescribed, will of course be found to live in the quiet water of lowlands where the adults abound. *H. annectans* is now known to breed in such water on the Yunnanfu plateau. One wonders to what altitude it ascends in the mountains of that province.

I have not attempted to distinguish between field and pond or pool inhabitants because larvæ are prone to stray from the site of their hatching and, even though the tadpole of *R. rugulosa* might be classed as a pond type, it is not adverse to wandering into almost any quiet water. *R. kuhlii* larvæ seemed to avoid open fields, however.

Since nearly all of the tadpoles listed above may be found in flooded fields, some idea of the importance of this habitat to Chinese frogs can be formed.

## MOUNTAIN STREAM

<i>Megophrys boettgeri</i>	<i>Rana spinosa</i>
<i>Megophrys kuatunensis</i>	<i>Rana</i> (species?)
<i>Megophrys pelodytoides</i>	<i>Staurois ricketti</i>
<i>Megophrys hasseltii</i>	<i>Polypedates oxycephalus</i>
<i>Rana montivaga</i>	<i>Microhyla heymonsi</i>

*Rana andersonii*, *R. chunganensis*, and *R. graminea* could be added with perfect certainty, even though their tadpoles have not been described.

## Breeding Habitats

## VEGETATION OUT OF WATER

## PLAIN AND PLATEAU

*Polypedates dennysi*\*  
*Polypedates leucomystax leucomystax*  
*Polypedates leucomystax megacephalus*\*  
*Philautus vittatus*

## MOUNTAIN

*Polypedates dennysi*\*  
*Polypedates leucomystax megacephalus*\*

## QUIET WATER

## PLAIN AND PLATEAU

*Bufo bufo asiaticus*\*  
*Bufo melanostictus*  
*Bufo raddei*  
*Hyla chinensis*  
*Hyla simplex*  
*Oeidozyga lima*  
*Rana asiatica*  
*Rana guentheri*  
*Rana japonica*\*  
*Rana limnocharis*\*  
*Rana macrodactyla*  
*Rana nigromaculata nigromaculata*  
*Rana nigromaculata reinhardtii*\*  
*Rana nigromaculata mongolia*  
*Rana rugulosa*  
*Microhyla butleri*\*  
*Microhyla ornata*  
*Microhyla pulchra*  
*Kaloula borealis*

## MOUNTAIN

*Hynobius chinensis*  
*Bufo bufo asiaticus*\*  
*Bufo bankorensis*  
*Hyla sanchiangensis*  
*Rana adenopleura*  
*Rana japonica*\*  
*Rana kuhlii*  
*Rana latouchii*  
*Rana limnocharis*\*  
*Rana nigromaculata reinhardtii*\*  
*Microhyla butleri*\*  
*Microhyla heymonsi*

The breeding of *Hyla immaculata* and *Rana fukienensis*, though unobserved, without doubt takes place in lowland quiet water. *Hyla annectans*, as stated above, is known to breed in quiet water. *Rana plancyi*

is certainly a lowland breeder. I have never observed it in the field, however.

#### MOUNTAIN STREAM

<i>Pachytriton brevipes</i>	<i>Rana chunganensis</i>
<i>Megophrys boettgeri</i>	<i>Rana montivaga</i>
<i>Megophrys kuatunensis</i>	<i>Rana spinosa</i>
<i>Megophrys pelodytoides</i>	<i>Rana</i> (species?)
<i>Megophrys hasseltii</i>	<i>Staurois ricketti</i>
	<i>Polypedates oxycephalus</i>

*Rana andersonii* and *R. graminea* could be listed here with perfect safety.

For the sake of emphasis, I wish to state again that this outline is by no means final or complete but distinctly suggestive and introductory. It is the summary of a long series of scattered observations.

#### ADAPTATION TO LIFE IN MOUNTAIN STREAMS

Collectors and field workers are in the habit of observing animals in their natural surroundings, but experimentalists study them in laboratories. These two groups are more than apt to disagree in their explanations of how species are evolved, because the attention of the first group is constantly focused upon beautiful examples of so-called adaptations to environment, while the efforts of the second are largely spent in trying to bring about permanent changes of almost any kind, and, finding their task a most difficult one, come to look upon animals as relatively fixed in structure, regardless of environment. In order to produce tangible results, the laboratory investigator is forced to work against time, but the field man is heedless of that element, for he describes and records what has taken place through countless ages. It is one thing to see that the tadpole of *Staurois ricketti* is adapted to an existence in swift water and quite another to evolve a sucking-disc tadpole! Almost anyone would concede that the sucking disc of this larva is correlated with life in a special environment, but it is no easy matter to decide about many other structural or instinctive modifications. My purpose is to discuss briefly some possible adaptations to life in mountain streams.

It must be understood at the outset that a frog, like almost any other living organism, finds living in swift water difficult because strong currents are not easily coped with. It is just this difficulty that is responsible for the evolution and survival of interesting changes in form and habits.

For the sake of clarity, I have divided the following discussion into two sections.



ADULTS.—Excepting those correlated with sex, leg strength, which may be taken as the equivalent of swimming ability, is the only structural difference constantly present in the swift-stream Salientia dealt with in this report. All such frogs that I have observed and studied, possess powerful, long legs and well-developed toe webs.

Every current-inhabiting species of the Kuatun-San Chiang region, Fukien, shows marked sexual dimorphism in either (a) body size, or (b) development of nuptial asperities, together with enlargement of the forearm by the male. In the case of *Rana graminea* and *andersonii*, this sex is only half the size of the female, but nuptial asperities are not well developed, while in *Rana spinosa* the sexes are of equal size, but the breeding male possesses nuptial asperities on the digits as well as on the chest, and enormous forelimbs. *Staurois ricketti* is intermediate between these two extremes; the female is slightly the larger, while the breeding male bears conspicuous nuptial asperities on the digits and moderately enlarged forelimbs. Among quiet-water frogs, I find no sexual differences comparable in degree of development to the above, so I feel justified in regarding such as directly correlated with and advantageous to mountain-stream life. It is obvious that nuptial asperities and strong forelimbs are useful during the egg-laying process because any current would tend to separate breeding pairs. Reduction of size in the male seems to be only another way of rendering the breeding process less difficult.

The form of the egg cluster and method of its attachment have, among current dwellers, great adaptive significance. Certainly no quiet-water frog anchors its eggs so securely as does *Rana spinosa*.

LARVÆ.—The sucking disc of *Staurois ricketti* cited above is by far the most convincing example of larval modification undoubtedly correlated with life in flowing water. The enlarged mouth of *Megophrys boettgeri* and *M. kuatunensis*, though also considered as such in this report, is by no means so convincing a case. The tadpoles of *Megophrys pelodytoides* and *Rana montivaga* not only possess well-developed mouths, but slender, depressed bodies and powerful tails as well, and certainly thrive in swift water. On the other hand, larval *Rana spinosa* and *Megophrys hasseltii*, though swift stream dwellers, show no sign of special modification. It should be remembered that the three main types of mountain-stream larvæ reported above as represented by *S. ricketti*, *R. montivaga*, and *R. spinosa*, do not choose exactly the same environmental niches of their common habitat. Only the first is to be seen continuously exposed to direct currents, while the second frequents pools or

ventures to swim under swift water among pebbles and stones upon which it relies for protection from the force of the flow. The third type, represented by *R. spinosa*, remains in the deeper pools and thus avoids the pull of the stream. One may reasonably conclude that mountain-torrent tadpoles make the best of their current-resisting faculties but it must be admitted that such larvæ more often than not show distinct degrees of adaptation to their unusual environment.

#### IDENTIFICATION OF ADULTS

Although it is not within the scope of this paper to give detailed keys for adult forms, I have written a key to the genera based largely on those of Van Kampen's general work (1923). This has been done because so little comprehensive literature on Chinese amphibians has appeared. After a frog has been placed in its proper genus, it often may be identified by simply glancing through descriptions. Of course, its habitat and locality of capture should always be taken into consideration. The above remarks are addressed largely to field workers and students of biology in China. Experienced museum men need no such advice.

#### KEY TO THE GENERA OF SALIENTIA INCLUDED IN THIS PAPER

- I.—Epicoracoid cartilages overlapping each other
- A.—Upper jaw toothed
- 1.—Ribs present (in the adult)..... BOMBINA.
- 2 —Without ribs
- a.—Terminal phalanges of digits not claw-shaped.  
MEGOPHRYS.
- b.—Terminal phalanges of digits claw-shaped... HYLA.
- B.—Both jaws toothless..... BUFO.
- II.—Epicoracoid cartilages firmly united in a median line
- A.—Diapophyses of sacral vertebra distinctly dilated
- 1.—Upper jaw toothed..... KALLUELLA.
- 2.—Upper jaw toothless
- a.—Clavicle present..... KALOPHRYNUS.
- b.—Clavicle absent
- a'.—Each palatine bone forming a prominent ridge  
across the palate..... KALOULA.
- b'.—Palatine bones not forming prominent ridges  
across the palate..... MICROHYLA.
- B.—Diapophyses of sacral vertebra not, or but slightly dilated
- 1.—An intercalary cartilage inserted between the two distal  
phalanges of the digits
- a.—Vomerine teeth present..... POLYPEDATES.
- b.—No vomerine teeth..... PHILAUTUS.

- 2.—No intercalary cartilage inserted between the two distal phalanges
- a.—Vomerine teeth present (very rarely absent). Digital discs, if present, without transverse groove across the lower surface. . . . . RANA.
- b.—Vomerine teeth absent or feebly developed. Digital discs large, broader than long, always present on both fingers and toes and with a transverse groove across the lower surface. . . . . STAUROIS.
- c.—Vomerine teeth absent. Finger tips never dilated into discs, toes without discs or with very small ones which never have a transverse groove across the lower surface. . . . . OÆIDOZYGA.

#### IDENTIFICATION OF LARVÆ

The following synopsis does not include salamander larvæ because so little is known of those inhabiting China. The only form considered in the present paper is both figured and described, so there should be little difficulty in its identification.

No effort has been made to indicate relationships in this key, its sole purpose being to facilitate the determination of species. Free use should be made of the illustrations, because, with a very few exceptions, all the tadpoles have been figured. *Oæidozyga lævis martensi* has been added for convenience even though its larva is not included in the collection, while *Bombina* and *Kalophrynus* are indicated as genera.

#### KEY TO THE GENERA AND SOME SPECIES OF TADPOLES INCLUDED IN THIS PAPER

- I.—Lips with transverse series of horny teeth; spiraculum median. . . . . BOMBINA.
- II.—Lips with transverse series of horny teeth; spiraculum sinistral
- A.—No sucking disc behind the mouth
- 1.—A series of papillæ extending entirely around the lips in a single row which may be very narrowly interrupted in the middle of the upper lip; vent dextral
- a.—Papillæ poorly developed; teeth of each row in a double series; at least 5 rows of teeth in each lip. . . . . *Rana rugulosa*.
- b.—Papillæ well developed; teeth of each row in a single series. . . . . MEGOPHRYS (part).
- 2.—Series of papillæ broadly interrupted or nearly absent on the upper lip, sometimes narrowly interrupted on the lower where the papillæ are always well developed; vent dextral. . . . . RANA (except *rugulosa*) POLYPEDATES, PHILAUTUS and HYLA (see key p. 484).
- 3.—Papillæ present only at the sides of the mouth; vent median; teeth of upper lip in one continuous and one interrupted row, those of lower in 3 continuous rows. . . . . BUFO.

- B.—A large sucking disc behind the mouth and a poison gland on each side of the belly posteriorly; 4 rows of teeth in the upper lip and 3 in the lower, only the innermost row of each lip interrupted.

*Staurois ricketti*.

III.—Lips without transverse series of horny teeth

A.—Spiraculum sinistral

- 1.—Lips united and developed to form a large, expansile, funnel-shaped appendage..... MEGOPHRYS (part).

- 2.—Lips small..... OŒIDOZYGA.

B.—Spiraculum median.. KALOPHRYNUS, KALOULA, KALLUELLA and MICROHYLA.

ANNOTATED LIST OF SPECIES

**CAUDATA**

**Hynobiidæ**

The members of this family are generally considered to be the most primitive of living salamanders. They are very closely related to the Cryptobranchidæ,—large, flattened, river inhabitants of eastern Asia, Japan, and eastern North America, diagnosed by Noble (1927) as permanent larvæ of an unknown hynobiid. The lowly position of the Hynobiidæ makes them especially important and, while museums possess much material, little is known of the life histories and larvæ of many species. Details of breeding habits may reveal important relationships, as Noble (1927) has demonstrated. Dunn (1923) has gathered the literature and reviewed the family, which will greatly facilitate field work on this group. It is hoped that field workers in China will study the life histories of the various species ensconced in the inaccessible regions of central Asia and western China.

**HYNOBIUS**

***Hynobius chinensis* Guenther**

Plates XVI and XIX; Figure 1

A large series of early, advanced, and metamorphosing larvæ (A. M. N. H. Nos. 30614–26) and eight recently transformed individuals (A. M. N. H. Nos. 30532–4), all from Ch'ungan Hsien, are referred to this species.

*H. chinensis* is based upon a single record of two specimens collected by Pratt at Ichang and described by Guenther in 1889, so any additional record of it is of great interest.

*Hynobius* is the one large genus among the five comprising the hynobiid salamanders and it contains the species representing the stock

from which the other forms have descended (Dunn, 1923). The range of this genus embraces Japan and Korea in the east, Siberia and Russian Turkestan in the north and west, and Hupeh and Formosa in the south. There is a great hiatus between these two southern limits, no specimen having been recorded on the Chinese mainland south or east of Ichang in 1923 when Dunn wrote his review of the group. In fact, the Formosan record did not exist until Maki (1922) described three species based upon four specimens collected in the high mountains of that island. Dunn places these three together under the name *sonani* and prophesies the discovery on the adjacent Chinese mainland of a form allied to his own *nævius* group, this form to be that from which the Formosan species were directly derived. He made this forecast to avoid the geographical difficulty of deriving *sonani* directly from any of the known species of the *nævius* group, all of which occur in Japan proper, and the structural one of deriving it from the two similar mainland species, *leechii* and

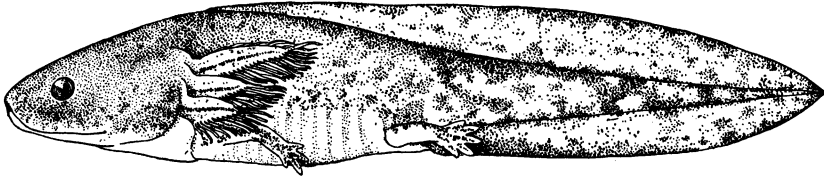


Fig. 1. Larva of *Hynobius chinensis* from Ch'ungan Hsien, Fukien: lateral aspect.

*chinensis*. Obviously then, the discovery of a form in Fukien brings up this important question of relationship, for it might reasonably be expected to be allied to either the Formosan or Hupeh species.

Unfortunately, this question cannot be settled finally because the new material is largely larval and the larvæ of neither *sonani* nor *chinensis* have been described. Having made a study of my recently metamorphosed specimens and the descriptions given by Dunn and Maki, I have concluded that the Fukien salamander has little in common with *sonani*, while the description of *chinensis* fits it fairly well. This description of *chinensis* is brief and the Fukien specimens immature, so I do not consider my identification at all certain and it is entirely possible that the new material represents an undescribed form. My conclusions are based largely upon the following points:

- 1.—The vomerine series (if fully developed) is short in the Fukien species. In this respect it differs radically from the Formosan form but resembles *chinensis*.
- 2.—The fifth toe is always well developed in the material at hand, while in *sonani* in exhibits a strong tendency to be lacking.

3.—The tail is compressed as in *chinensis*, but apparently this is not the case in *sonani*.

4.—No mottling is evident dorsally in the questioned form as in the salamanders from Formosa, while *chinensis* is described as "nearly uniform horny black," a phrase partly applicable to the Fukien specimens. I will close this discussion with a description of A. M. N. H. No. 30532, the proportions of which must be considered decidedly juvenile: Costal grooves 11, appressed toes meeting. Head length (measured from snout to gular fold) 9.5 mm., width 9 mm.; total length 52 mm.; length from snout to vent 31.5 mm. Head oval as seen from above; eye distinctly shorter than its distance from snout; outline of upper jaw seen from side straight; angle of jaw behind posterior corner of eye; a groove from eye to gular fold. Limbs well developed; fingers 2, 3, 4, 1 in order of length; toes 3, 4, 2, 1, 5; an indistinct tubercle under base of first finger and first toe. Tail compressed throughout, its latter half very flat; a dorsal crest extending forward to above posterior angle of vent; ventral crest slight; tip obtusely pointed. Vent a simple slit. Vomerine teeth arise opposite or just back of inner border of nares and curve sharply inward as they extend forward. After approaching one another both turn backward to end side by side at a point only a little posterior to the line of their origin and anterior to the center of the eyeballs. Uniform lead black above; ventrum a little lighter with faint whitish mottling. This specimen retains no scar on the side of the neck where the external gills were absorbed, so it may be regarded as completely transformed but I do not know whether or not the vomerine teeth, etc., have attained their final form.

DESCRIPTION OF LARVA.—The dorsal fin extends forward past the middle of the back. The body and tail are spotted with gray, the spots being most profuse on the tail fins where they often tend to run together. The head is uniformly gray and the external gills are sparsely speckled with the same color. The maximum size is reached in a specimen with the following dimensions: head, measured from tip of snout to base of gills, 13 mm.; snout to vent 36 mm.; total length 62 mm. This specimen (A. M. N. H. 30617) is in its early metamorphosis but the shortened gills still retain rami on all three branches. Two barely metamorphosed individuals with gill stumps still evident (A. M. N. H. 30624) measure just 32 mm. from snout to vent.

Measurements of a few larvæ follow:

	HEAD	SNOUT TO VENT	TOTAL LENGTH
A. M. N. H. No. 30623	13.5 mm.	30 mm.	54 mm.
A. M. N. H. No. 30618	14.0 mm.	29 mm.	55 mm.
A. M. N. H. No. 30622	13.0 mm.	27 mm.	50 mm.

These larvæ were first obtained May 23, 1926, from two pools in the same bamboo grove. (One of these pools is shown in Plate XVI, fig. 2). They seemed to be made up of two lots; those of one measuring about 17 mm. from snout to vent, while those of the other measured 26 mm. This indicates two periods of egg laying some days apart. As the larvæ developed, it became difficult to distinguish these lots. The first

metamorphosed specimens were found July 2. As late as August 30, one of the pools still contained a few larvæ with long gills, but the vast majority had left for dryer ground. Constant search for many months brought to light only three breeding sites, all small, temporary pools of rainwater on the very tops of high ranges. Two of these pools dried in midsummer before the larvæ had transformed. Moreover, they were constantly visited by the wild pigs that used them as wallows and such a visit always wrought havoc with the amphibian inhabitants of the wallow. All this shows what a precarious existence these hynobiids must lead in the Kuatun region. It was difficult to search for adults because of the nature of the soil of the bamboo groves surrounding the wallows. The unbelievably numerous and tough bamboo roots had transformed the soil for many inches below the surface into an impenetrable meshwork, and the top of the soil was free from loose objects large enough to harbor even a salamander. The adults must enjoy an existence infinitely safer than that of their larvæ, which is only mildly described as precarious.

These *Hynobius* larvæ were aggressive enough to deprive the smaller *Polypedates dennysi* tadpoles, also inhabitants of the pig wallows, of the ends of their tails.

#### BATRACHUPERUS

##### *Batrachuperus tibetanus* Schmidt

No additional specimens of this form have been received since its description in 1927. The type locality is "Tibetan border of Kansu, at about latitude 33° N., elevation 9000 feet." Schmidt's diagnosis follows: "Closely allied to *Batrachuperus pinchonii*, from which it may be distinguished by the more posteriorly situated vomerine teeth; the more depressed head; the fourteen costal grooves; the absence of horny covering on the palms and soles, only the tips of the digits having a horny epidermis; the somewhat longer tail, .49-.52 of the total length; and the much lighter coloration."

Schmidt had three specimens, all from the type locality. The type is F. M. N. H. No. 5900. He suggests that the specimen recorded by Barbour (1912) from "Lianghokow," western Szechwan, belongs to the new form rather than *B. pinchonii* (= *sinensis*), as stated by Barbour.

Mr. Zappey collected the specimen recorded by Barbour in 1912, while on an expedition under the direction of the late Mr. E. H. Wilson of the Arnold Arboretum. The name Lianghokou is such a common one in Szechwan that I wrote to Mr. Wilson to determine the exact whereabouts of the one in question. In reply, Mr. Wilson stated: "The Liang-ho-kou

where Zappey secured the salamander is situated west of Tachienlu in about latitude 102 east in extreme western Szechwan."

### Salamandridæ

#### TYLOTOTRITON

##### *Tylototriton verrucosus* Anderson

Schmidt (1927) reported three specimens, two collected at Tengyueh and one at "Genkang" or, more properly, Chenkang, a Yunnan town southwest of Shunningfu and about midway between it and the Burma frontier. Since then the American Museum has acquired, through exchange, an additional specimen labeled Yunnan (No. 23490).

In his original description (1871), Anderson gave the habitat of *verrucosus* as "Nantin, Momien, and Hotha valleys, Western Yunnan." Momien is, of course, the same as Tengyueh. Annandale (1911) reported this species from Yangpi, a locality about ten miles west of Talifu at an altitude of 5200 feet, and Tengyueh, while Boulenger (1882) lists another Yunnan specimen, as well as one of Anderson's, from the Nantin Valley. Outside of China, *verrucosus* has been reported from the Kak-hien Hills, Upper Burma (Boulenger, 1887); Darjiling (Dunn, 1918); Sikkim (Mr. Wood-Mason quoting Colonel Mainwaring, 1877); "at Kurseong (alt. 4500-5000 feet) in the Darjiling district" (Annandale, 1911); and Chieng Dao, northern Siam, between 5000 and 6000 feet (Smith, 1924).

Anderson found it in "flooded rice-fields"; Colonel Mainwaring, "in damp situations amongst decaying leaves and sticks." Annandale describes the habits as follows: "It is very abundant at Kurseong, . . . breeding there in small pools of rainwater in June and July. Larvæ evidently just about to undergo their final metamorphosis are common in August, but I have seen quite young larvæ also in April and it seems possible that the early spring showers induce a few individuals to breed, although the majority do not do so until the real break of the rains." Brown (1910) states that *T. verrucosus* "is common in damp ditches and old wells around Tengyueh."

Smith (1924) has written a paper on the larvæ of this form in which he quotes Annandale as follows: "The life-history is interesting and the metamorphosis apparently prolonged. The adults enter the water as soon as the first spring showers fall in March or April and the females begin to lay their eggs shortly afterwards. The eggs are lightly attached, singly, to weeds, etc., and apparently hatch rapidly. The breeding season probably continues throughout the rainy season but the adults



have left the water by the beginning of October. The growth of the larva is very slow in the first year, but the four legs are usually, if not always, developed before winter, in which growth probably ceases. I am not sure whether the young leave the water in the following year or whether there is a further larval period of one or more years, but I think that the metamorphosis is complete by the beginning of the second winter at any rate in most individuals. There may, however, even be a kind of 'axolotl' stage in suitable conditions. The larva may, at any rate, attain about half the size of the adult before its gills begin to shrivel up and it leaves the water. This it does in October before the gills have completely disappeared." Continuing on his own account Smith states: "The eggs of this newt are large although somewhat variable in size, measuring, when the gelatinous envelope is fully distended by the developing embryo, between 6 and 10 mm. in diameter. The young one on emerging is about 11 mm. long, and is provided with well developed external gills, with a pair of elongated 'balancers' originating from a point behind and below the eye and in a line with the continuation of the mouth backwards, with a crested tail and budding fore-limbs. These latter develop rapidly and all four legs, with their digits, are complete at quite an early stage in life. The 'balancers' apparently soon disappear, although a trace of them often persists in the form of a small tubercle at their point of origin."

*Tylostrotion asperrimus*, described by Unterstein as recently as 1930, must certainly be placed in the synonymy of *T. verrucosus* because the description of this alleged new species fits *verrucosus* in every detail. The two types of *asperrimus* come from an unnamed locality in Kwangsi and there is no reason to doubt that *verrucosus* ranges eastward through Yunnan into Kwangsi. In describing *asperrimus*, Unterstein does not mention *verrucosus* but compares his new material to *andersoni* of the Riu Kiu Islands. Every point brought out by him as distinguishing *asperrimus* from *andersoni* also serves to distinguish *verrucosus* from *andersoni*, so one is forced to conclude that Unterstein made no comparison between his types of *asperrimus* and specimens of *verrucosus*. *Tylostrotion* still stands with its two forms, *verrucosus* from Yunnan (and Kwangsi), and *andersoni* from the Riu Kiu Islands.

#### TRITURUS

##### *Triturus orientalis* (David)

Schmidt's 1927 report included seven specimens collected by me at Ningkwo.

This salamander was discovered by David in 1872 at "Tche-san" village, near Chüchowfu, Chekiang (David, 1875). The same explorer also found it at "Tsitou," a village seven to eight miles east of Kienchangfu, eastern central Kiangsi, and again at "Mi-ouan," another village only five miles to the southeast of Tsitou. David named his newt *Triton orientalis*. Boulenger recorded a specimen from the Kiu-kiang Mountains in 1882 as *Molge pyrrhogastra*. It was not heard of again until Wolterstorff (1906) reported it as *Triton pyrrhogaster orientalis* from "25 miles inland of Cheechow (undoubtedly Kichow) and Wusüeh, two Hupeh localities on the Yangtze River." As recently as 1925, he listed specimens from "Hanchow" (certainly Hangchow), Chekiang, also as *T. p. orientalis*. Stejneger (1925) records a Nanking example.

H. H. Wilder (1921) states that larvæ and adults were abundant in "little ponds leading up from Lake Si-Wu to the great Buddhist temple of Ling-Ing" near Hangchow, in May, 1920.

Another newt, *T. sinensis* (Gray), described in 1859 from "inland of Ningpo," is said to occur as far south as Hongkong. It was supposedly found on the mainland but very near Hongkong Island (Boettger, 1888, and Mell, 1922). Obviously, then, all records of salamandrids from eastern China are of great importance.

Under *Pachytriton brevipes* my reason for placing the recently described *Molge labiatum* in the synonymy of *P. brevipes* is stated.

Wolterstorff as recently as 1926 has discussed the relationships of all the oriental forms.

#### **Triturus wolterstorffi** Boulenger

Schmidt's 1927 report listed three specimens (A. M. N. H. 6560-2) from Yunnanfu. Seven additional ones from the same locality (A. M. N. H. 5451-5 and 16093) were apparently overlooked. Since then two more of these newts have been purchased (A. M. N. H. 26373-4). They, too, are from Yunnanfu, the only place from which this newt has ever been recorded.

The Museum of Comparative Zoölogy, Cambridge, also has material from Yunnanfu (Dunn 1918).

#### **PACHYTRITON**

##### ***Pachytriton brevipes*** (Sauvage)

Plates XIX, XX and XXII

A large series of 173 specimens was collected: 94 from Ch'ungan Hsien (A. M. N. H. 28982-29007 and 30535-602), 24 from Yenping

(A. M. N. H. 28481-90, 28552-8 and 30837-43) and 55 from Futsing Hsien (A. M. N. H. 29203-57). Schmidt (1927) reported 61 additional ones collected by Caldwell in Fukien. A specimen labeled Yunnan has been recently received from Werner (A. M. N. H. 24319), a record open to doubt.

Unterstein's *Molge labiatum*, described from Kwangsi in 1930, differs in no recorded character from *Pachytriton brevipes* and I am therefore considering these forms as identical. The presence of *P. brevipes* in Kiangsi, Fukien, Kwangtung, and possibly also in Yunnan, make its occurrence in Kwangsi very probable.

Stejneger (1925) considers his two Yenping specimens the second record for this species, but Mell reported it from Kwangtung in 1922. *P. brevipes* is known, then, from eastern central Kiangsi, whence the type was described in 1877 as *Triton brevipes*; northern Kwangtung; Kwangsi (as *Molge labiatum*); Yunnan (?); Futsing Hsien, and the Min River drainage, Fukien. Judging by David's Journal, p. 239, etc., the actual type locality is "Tsitou," a village in eastern central (not southern) Kiangsi, seven to eight miles east of Kienchangfu.

As already pointed out by Schmidt (1927), Werner's 1924 record of *brevipes* from Hunan is a mistake, for he obviously had *Batrachuperus pinchonii* (David) in mind. This is shown by his synonymy and description.

*P. brevipes* is abundant in all the real mountain streams of Fukien, even down to those of the low seaside ranges of Futsing Hsien. It shows little altitude preference, being as common in Futsing Hsien as in the high ranges about Kuatun. Mell found it from 450 to 800 m. altitude in northern Kwangtung.

A study of my large series shows that there is a definite average difference in color pattern between Futsing and Ch'ungan specimens, the latter being always distinctly spotted, the former only occasionally so. The belly is sometimes marked in both races but in those from Futsing Hsien these ventral markings are elongate and tend to run together, while the bellies of the Ch'ungan Hsien individuals, when marked, are simply spotted. The Ch'ungan Hsien race is also the larger. These differences are not constant enough to justify even subspecific recognition but are significant in further illustrating the general distinctness of the two faunas, even identical species from the two regions showing a strong tendency to differ. As one would expect, the Yenping specimens resemble those from Futsing Hsien.

The five largest specimens among a series of 224 Fukien individuals are made up of three males measuring 94, 93, and 92 mm. from snout to

vent, and two females of about the same size, measuring 93 and 92 mm. There is no indication of marked sexual dimorphism in size, but such figures would not reveal a small average difference. All of these five largest specimens come from Ch'ungan Hsien. Cloacal papillæ of the larger males are 2 mm. in length. The smallest individual secured measures just 30 mm. from snout to vent and differs from all the rest in having a very rough skin both above and below. In other respects, however, it entirely agrees with the rest of the specimens, several of which range only from 36 to 40 mm. in length. This small specimen may be the equivalent of the rough terrestrial form commonly found in newts. It was also taken in a stream, but lack of definite data prevents the drawing of a conclusion concerning its habits.

All the mountain streams elevated at least a few hundred feet above the open plains harbor these salamanders, but they are most abundant in higher, rock-bound streams of all sizes down to mere trickles. They are sluggish in their movements and easily picked up once uncovered. I saw one creeping over the top of a large, submerged boulder devouring tadpole after tadpole of *Staurois ricketti*. This took place in broad daylight, hence *brevipes* is to some extent diurnal. In fact, I have often seen them abroad on the bottom of pools through the day but they are more easily found at night by use of lights. I have never seen one voluntarily leave the water and even when a stream was poisoned they did not take refuge on land but only tried to go deeper into the submerged rocks of the stream bed. A characteristic, strong odor emanates from captive *brevipes*.

The number of ova produced at one time by *brevipes* is not great. Two females containing ripe ova were opened on July 8, 1926, at San Chiang. The larger measured 163 mm. total length and held 37 well-developed and 12 smaller ovarian eggs, the larger, 3 to 3.5 mm., the smaller, 2 mm. in diameter. The second specimen was only 135 mm. long and contained 40-45 ova only 1.2 to 2 mm. in diameter. A third female of unknown length opened August 11 of the same year, held 72 ripe ova, the majority of which were 3.5 mm. in diameter, while a few measured only 3 mm. through.

## SALIENTIA

### Discoglossidæ

#### BOMBINA

The larvæ of this genus may be recognized at once in China by the combination of median spiraculum, median vent, and the fact that the

rows of teeth are not simple in form but made up of two or three series to each row.

### ***Bombina orientalis* (Boulenger)**

Schmidt's 1927 report included five specimens: two from Sokako in Amposen, Manchuria (A. M. N. H. 5168-9), and three from Moukden (A. M. N. H. 5180-2).

Type locality, Chefoo. In 1890, Boulenger proposed the name *Bombinator orientalis* for the Oriental frogs now under consideration. He designated neither type nor type locality but listed 19 specimens: 11 from Chefoo; four from North China; one from the southeastern coast of Korea; and three from Chabarowka. I therefore designate Chefoo as the type locality of *Bombina orientalis*.

Exclusive of China, this frog is distributed from Tsushima and Quelpart Island northward through Korea, the Ussuri and Amur countries to Primorskaya (Nikolsky, 1918, and Okada, 1927). Additional Chinese records are as follows: Chefoo (Martens, 1878, as *Bombinator igneus*; and Stejneger, 1925); Tsingtao (Werner, 1903, and Wolterstorff, 1906, as *Bombinator orientalis*); on the Yalu River, 180 miles from its mouth in southern Railway, Manchuria (Stejneger, 1925); Iliampo<sup>1</sup> Station, Chinese Eastern Manchuria (Nikolsky, 1918); and Yablonia<sup>2</sup> Station, Manchuria (Pavloff, 1926). *B. orientalis* is well known in Korea (Slevin, 1925, etc.).

Stejneger (1907) describes breeding males as possessing nuptial asperities "on the inner side of fore arm, palmar tubercle and first, second, and third fingers," but lacking them on the posterior extremities. According to him, the fingers of the females are longer and more slender than those of the males. Slevin (1925) says that the males are rougher and have fuller webbing, while the black dorsal markings are less distinct in them than in the females.

Pavloff (1926) gives a brief account of the habits of *B. orientalis*, stating that it frequents swamps.

### ***Bombina maxima* (Boulenger)**

Schmidt's 1927 report listed 17 Yunnan specimens: two from Yunnanfu; three from Hsinshao<sup>3</sup>; one from Wutingchow District; and 11 from Likiang.

<sup>1</sup>I am unable to identify this place unless it is Imienpo, a station about 200 kilometers southeast of Harbin and 25 east of Udimi (or Wuchimi).

<sup>2</sup>This station is, apparently, located some 250 kilometers southeast of Harbin and 75 east of Udimi (or Wuchimi). I am not sure about the English spelling but a strict Anglicization of the Chinese characters for it would be Ya-pu-lo-ni.

<sup>3</sup>Also spelled Hsinshow; located approximately 20 miles northwest of Süntien, northeastern Yunnan.

This species was described in 1905 from Tunghwanfu, northeastern Yunnan, as *Bombinator maxima*. Mell (1922) reported it not rare in damp woods around "Chauchow" (probably Chaochow, a locality just south of Talifu) at an altitude of 2000-2400 meters. Werner (1924) recorded two specimens from Likiang.

I find that eleven Likiang specimens are still available for comparison. This small series is made up of six males measuring 50, 46, 39, 39, 36 and 33 mm. from snout to vent, and five females measuring 61, 61, 52, 36 and 35 mm. Since even the smallest male has well-developed nuptial asperities, these data indicate that the females attain the greater size. A female from Hsinshao measures 57 mm., a male from the same locality, just 48 mm. Boulenger gives the length of one of the types, a female, as 68 mm., while Werner records 60 mm. as the length of his males. Schmidt has already pointed out that, "The first, second, and third fingers, the metacarpal tubercle, and the inner face of the forearm are provided with horny, nuptial asperities," and that the metacarpal tubercle is enlarged. I would like to add that the asperities on the breast of the males differ slightly from those of the females in being smaller and more uniform in size. Werner has noticed that the leg is longer and the web fuller in the male but I cannot agree with him when he states that the male is the rougher of the two sexes because I find females fully as rough as any of the males. There seems to be, however, a tendency of old females to grow smoother.

### Pelobatidæ

#### MEGOPHRYS

Noble (1924 and 1927) considers *Megophrys* the most primitive pelobatid genus. Its relationships to other genera are not entirely clear. This is in part because of the almost total absence of good life-history data. Therefore, it behooves residents of southern Asia to fill in this void by describing the egg clusters, breeding habits, etc., of the various species. Noble's 1927 discussion of the value of life-history data is an excellent guide to such studies.

In addition to the four forms dealt with in detail on the following pages, the species listed below occur in China or adjacent to its frontier:

*M. boulengeri* (Bedriaga), described in 1898 from the Di chu<sup>1</sup> River, China. It has not been re-discovered.

*M. feae* Boulenger, described in 1887 from the Kakhien Hills of the Yunnan-Burma border region east of Bhamo, and found again in the Man-Son mountains of Tonkin near the Kwangsi frontier (Boulenger, 1908).

<sup>1</sup>A name sometimes applied to the Yangtze River in the region of its emergence from Tibet and entrance into Szechwan.

*M. carinensis* (Boulenger) of Burma, recorded from Hsia-kuan<sup>1</sup> (6700 feet altitude) Yunnan, by Annandale in 1911. It was described in 1889.

*M. weigoldi* Vogt, described in 1924 from a specimen taken at Washan, Szechwan.

*M. minor* Stejneger, described from Kwansien, Szechwan, in 1926. The type is unique.

*M. major* Boulenger is known from Upper Burma; the Man-Son Mountains, Tonkin, near the Kwangsi frontier; and doubtfully from western Yunnan. It certainly is to be expected through southern Yunnan.

*M. kempii* Annandale, described from the Abor country in 1912, is sometimes united with *boettgeri*. Its validity is discussed under that form.

Among the seven species named above, only the tadpole of *major* has been described. It is very important to know definitely whether or not the six remaining forms have the remarkable oral apparatus found in all known tadpoles of the genus, with the exception of *hasseltii* and *pelodytoides*. The genus is considered to comprise two groups: a small one in which the larvæ are unspecialized and the adults Rana-like; and a larger one in which the tadpoles possess the remarkable expansible oral apparatus or funnel mouth and a median instead of a dextral vent (M. A. Smith, 1917).

LARVÆ.—The following key should serve to separate the larvæ treated below.

- I.—Mouth lacking transverse rows of teeth, produced into a conspicuous, funnel-shaped organ.....*M. boettgeri*, *M. kuatunensis*.
- II.—Mouth entirely devoid of funnel-shaped production. Numerous transverse rows of teeth present.
  - a.—Lips large, teeth small and inconspicuous, arranged in 4 rows above (Fukien larvæ; 5 to 6 rows in Siamese specimens) and 4 below. Tadpole long and slender, total length about 52 mm.
    - M. pelodytoides*.
  - b.—Lips relatively small, teeth conspicuous, in 6 rows above and 5 below. Tadpole large and very thick-set, attaining a maximum length of 108 mm. from tip to tip.....*M. hasseltii*.

**Megophrys longipes Boulenger**

The collection of the American Museum contains a single specimen of this species from China (A. M. N. H. 23549). This individual is from northern Kwangtung where it was collected by Mell. The identification seems to be correct but I cannot be sure because no comparative material is available. It lacks supraocular appendages and measures 75 mm. from snout to vent.

Mell (1922) records *longipes* from northern Kwangtung at altitudes of 400–700 m. He names the following localities where it was collected

<sup>1</sup>Or Siakwan, a locality at the outlet to Erh Hai, the lake on which Talifu is situated.

by him: "Drachenkopf," a mountain directly east of Shiuchow and about midway between it and the Kiangsi boundary; "Teeberg," a mountain between Shiuchow and Drachenkopf; and "Gau-fung," a locality north and a little west of Shiuchow, almost on the Hunan boundary.

The distribution of this form is remarkable. It appears to be known only from Kwangtung and the Malay Peninsula whence it was described by Boulenger, in 1885, from the "mountains of Perak."

**Megophrys boettgeri** (Boulenger)

Plates XIX and XXII; Figure 2

A large series of this species was secured in Ch'ungan Hsien (A. M. N. H. 28751-810, 30259-323 and 30325-94). Larvæ were collected at Yenping (A. M. N. H. 31082 and 31092), in Ch'ungan Hsien (A. M. N. H. 29008, 29015, 30638-9 and 30642-4) and in Futsing Hsien (A. M. N. H. 29411). For reasons given under *Megophrys kuatunensis*, it is impossible to state that the Ch'ungan Hsien series does not contain ANY tadpoles of that species. It is extremely improbable, though, that more than a very few are included here.

A single tadpole from Mokanshan<sup>1</sup> collected by Wilder, is in the American Museum (A. M. N. H. 32957).

*M. boettgeri* was recorded from Lushan, near Kiukiang, as *Leptobrachium monticola* by Boettger (1894). It was first recognized and described as new by Boulenger in 1899 who had six specimens from La Touche's Kuatun collection. Boulenger named it *Leptobrachium boettgeri* and gave a good figure. In 1908, he united *Xenophrys* and *Leptobrachium* with *Megophrys*, so *Leptobrachium boettgeri* became *Megophrys boettgeri*.

Some years later, du Bois-Reymond secured funnel-mouth tadpoles on Lushan, near Kiukiang, which he described and figured in 1910. They undoubtedly are *M. boettgeri* larvæ. Annandale (1917) found tadpoles on the Peak at Hongkong and, thinking that they might be larval *boettgeri*, described and figured them as such, placing a question mark before the name. Smith (1924) confirmed this questioned record by a visit to the Peak in 1923 where he secured both adult and larval *boettgeri*. In the meantime, Mell (1922), working in Kwangtung, collected a specimen in the mountains of the Kwangtung-Hunan border, and Wilder found tadpoles on Mokanshan,<sup>1</sup> which undoubtedly are larval *boettgeri* (Wilder, 1921). The tadpole from Wilder's lot, now in the American

<sup>1</sup>A mountain resort frequented by foreigners situated about 30 miles north of Hangchow, Chekiang.



Museum, is accompanied by a note to the effect that adult *boettgeri* were also secured on Mokanshan.

This historical record shows that *M. boettgeri* is known to occur in Kiangsi, Chekiang, Fukien, and Kwangtung Provinces on the Chinese mainland, as well as on the Island of Hongkong. Southern Hunan might be added to the list, since Mell's specimen came from the Kwangtung-Hunan border region. Its range in northern Fukien is universal, for I

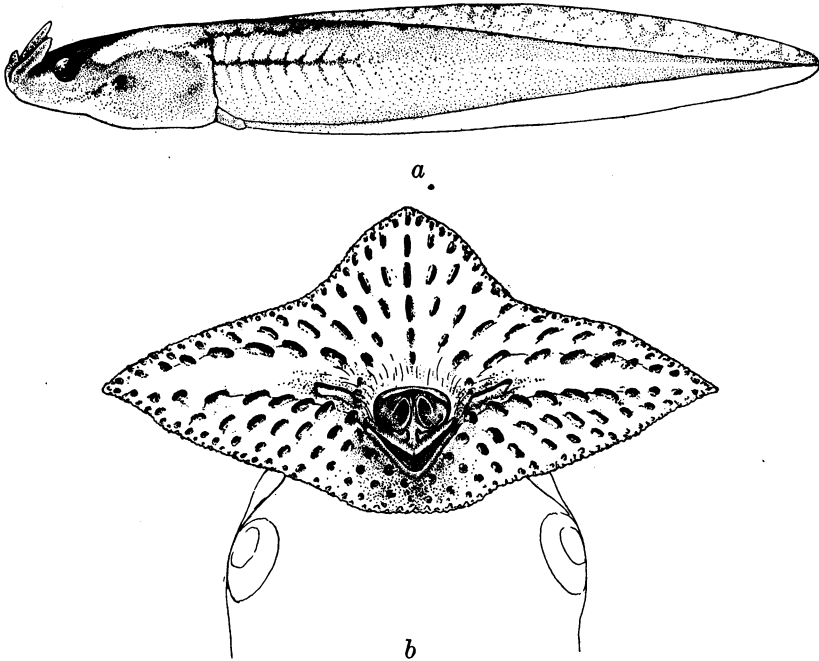


Fig. 2. Larva of *Megophrys boettgeri* from Ch'ungan Hsien, Fukien: (a) lateral aspect; (b) mouth.

found it as abundant in the mountain streams of Futsing Hsien and the Yenping region as in those of Ch'ungan Hsien. It should not be forgotten that all of my series of adults came from the vicinity of Kuatun Village, the type locality of the species.

Unfortunately, no adults were found at Yenping and in Futsing Hsien, but the abundance of the tadpoles in both of these localities is conclusive proof of the presence of adults. In one comparatively low Futsing coastal range, larvæ were common in cascades only a few hundred feet above sea-level and this may be taken as evidence of the small

part that altitude plays in the distribution of *boettgeri*. This point is discussed in greater detail below.

Whether or not Annadale's *kempii*, described from northern Assam in 1912, is the same as *boettgeri*, I am unable to determine. If Annadale's figure is accurate, the snout of *kempii* does not project enough for it to belong to the long-snouted group in which *boettgeri* is placed. In view of the fact that new species of *Megophrys* are constantly being discovered in China, I think it very likely that *kempii* is a distinct form with its nearest allies in western China, or else an immature example of some known western species. In the future it will be much easier to unite these two distant ranges after sufficient proof of identity of the forms has been secured than to eradicate from the literature records of too wide a distribution of *boettgeri*, should it be incorrectly united with *kempii*.

The adults of the large Ch'ungan Hsien series fit Boulenger's description well and are especially constant in dorsal color pattern. The skin, though usually smooth, is often covered with distinct tubercles either single or joined to form short irregular rows. Externally, the males can only be distinguished from the females by the loose skin of their throats, slightly enlarged arms, and a minutely granular nuptial "pad" on the inner side of each first finger. Though small and scarcely raised, the brown color of this modified patch of skin renders it moderately conspicuous, decidedly more so than the corresponding pad of *kuatunensis*, for in that species the normally brown skin of the arm matches the pad so well that it can scarcely be distinguished.

The following figures show that there is a constant if small sexual difference in length. Thanks to the secretive habits and lack of voice in the females, only 19 individuals of this sex are to be found in a series of 195 adult specimens. The largest 12 among this series of 19 range from 40 to 46 mm. in length, averaging only 41.7 mm. Two of the 10 largest males among 176 were 40 mm. long, while the remaining 8 measured 39 mm. The average length of these 10 is 39.2 mm. or only 2.5 mm. below the average for the 12 largest females, but it must be remembered that the two series upon which these figures are based are very unequal in size. Seventy per cent of the remaining 166 males are 35 or more millimeters in length, so it may be considered that the normal length of males from Ch'ungan Hsien is from 35-37 mm. Maximum size is of some importance in this genus when, let us say, we compare the size of *boettgeri*, *minor*, *kuatunensis* or *pelodytoides* to that of giant *carinensis*, a species attaining a length of 150 mm. or four times that of *kuatunensis*.

About Kuatun, these frogs were extremely abundant in the smaller mountain streams up to a certain height above which their place was taken by *M. kuatunensis*. I have no exact data to prove just what the controlling factors in the distribution of the two species were, but I judge that there were three: (1) humidity, which was certainly greater in the highest parts of Kuatun Mountain so continuously wreathed in clouds during the spring and summer months; (2) air temperature, which was, of course, lowest in the highest valleys, and; (3) light, that was largely cut out by the dense vegetation where I found *kuatunensis* taking the place of *boettgeri*. I do not think that water temperature plays a part because I have never found adults of either species actually in the water, nor have I found any constant difference between the temperature of the water inhabited by *boettgeri* and that inhabited by *kuatunensis*. Thanks to the incessant calling of the males, it was an easy matter to follow the distribution of the two species as one ascended the stream beds. *M. boettgeri*'s tolerance of difference in humidity, temperature of both air and water, and light must be fairly great in order to allow it to range from almost sea-level in Futsing Hsien to perhaps 5500 feet in northwestern Fukien, while the tolerance of *kuatunensis* for these factors seems to be very limited.

*M. boettgeri* was to be found every night calling from vantage points either along or in the stream beds but not actually in the water and only seldom very close to it. The males were generally to be seen conspicuously perched on a boulder or other projecting object and I have never found them together in numbers. I have seen but one specimen among many score observed more than a few yards from a stream bed.

The call is a monosyllabic, explosive "chirp" repeated from twenty to forty times in rapid succession. The first few syllables are uttered with increasing volume and speed, until the climax is reached when the volume and speed again diminish with each successive note. The contrast between the rather rapid rise to a climax and the gradual decline gives a mournful air to the call as a whole. While calling, the frog assumes an alert attitude, the head held high and the body slightly raised on the legs. The expansion of the throat is considerable at the climax of the call. This species, like all the others found in the Kuatun streams, prefers hot, still nights for calling.

The breeding season is extensive and this perhaps explains in part why the discovery of mating couples is so difficult.

The evidence for the extent of the breeding season at Kuatun is chiefly in the form of almost completely metamorphosed tadpoles found

as early as May 11 and as late as July 17 and small, immature tadpoles entirely lacking leg buds, found at approximately the same dates. These dates serve only as incomplete evidence because little collecting of this species was done before May 11 or after July 17. In fact, a series of very small, immature tadpoles was secured August 25 from a stream frequented by *kuatunensis*, and while these will be taken as larvæ of that species, I am certain that *kuatunensis* does not have a more extensive season than its ally of lower altitudes. As positive evidence of the actual time of egg laying, I have a record of a female confined in a bamboo tube depositing her eggs June 27, and of gravid females containing mature ova brought in July 8 and 25. Judging by the most active period of calling, I conclude that the season was at its height from the middle of June through the middle of August. This evidence is not to be taken as seriously as that based upon records of larval development because the human ear plays strange tricks. *M. boettgeri* tadpoles of various sizes were common in the Yenping mountains about the middle of May, 1925. This is not surprising in view of the facts cited above. It is more interesting to know that this was true in Futsing Hsien early in October of the same year for thus we have evidence of an extremely prolonged season there.

Although I made efforts to secure fertile eggs by hunting for them in the open, as well as by confining males with gravid females, I was unsuccessful. The unfertilized eggs laid in the bamboo tube June 27 were pale gray in color and evenly distributed through perfectly clear, soft jelly that almost flowed out when the bamboo tube was tilted. The unusually soft eggs were 1.5 mm. in diameter and about 200 in number. A female dissected in the field held 238 ripe ova, and another examined in the laboratory, about 240, numbers that check up remarkably well. The ova measures 2 mm. in diameter in the laboratory.

The function of the oral apparatus or so-called funnel-mouth of tadpoles of certain species of *Megophrys* has been discussed at length by various authors. The latest paper devoted to it that has come to my attention is by Hora (1928) and includes a bibliography of no less than twenty-eight titles. I observed the tadpoles of *boettgeri* off and on for several months and believe that I can add a few points to the subject.

In the first place, I agree with Smith in thinking that surface feeding is the only direct function of the apparatus, but can only offer as evidence the fact that I have never seen a tadpole attempt to open the funnel out under water or attempt to feed there in any other way. Secondly, I believe that the tadpoles of *boettgeri*, at least, are primarily

adapted to life on the beds of small, mountain streams. This I believe chiefly because I found them extremely abundant in such places and nowhere else in Fukien, and secondarily because their agility on these stream beds forces me to consider them completely adapted to such an existence. Above, I say "beds" advisedly, because about Kuatun *boettgeri* tadpoles may be found among pebbles in tiny trickles where they seem to be perfectly at home, thanks to their cylindrical form, powerful tail, and lack of caudal crests worthy of the name. They make their way about with unbelievable ease as no other tadpole can do. If one is stranded, it jumps about until it finds water. I have seen one cover several inches at every jump. They also seem to be able to adhere to pebbles by using the ventral surface of the base of the funnel together with the belly. In short, they are thoroughly at home while contending with unusual conditions in a special way of their own and I failed to find any other tadpole habitually frequenting the same sections of these steep mountain springs and trickles. *M. boettgeri* tadpoles also inhabit the largest streams, but here they seek out the ecological equivalent of the pebble- and stone-laden beds of the steep mountain cascades, i.e., the edges of the larger water-courses. Moreover, when put in an aquarium containing water alone, they seem unable to rest on the bottom without turning over and they constantly try to escape by darting upwards, unless they find something to rest against or burrow under. If the larvæ are so well adapted to mountain-stream life, why may we not consider the oral apparatus an adaptation to surface feeding in comparatively pure, flowing water where food is scarce? Is not *Microhyla heymonsii* another example of such an adaptation? The fact that the larvæ of other species inhabit sluggish water does not injure our point, because the oral apparatus would not be disadvantageous even there. If short, thick, deep-crested tadpoles such as those of *hasseltii* can survive in mountain streams, we know that form is not all-important and that animals adapted for life in one niche can survive in others as well, provided the differences are not too great. Numerous observers report that funnel-mouth tadpoles hunt out either shallow or vegetation-laden sluggish water where conditions are nearest to those of the beds of mountain streams and where the tadpoles can avoid open pools and have abundant support for their unstable, crestless forms. If such tadpoles had evolved in quiet water their tails would not have become cylindrical and crestless, but instead would have developed crests for support in currents and open water. They would scarcely find such an elaborate oral mechanism necessary in food-laden water of sluggish streams or

quiet pools. Certain *Microhyla* tadpoles survive by the hundreds in tiny pools of clear rainwater and yet they entirely lack enlarged lips.

***Megophrys kuantunensis* Pope<sup>1</sup>**

Plate XIX; Figure 3

TYPE.—A. M. N. H. 30126; adult ♂; Kuantun Village, Ch'ungan Hsien, north-western Fukien Province, China; altitude 5500–6000 feet; April–September, 1926; Clifford H. Pope, collector.

DIAGNOSIS.—Closely allied to *boettgeri* of the same locality and *minor* of Szechwan. It differs from both in the possession of a dark, thin, Y-shaped mark occupying the middle of the back; from *boettgeri* in being dull brick-red instead of blackish,

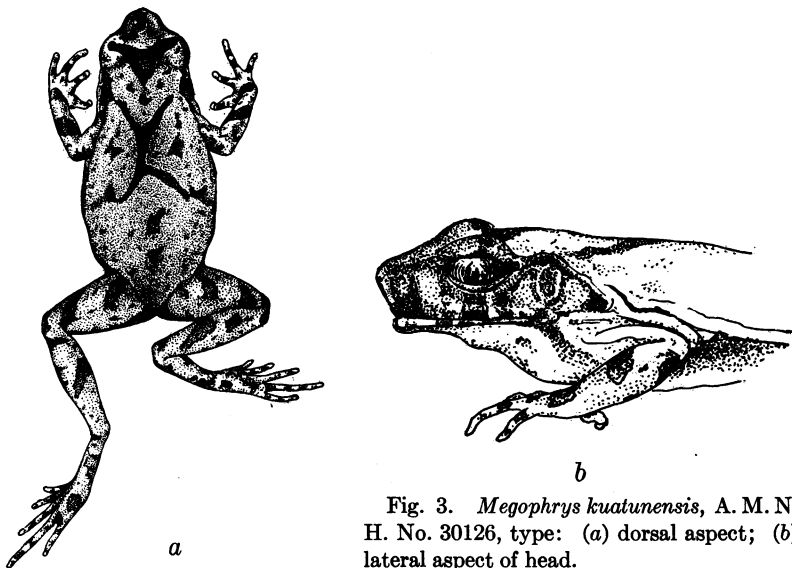


Fig. 3. *Megophrys kuantunensis*, A. M. N. H. No. 30126, type: (a) dorsal aspect; (b) lateral aspect of head.

and in having distinctly smaller toe webs. The tibia of the new species is less than half as long as the head and body, while that of *minor* is more than half this length. The tibiotarsal articulation never reaches beyond the eye in *kuantunensis* but in *minor* it reaches almost to the tip of the snout.

DESCRIPTION OF TYPE.—Tongue entire, vomerine teeth lacking. Head moderate, as long as broad; snout very short, obliquely truncate, strongly projecting beyond mouth. Canthus rostralis angular, loreal region concave; interorbital space as broad as upper eyelid. Tympanum distinct, half diameter of eye. Fingers slightly swollen at ends, first and second equal. Toes slender, scarcely swollen at tips, with barest rudiment of web; a small, oval, flat inner metatarsal tubercle; no subarticular

<sup>1</sup>The original description (Amer. Mus. Novitates No. 352, May 20, 1929) is given herein full for the sake of completeness.

tubercles. Tibiotarsal articulation reaching tympanum; tibia two-fifths as long as head and body. Skin smooth. Length, from snout to vent, 32 mm.; tibia 14 mm.

The dorsum is brown, a little darker than the ventrum. There is a dark,  $\chi$ -shaped marking on the back and another triangular one on the head, one point of which extends onto either upper lid. In addition, there are a few small spots on the back. The belly is boldly marked with dark spots, the two largest of which are longitudinal, one extending along either side of the mid-region of the ventrum, the next two in size, also longitudinal, occupying corresponding lateral positions just anterior to the base of the forelimbs. These four spots are light-centered. Another conspicuous spot lies between the insertions of the forelimbs. The jaws, especially the lower, are barred. The limbs are banded dorsally and, except on the ventral side of the thighs, spotted below the bands. A dark band extends from the tibiotarsal articulation onto the bottom of each foot. There is a light spot on the back of each thigh.

NOTES ON PARATYPES.—The thirty-two<sup>1</sup> paratypes come from the type locality (A. M. N. H. 30123-4, 30230-58, and 30324) and well agree with the type.

Many tadpoles were collected in streams apparently inhabited by this form alone (A. M. N. H. 30606 and 30645), but I fail to find a character by which they may be distinguished from those of *boettgeri*. For the present, the larvæ of these two species must be considered identical, though doubtless a close comparison of material in the field will reveal points of difference. I am only tentatively placing the first series here (A. M. N. H. 30606).

The paratypes are comparatively uniform in structure but vary slightly in the shade of the ground color, some being more reddish and much lighter than the others. The posterior half of the  $\chi$ -shaped dorsal pattern may be obscure but the anterior part is uniformly evident. The belly is seldom so profusely spotted as in the type, but a longitudinal spot is always present on either side of the mid-region of the belly and a corresponding but shorter pair on either side of the chest just anterior to the arm insertions. The spot in the middle of the chest is almost always present.

Examination of the entire series of 33 types shows that there is great uniformity of size among them. Two specimens are very immature and among the remaining individuals only 5 are females. The following figures represent the total lengths of these 5 females in millimeters, together with the lengths of the right tibiæ enclosed in parentheses: 38 (17.5); 34 (13.7); 34 (15); 32 (15.5); and 31 (17). In these specimens, the tibiotarsal articulation reaches to the tympanum in the first, second, and fourth; to a point between the tympanum and eye in the third; and to the eye in the fifth. The 26 males are quite uniform in size,

<sup>1</sup>An additional specimen has been found since the appearance of the original description which listed only 31 paratypes.

the 3 largest measuring 32.0, 31.5, and 30.5 mm., the next ten 29.5 mm. from snout to vent. Thus, 10 among the largest 13 are the same size. The right tibiæ of these 13 range from 13.4 to 15 mm. in length, only 2 being less than 14 and 2 as much as 15 mm. long. The tibiotarsal articulations reach from just behind the tympanum to the eye. The foregoing figures are set down to show the great range of variation in leg length found in *kuatunensis* and to obviate the suspicion that long- or short-legged individuals found in the future may represent new species or subspecies. They also show that sexual dimorphism in size is rather marked. In addition to the loose skin of the throat, the males have slightly enlarged arms and a small patch of minutely granular skin on the inner side of each first finger. This nuptial pad is not noticeably raised or thickened and nearly matches the surrounding unmodified skin in color. Consequently, it is very inconspicuous.

In habits, I detected only three points in which *kuatunensis* differed from *boettgeri*. They were as follows:

1.—The new species was confined to the very highest streams about Kuatun. At certain altitudes *boettgeri* could no longer be heard, but *kuatunensis* alone was abundant. I never found the new form in any of the larger valley streams where *boettgeri* was so common and, indeed, one always seemed to replace the other. This point is discussed in detail under *boettgeri*.

2.—*M. kuatunensis* has a call distinguished from that of *boettgeri* by its sharper, more vigorous syllables that follow one another in less rapid succession. Each syllable suggests a short buzz of an electric buzzer and lacks much of the mournful tone of *boettgeri*'s more slowly repeated syllables.

3.—*M. kuatunensis* is more secretive in habits and does not call from conspicuous, elevated vantage points as *boettgeri* so often does.

Now that three small species of *Megophrys* with strongly projecting snouts have been described from China, it becomes necessary, in the interests of clarity, to distinguish between them. *M. boettgeri* is characterized by a black area that almost entirely covers the back, is constricted on the neck and brought to an abrupt end on the head near the anterior extremities of the upper lids. The shape and extent of this band is extremely constant, for among some 200 specimens I find almost no variation in it. It is clearly shown in Boulenger's original figure (1899). The equally persistent but more variable dorsal pattern of *kuatunensis* has already been described and, while it is found in other species of the genus, no trace of it is ever seen in *boettgeri*. *M. minor* seems to lack dorsal markings. These color distinctions, though possibly not as fundamental as structural differences, are by far the most useful in distinguishing these three Chinese forms. *M. minor* is readily told from the other



two by its long leg whose tibiotarsal articulation reaches to the snout. In *boettgeri* and *kuatunensis*, this articulation reaches no farther forward than the eye. The toe webbing of *boettgeri*, though described by Boulenger as a "slight rudiment," is, nevertheless, very distinct, and the toes of the males might be called a quarter webbed. In *kuatunensis*, on the contrary, what I have spoken of as the "barest rudiment" of a web might be characterized by another as "web lacking." It would be comparatively more accurate to describe the toes of *boettgeri* as having a "full rudiment of web to a quarter web," those of *kuatunensis* as "web lacking or present as a bare rudiment."

***Megophrys pelodytoides* (Boulenger)**

Plates XX and XXII; Figure 4

Thirteen specimens of this species were secured: one from Yenping (A. M. N. H. 28417) and 12 from Ch'ungan Hsien (A. M. N. H. 30127-

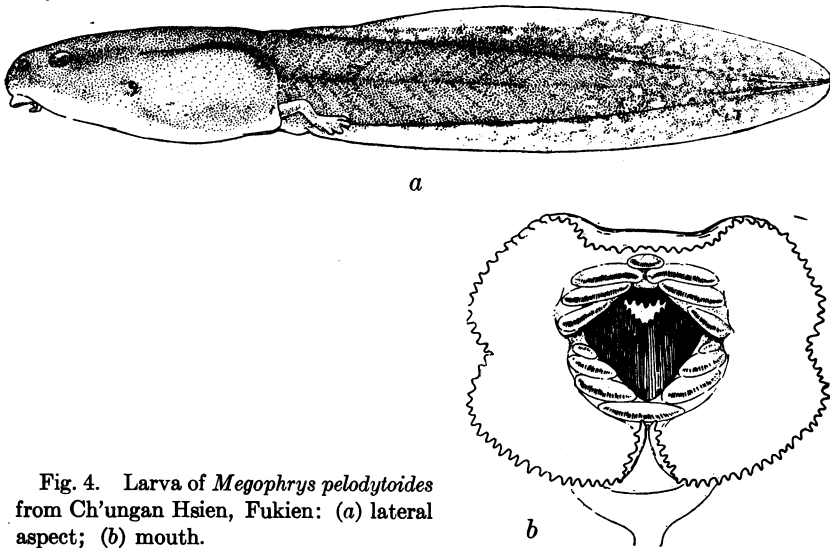


Fig. 4. Larva of *Megophrys pelodytoides* from Ch'ungan Hsien, Fukien: (a) lateral aspect; (b) mouth.

38). Many larvæ were collected in Futsing Hsien (A. M. N. H. 29413 and 32948), at Yenping (A. M. N. H. 31085), and in Ch'ungan Hsien (A. M. N. H. 29016, 29019, 29025, 30609 and 30683-6).

*M. pelodytoides* was described in 1893. It was "discovered in the Karin or Karenee Hills, east of Toungoo, between Burma and Siam, by the late La Fea. The types were obtained at Thao (1300-1400 m.)

and in the district of the Karin Bia-po. I refer to this species a number of specimens from a collection made in the Man-Son Mountains (3000–4000 feet) in Tonkin, on the Kwangsi frontier." (Boulenger, 1908). It is also known from Perak (Butler, 1903–1904) and Smith reports it "not uncommon above 1000 meters" in Siam. So far as I can ascertain, it has never before been reported from China.

Even though I have adults only from the vicinity of San Chiang and Kuatun in the mountains of Ch'ungan Hsien, the numbers of tadpoles collected in the Yenping and Futsing Hsien cascades prove its presence there. In Ch'ungan Hsien, it was found in the larger valley streams, while the larvæ taken in Futsing Hsien inhabited even the lowest cascades of a coastal range. Altitude apparently plays less part in its distribution throughout northern Fukien than in more southern regions, such as Siam, where it does not descend to within a few hundred feet of sea-level as in Fukien. This is not surprising but rather what might be expected. It is hard to understand why Mell did not find this species abundant in Kwangtung.

There is little doubt about the identity of my material, because I have before me for comparison one of Boulenger's Man-Son specimens (A. M. N. H. 23821), as well as a second individual from Siam kindly sent me by Dr. Smith. The Fukien frogs resemble the specimen from Siam rather than the one from Tonkin, but are distinctly smaller than either. My 13 specimens are made up of one gravid female 29 mm. long, five adult males 27, 26, 25, 25, and 24 mm. in length, respectively, and five very small individuals. Thus, 29 mm. seems to be very nearly the average size of Fukien *pelodytoides*, while the Siamese female measures 35 mm., the Man-Son female 38 mm. These measurements indicate but do not prove that the females slightly exceed the males in maximum length. The male is described by Boulenger as having an internal subgular vocal sac. I fail to detect nuptial finger pads or enlarged forelimbs in the present series.

Ripe ova of the single adult female from Fukien, No. 30128, are relatively large and correspondingly few, measuring 2 mm. in diameter and numbering 83. They are remarkably uniform in size. As would be expected, the larger Man-Son female, No. 23821, contains more ova, for my count is 205. They are the same size as those of No. 30128 and apparently well developed.

An extensive breeding season in Ch'ungan Hsien is indicated by the following data: tadpoles with leg buds 1 mm. long were found July 6 and 16, 1925 and August 28, 1926; tadpoles with leg buds 3–4 mm. in

length were taken June 1 1926; tadpoles collected July 16, 1926, had well-developed legs and forelimbs on the point of breaking through. Few data were secured at Yenping where two tadpoles were collected May 20, 1925; one with 2 mm. leg buds, the other immature with a body 11 mm. long and no sign of limbs. It is not surprising, in view of the above data, to find the following specimens in Futsing Hsien, September 20-30, 1925:

- 2 tadpoles only 7.5 mm. body length (immature)
- 4 tadpoles only 10.0 mm. body length (immature)
- 2 tadpoles only 13.0 mm. body length (immature)
- 1 tadpole only 14.0 mm. body length (immature)
- 2 tadpoles with leg buds 1.0 mm. long (barely mature)
- 1 tadpole with 4 limbs but tail scarcely reduced

Smith secured tadpoles on Dio Nga Chang, northern Siam, early in March.

Larval *pelodytoides* was not known until described by Smith in 1917. It has proved to be the second *Megophrys* tadpole without a specialized "funnel-mouth" and for this reason is especially interesting. Upon comparing my specimens with Smith's description, I noticed several points of difference, so I borrowed two of his tadpoles from Siam and find them to be essentially similar to mine but differing in the following points:

**TEETH.**—Fukien tadpoles have only four rows in the upper lip, those from Siam five and six. I have examined 24 Fukien specimens. The Siamese larvæ have proportionately longer and apparently more numerous teeth, while the lips appear correspondingly smaller. This difference is noticeable.

**PAPILLÆ.**—I fail to detect any papillæ other than those of the marginal row in Fukien tadpoles, but the tadpoles from Siam may or may not possess scattered papillæ in the corners of the mouth, as shown in Smith's figure.

In addition to the above, I wish to call attention to a few more points, some of which are omitted by Smith, while in others his description is either inaccurate or misleading. These points may now seem unimportant but it is entirely possible that in the future they will prove to be of real significance.

**MOUTH.**—Smith's figure by no means does justice to the greatly developed lips of this tadpole. Moreover, it pictures the teeth entirely too large. This fact will be made clear by a comparison of his figure with mine. Some allowance must be made, however, because the Fukien tadpoles do have lips even larger than those from Siam. The true shape of the lips is shown in the new figure and I find this shape to be the same for Siam as well as for Fukien tadpoles. This fact is worth emphasizing because the enlarged lips of *pelodytoides* appear to be correlated with its cascade habitat, a point brought out by Smith who says that the lips serve as an adhesive disc. My

tadpoles can be told at a glance from any other Fukien larva simply by the relative size of these broad lips.

**TEETH.**—Instead of being set directly on the lips, the teeth are ranged in rows along the crests of high, fleshy ridges, the ridges themselves being much higher than the teeth are long. While other tadpoles have raised teeth, I have never seen one with ridges comparable to those of *pelodytoides* unless it be *M. hasseltii*, and, even in this related form, the teeth are proportionately larger and the ridges smaller than in *pelodytoides*. This character alone would serve to identify larval *pelodytoides* among the other Fukien tadpoles of my acquaintance.

**NASAL PAPILLÆ.**—Each nostril is bordered by four conspicuous papillæ. It is entirely possible that these have a definite function. Field observations combined with a histological study would be required for the determination of this point. This is the third unusual character that might serve to identify this tadpole! It is true that such papillæ are also found in the closely allied *M. hasseltii*, but in that form they are extremely variable in size, form, and arrangement, being well developed only on the dorsal side of the nasal opening. I have examined 13 specimens of each species, all taken at random from large series and find *pelodytoides* to have regularly four symmetrically arranged papillæ completely surrounding each nostril, except in one specimen on one side of which there are only three papillæ. On the other hand, eight of the 13 *hasseltii* tadpoles examined have from three to five small papillæ on the UPPER side of the nostril only, one more has only a single papilla on the dorsal side, an additional one has eight papillæ almost surrounding the nostril, while the remaining three have 13 very small, widely separated papillæ completely surrounding this aperture. Only one nostril of each *hasseltii* tadpole was examined.

Smith brings out the fact that *pelodytoides*, in contrast to *hasseltii*, is an inhabitant of swift water. In fact, its entire structure indicates such to be the case, indications completely confirmed by my field observations, as well as those of Smith. A flattened body and a powerful tail, provided with low crests and well-developed belly muscles, combine to enable this tadpole to cope with swift water.

### **Megophrys hasseltii** (Tschudi)

Plates XIX and XX; Figure 5

A series of 20 metamorphosing and very immature individuals, allied to, if not identical with this species, was secured in Ch'ungan Hsien (A. M. N. H. 30682). Four lots of tadpoles were collected at the same locality (A. M. N. H. 29018, 29020, 30681 and 32947).

The recently transformed specimens are too immature to serve as the basis of a description, but their resemblance to *hasseltii* is very strong, while the numerous larvæ are strikingly like those of typical *hasseltii*. Comparing these larvæ with Van Kampen's 1923 description. I find only the following differences:

1.—The tail is normally twice as long as the body, instead of only one and a half to one and three-fourths times as long (in *hasseltii*).

2.—The nostril is equidistant from the eye and the tip of the snout, rather than nearer to the eye as in typical *hasseltii*.

3.—The distance between the eyes is only slightly, if at all, greater than that between the nostrils. In *hasseltii*, as described by Van Kampen, the eyes are twice as far apart as the nostrils.

4.—The tip of the tail is pointed, not rounded as in *hasseltii*.

In contrast to these differences in proportion, the lips and dental formula seem to be almost identical. Examination of 25 Ch'ungan tadpoles shows that they always have six rows of teeth above and five below, with only the outer row of each lip undivided. Some of the other rows

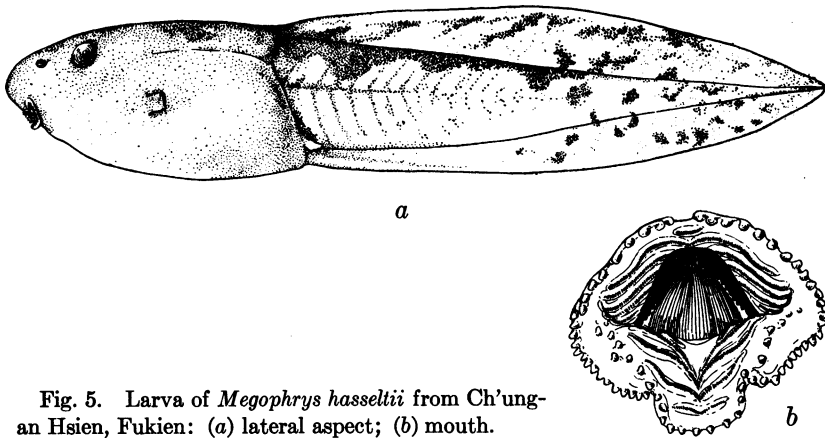


Fig. 5. Larva of *Megophrys hasseltii* from Ch'ungan Hsien, Fukien: (a) lateral aspect; (b) mouth.

may appear to be continuous, but they really are divided in the middle in spite of their two halves coming in contact there. Fortunately, I have some Javan tadpoles for comparison, and, even though all of Van Kampen's points cannot be checked on account of the poor condition of this series from Java, I find that the space separating the nostrils is decidedly greater in the Fukien tadpoles. The larval differences thus brought out are about what one would expect to find in a subspecies or distinct form closely allied to *hasseltii*. The solution of this question must await a good series of adults from Fukien.

Mell reported *hasseltii* from northern Kuangtung in 1922 and his specimens may prove to represent the possibly distinct Fukien form. There is no other Chinese record of this widely distributed amphibian. It ranges through Burma, Siam, the Malay Peninsula, Singapore, Sumatra, Java, and Borneo to the Philippines.

I have a large and well-preserved series of these handsome tadpoles

from Ch'ungan Hsien and find that they attain a greater size than that given by Van Kampen for *hasseltii*. This might also be taken as additional evidence for the distinctness of the Fukien form, but I have not included it above because size, as a character for distinguishing tadpoles, is more often misleading than otherwise. The maximum length in my series is reached by an individual with legs 26, body 36, and tail 72 mm. long.\* This makes a total length of 108 mm. compared to Van Kampen's maximum of 79 mm. A mature specimen of average size has leg buds 12, body 30, and tail 63 mm. in length and these dimensions may be taken to represent the normal size of mature Ch'ungan Hsien tadpoles. They make a total of 93 mm. or 15 mm. greater than Van Kampen's maximum of 79 mm. As shown in Fig. 5*b*, the inner row of papillæ in the Ch'ungan Hsien tadpoles is little more than two irregular series of scattered papillæ, one on either side of the lower lip. Van Kampen speaks of two series of papillæ along the "sides and lower margin" of the lips, so in case a detailed comparison of larval forms becomes advisable, a distinction may possibly be found in the arrangement of the inner papillæ of the lower lip, Van Kampen's "lower margin series." Van Kampen failed to describe the external structure of the nasal opening, but I find it surrounded by a raised edge, the dorsal and lateral parts of which are in the form of papillæ. These papillæ are especially well developed in the Ch'ungan Hsien series, less so in the Javan tadpoles available to me.

The habits of larval *hasseltii* have been described by Smith and Annandale in 1917 and Van Kampen in 1923. All these observers have found the tadpoles in pools, but Annandale's pools were in streams of open country, Smith's in pools of comparatively sluggish hill streams, while Van Kampen is noncommittal but simply says, "pools and clear, swiftly running water." In Ch'ungan Hsien, the tadpoles frequented the deeper pools of both large and small mountain streams. They seemed to be confined to these deeper pools even though smaller individuals could also be found nearer the current in small, shallow pools. We may conclude that larval *hasseltii*, even though entirely devoid of any structural adaptation enabling it to cope with swift water, can survive in mountain streams simply by remaining in pools. Its lack of adaptive features has allowed it to live in different habitats in contrast to more specialized forms whose very specializations have confined them to a single type of habitat. As an example of such, one might cite tadpoles of the various species of *Staurois*.

Smith (1917) reports the finding of *hasseltii* tadpoles in January, April, and July. This indicates either a long breeding season, slow larval

development, or both. My data also indicate but do not prove slow development and a protracted season. The San Chiang Chinese insist that these frogs breed only in the late fall at which time they may be traced down by their loud croaking from deep recesses among the boulders lying along the streams. The height of a protracted season might, of course, come at this time of the year in *hasseltii*, just as is reported by Smith to be the case with *Bufo melanostictus*. I am putting the following data in tabular form so that independent conclusions may be drawn from them. Measurements are in millimeters.

DATE OF PRESERVATION	LENGTH OF BODY	LEG BUDS
May 7, 1926	9 (immature)	None
May 26, 1926	35 (immature)	Present
June 4, 1926	8-12 (immature)	None
June 10, 1926	9-11 (immature)	None
June 22-July 30, 1925	15-20 (immature)	None
June 22-July 30, 1925	32 (mature)	Well developed, 15 mm. long
June 22-July 30, 1925	Two metamorphosing specimens with tails almost completely absorbed	

In the field, this tadpole is very easily confused with that of *Rana spinosa* because of similarity in form, color, and choice of habitat. The pelobatid may be recognized at sight by a light area at the dorsal juncture of the tail with the body. This conspicuous area is in the form of a V whose apex is directed posteriorly. Both species have conspicuously spotted tails and dark bodies but the mature *spinosa* tadpole never shows trace of this light, V-shaped marking.

### Bufonidæ

#### BUFO

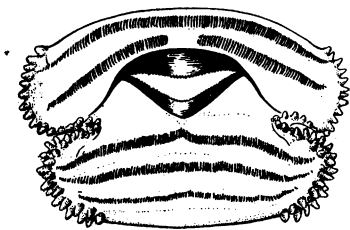
The tadpoles of this genus are remarkably similar in a great number of species. They are, however, readily recognized as a group by their generally dark or black color, thick-set bodies, median vent, and rounded

tails. The dental formula is probably about the same in the Chinese forms though the rows of teeth may vary in proportionate lengths. The true differences can only be pointed out after examination of large series. Field workers should have little trouble because of the general scarcity of species in any one region.

***Bufo melanostictus* Schneider**

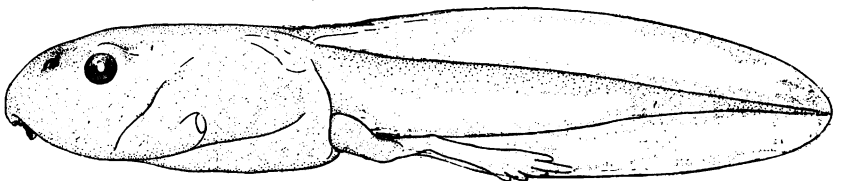
Plate XXII; Figure 6

A large series of 246 specimens represents this species: 122 from Nodoa (A. M. N. H. 27308-77 and 27379-430), 53 from Futsing Hsien (A. M. N. H. 29115-67), 33 from Yenping (A. M. N. H. 28137-69), 14 from Kianning (A. M. N. H. 30771-84), 21 from Ch'ungan Hsien (A. M. N. H. 28871-87 and 30201-4), two from Yuankiang (A. M. N. H.



a

Fig. 6. Larva of *Bufo melanostictus* from Hainan (A. M. N. H. No. 27448): (a) lateral aspect; (b) mouth.



b

30971-2), and one from Yangwupa, a Yunnan locality about 25 miles northeast of Yuankiang (A. M. N. H. 30918). A single tadpole was secured at Yenping (A. M. N. H. 31079) and a large series at Nodoa (A. M. N. H. 27448).

Schmidt's 1927 report included one specimen from Pinghsiang,<sup>1</sup> one from Yenping, 11 from Fukien, and 23 from Tengyueh.

Van Kampen (1923) states that *B. melanostictus* ranges from India and southern China through the Malay Peninsula and Archipelago to

<sup>1</sup>This record is very doubtful and should be omitted unless substantiated by new material.



the Philippines.<sup>1</sup> The Chinese records for this toad follow: Hainan (Boettger, 1888 and 1894; Boulenger, 1899; Vogt, 1913; and Smith, 1923); Whampoa (Hallowell, 1860, as *griseus*); Canton (Boulenger, 1882; Boettger, 1885 and 1888; Wolterstorff, 1906; and Vogt, 1924); Kwangtung (Vogt, 1914, and Mell, 1922); "Drachenkopf," a mountain directly east of Shiuchow and about midway between it and the Kiangsi border, northern Kwangtung (Mell, 1922); Kwangsi (Vogt, 1930); Amoy (Steindachner, 1869); Foochow (Stejneger, 1925); Futsing (Stejneger, 1925); Fukien (Stejneger, 1925); Tengyueh (Annandale, 1911); Talifu (Mell, 1922). Hongkong records are few in number: (Boulenger, 1882, and Boettger, 1888 and 1894). *B. melanostictus* is well known from Formosa (Stejneger, 1907, etc.).

I found this to be the common toad of the Hainan lowlands and so did Smith (1923). Mell states that it is abundant everywhere in Kwangtung from sea-level to 800 m. In northern Fukien, it is universally distributed from the Futsing Hsien coast to the base of the high Ch'ung-an Hsien range. It did not reach San Chiang nor did we find it at Hok'ou on the Kiangsi side of the mountain barrier. This may be taken as an indication that *melanostictus* does not reach the plateau of northern Kiangsi.

Van Kampen states that the males have a subgular vocal sac and, during the breeding season, develop nuptial excrescences on the two inner fingers. I find this to be the case in my specimens and can add that the arms of breeding males are slightly enlarged. The females attain the greater size, for I find upon examining a series of 53 toads from Futsing Hsien, that the ten largest among the 29 males range from 65 to 72 mm. in length and average 67.8 mm., while the ten largest among 24 females range from 74 to 85, averaging 78.3 mm. The females are more variable in size, the smallest being 46 mm. long compared to 47 mm. in the more numerous males. I fail to detect any difference between the sexes in either coloration or texture of the skin.

The *Nodoa* tadpoles agree with Van Kampen's description. Flower (1896), Smith (1917), and Annandale (1918) have also given good accounts and descriptions of this tadpole.

*B. melanostictus*, according to Smith and Van Kampen, breeds throughout the year at Bangkok and in Java, but Smith states that increased sexual activity, correlated with the dry, cool weather, takes place in November. Observation of a large colony of immature tadpoles in a stagnant pool at *Nodoa* on December 7, 1922, corroborates Smith's statement. In February of this same year, numerous metamorphosing

<sup>1</sup>Taylor (1912) questions the single Philippine record.

tadpoles were seen about Nodoa. Constant search at later dates failed to reveal larvæ in any stage of development. It would be extremely interesting to have data on the breeding season at various points on the Chinese mainland. Most of the large Futsing females collected through September and October contain ova in the process of development, so it is possible that the toads there also have a November–December season of sexual activity. The presence of tadpoles in various stages of development at Yenping, May 8, 1925, indicates that spring breeding occurs in Fukien, too. These points can be settled only by field workers.

*B. melanostictus* ranges to 10,000 feet in the Sikkim Himalayas (Boulenger, 1890), therefore its absence at San Chiang probably indicates that the Ch'ungan Hsien mountains are on the edge of its range. Mell reports it at 800 m. in Kwangtung, so it may be expected at high elevations farther south in Fukien. Altitude records should be made there.

#### ***Bufo bufo asiaticus* Steindachner**

A series of 235 specimens represents this form: 22 from Hok'ou (A. M. N. H. 30707–28), 47 from Peking (A. M. N. H. 27457–503), 29 from the Western Hills, near Peking (A. M. N. H. 27708, 27710–1, 27713–9, 27726–7, and 27738–54), 85 from Tsinan (A. M. N. H. 27816–900), seven from Sohuang, a village 5 miles south of Pingting (A. M. N. H. 25845–51), one from Niangtzekwan (A. M. N. H. 25800), and 44 from Chinszu (A. M. N. H. 25615–44 and 25686–99). Niangtzekwan is in Shansi, near the Chihli (Hopeh) boundary, east and a little north of Pingting, while Chinszu is about ten miles south and a little west of Taiyuanfu. In addition, there is a series of juveniles from Ma Ying Hai, near Ningwu, northern Shansi (A. M. N. H. 31011) and another from Tsinan (A. M. N. H. 32952). Numerous tadpoles were also secured at Tsinan (A. M. N. H. 32951).

I am also placing here 81 specimens identified by Schmidt (1927) as *bankorensis* from the base of Tei Pei Shan, Tsing Ling Mountains, Shensi; Chikungshan, southern Honan; Changsha and Shenchowfu, Hunan; Ningkwo and Wuhu; Yenchingkou and Luanshihkou, two localities within 20 miles of Wanhsien, Szechwan; and 32 additional ones called *B. b. japonicus* by him, from Peking and Hsing Lung Shan, northeast of Peking; and Kweihwa, Shansi.

I cannot follow Schmidt in carrying *bankorensis* into the lowlands of central China because my series from the mountains of northwestern Fukien too obviously represents *bankorensis*, the types of which I have examined, while the series from Hok'ou, on the eastern edge of the

Kiangsi plateau, agrees with my Anhwei series in having a narrower head than *bankorensis*. I fail to find any point of distinction between the Shansi and Chihli toads called *japonicus* by Schmidt and those from central China.

Shaw (1929) has written a brief account of the habits of this toad but does not give dates in his notes on their breeding. A series of toads taken at Peking from August 28 to September 1, 1924, contains many males with very conspicuous nuptial asperities and females whose well-developed ova are 1.5 mm. in diameter, indications of imminent mating. These data should be checked because, in view of the fact that the greatest amount of rainfall occurs at Peking in June, July, and August (Shaw, 1929), they are of special significance. The closely allied *bankorensis* breeds through April in Fukien but it probably has a late summer or early fall mating period as well.

Schmidt (1926) has suggested that these Chinese toads are not so similar as generally considered but include closely allied forms with different habits. If such is the case, field men alone can solve the problem and lead the way to a more accurate classification.

### ***Bufo bankorensis* Barbour**

#### Plate XVIII

Numerous specimens from Ch'ungan Hsien represent this species (A. M. N. H. 28811-30, 28898, 30205-29, and 30484-512). In addition, there is a series of juveniles from the same locality (A. M. N. H. 30125). Tadpoles were also secured in Ch'ungan Hsien (A. M. N. H. 30687-92).

*B. bankorensis* was described by Barbour from central Formosa in 1908 and introduced into the mountain fauna of China by Stejneger when he reported it from Suifu and Shin-Kai-Si, Mt. Omei, Szechwan, in 1925. I am glad of this opportunity to give confirmation by recording it from the high mountains of Fukien. It is probable that the toad from "Drachenkopf," a mountain in northern Kwantung east of Shiuchow, listed by Mell in 1922 as *B. b. asiaticus*, really represents *bankorensis*. Boulenger's 1899 series of "*B. vulgaris*" from Kuantun certainly belongs here, while Vogt (1930) reports *bankorensis* from Kwangsi.

The Ch'ungan Hsien series is made up of 75 specimens, eight of which are less than 47 mm. in length, while the remaining 67 are equally divided between the sexes, 35 being male and 32 female.

The following table gives the important characters for the ten largest specimens of each sex. Measurements are in millimeters.

A.M.N.H. No.	Sex	Length, Snout to Vent	Width of Head at Angle of Jaw	Tip of Snout to Posterior End of Parotid	Vent to Tip of Longest Toe	Length of Tibia	Top of Head
30222	♂	96	37.0	42.5	148	42.5	smooth
30503	♂	96	36.0	40.0	137	40.0	smooth
30219	♂	96	37.0	38.5	135	37.5	smooth
30510	♂	93	34.0	40.0	134	38.5	smooth
30512	♂	93	33.5	38.5	135	39.5	smooth
28823	♂	93	38.5	38.5	125	37.5	smooth
30225	♂	90	38.0	38.0	135	38.0	smooth
30491	♂	90	37.5	38.0	124	35.0	smooth
30488	♂	90	34.0	38.5	137	38.0	smooth
30494	♂	90	35.0	35.0	132	36.0	smooth
30501	♀	117	48.0	48.5	155	43.5	smooth
30500	♀	115	49.5	49.0	151	46.0	smooth
30487	♀	115	47.0	47.0	153	44.0	smooth
28813	♀	115	48.5	43.0	151	43.0	smooth
30486	♀	114	46.5	46.5	155	45.0	smooth
30485	♀	113	46.0	46.0	152	43.5	smooth
30215	♀	112	48.5	48.5	150	44.0	smooth
28816	♀	112	46.0	48.0	144	42.0	smooth
28812	♀	107	45.0	43.0	140	41.0	smooth
30490	♀	105	44.0	44.0	139	39.0	smooth

This table includes the best available data on *bankorensis*. It also records the range of variation in the principal characters. A glance at it will show that the females are decidedly the larger. The ten largest of this sex average 112.5 mm. in length, while the ten largest males average but 92.7 mm. The old males are remarkably smooth, the warts often being almost absent and entirely devoid of tuberculate tips. The females seldom if ever attain this same degree of smoothness and are usually quite rough. Breeding males bear dark asperities on the inner side of the first three fingers. In life, *bankorensis* often has conspicuous red spots on the sides, a part of the pattern that is not evident in preserved specimens.

About Kuantun, these toads ascended the highest mountains where I often found them in heavily-shaded bamboo forests and, indeed, our entire series came from the mountains at San Chiang and Kuantun.

Paired couples were brought in on April 25, 1926, at San Chiang, but breeding had been going on for some time then because I have tad-

poles with leg buds 2 mm. long collected there April 24. Recently metamorphosed toads, only 9.5 to 10.5 mm. in length from snout to vent, were taken at San Chiang on May 17 and June 5 of the same year. I found the numerous larvæ in the quiet water of flooded fields at San Chiang. A large female, containing 3725 moderately well-developed ova 1.5 mm. in diameter, was taken on August 3 at San Chiang, a fact indicating that these toads breed in the late summer or early fall as well as in the spring.

The tadpoles of *bankorensis* are not distinctive but have a type of oral structure frequently found in toads: two rows of teeth in the upper lip, the inner narrowly interrupted, and three continuous rows below. Papillæ are present laterally only. The tadpoles are black and rather large; a specimen with leg buds 3.5 mm. long measures 29 mm. from tip to tip, the tail occupying 18.5 mm. I am unable to find characters distinguishing *bankorensis* larvæ from those of *B. b. asiaticus* collected at Tsinan.

#### ***Bufo andrewsi* Schmidt**

One specimen collected at Yunnanfu by Walter Granger may be considered as representing this form (A. M. N. H. 30883).

*B. andrewsi* was described in 1927 from 14 Yunnan toads. The type locality is Likiang, but paratypes were reported from Yunnanfu; Muyang, 40 miles north of Yunnanfu; and the Wutingchow District. Schmidt states that the six specimens recorded by Werner in 1924 from the region of Likiang<sup>1</sup> as *B. vulgaris asiaticus* "appear to be plainly referable to this species."

*B. andrewsi* was diagnosed as "closely allied to *Bufo bufo* from which it is distinguished by the presence of a tarsal fold, its finer and more uniform tuberculation, the less divergent parotids, and the tuberculate top of the head."

It is hoped that additional Yunnan material will soon be available for comparative studies. At present this species does not appear to be a very distinct form.

#### ***Bufo raddei* Strauch**

A series of 102 specimens represents this species: six from Ma Ying Hai, near Ningwu (A. M. N. H. 31005-10), 14 from Tsinglo (A. M. N. H. 25821-34), 22 from Chinszu, near Taiyuanfu (A. M. N. H. 25645-66), ten from Sohuang, a village five miles south of Pingting (A. M. N. H.

<sup>1</sup>Werner's text reads, "Zwischen Yungning, Yungbei und Lidijang." Yungbei is probably the same as Yungpeh of the Chinese Postal Map.

25835-44), 24 from the Western Hills, near Peking (A. M. N. H. 27709, 27712, 27720-5, 27728-37, and 27755-60), and 26 from Artsa Bogdo, Altai Mountains (A. M. N. H. 31022-47). Ningwu and Tsinglo are towns in northern Shansi.

Schmidt's 1927 report included 206 specimens: one from Chinszu (spelled by him Chen Tzu), one from Tsingtao, and the rest from Mai Tai Chao, a monastery in northern Shansi between Kweihwa and Saratsi.

Two larvæ, both with buds 1.5 mm. long, taken at Ma Ying Hai, July 10-16, 1922 (A. M. N. H. 32950), are provisionally placed here because they seem to differ from my series of *Bufo bufo asiaticus* larvæ in a few minor respects and, coming from northern Shansi, they certainly are either *asiaticus* or *raddei*. It is well known that most *Bufo* tadpoles are remarkably similar, so it is entirely possible that the two variants are not *raddei* larvæ but abnormal *asiaticus* tadpoles. The differences are:

1.—In the Ningwu larvæ, the nostril is half as long as the eye and separated from it by a space equal to the diameter of the nostril. In *asiaticus* the nostril is only one-third as long as the eye and separated from it by a space twice the diameter of the nostril.

2.—The interocular space equals the width of the mouth in *asiaticus* but in the Ningwu tadpoles this space is only three-fourths the width of the mouth.

3.—The Ningwu tadpoles are not black like those of *asiaticus*, but very finely spotted, appearing quite light to the unaided eye. In fact, the throat and tail crests are entirely unpigmented. The difference in color is very marked but it is possibly due to preservation. This is improbable because the Ningwu specimens are in good condition.

Questions such as the above should be taken up by field workers. A median vent occurring together with three rows of teeth below and two above, and the absence of bordering papillæ, except on the side of the lips, should serve to identify any tadpole in northern China as belonging to the genus *Bufo*. It is hoped that a good description of undoubted *raddei* tadpoles will be published so that the larvæ just described may be definitely placed.

Stejneger (1907) describes the range of *raddei* as "the eastern part of the desert Gobi, Alashan, and Ordos in Mongolia to Peking and Chefu in the south and north to Dauria, the valley of the Amur and the Ussuri country." Nikolski (1918) gives a long list of localities, among them Kokonor, eastern Tibet. Stejneger (1925) records specimens from Yen-an, northern Shensi; the Lanchowfu region of Kansu; and so forth. There are old records of *raddei* occurring as far south in eastern China as

Chefoo (Wolterstorff, 1906) and Tsingtao (Werner, 1903). It seems to be lacking at Tsinan, however. The southern extent of its range in the Yellow River region, in southern Shensi and possibly northern Szechwan, should be traced by a careful accumulation of locality records.

Shaw (1929) states that *raddei* is rare about Peking. Our series from the Western Hills indicates that it is more abundant where the country is at least slightly elevated and rugged. Stejneger records it from 6700 feet above sea-level in Kansu. I found these toads breeding in the region of Mai Tai Chao on May 6 and 22, 1922. In one case, they had congregated in great numbers throughout a grass-grown, swampy area on the plain but near some mountains.

*Bufo raddei* is interesting in exhibiting two types of sexual characters: one invariably confined to the males, the other only partially correlated with sex. To the first type belong the subgular sac, nuptial asperities on the fingers, enlarged forelimbs, and smaller size, all of which are perfectly constant masculine characters. The only two characters of the second type are:

1.—The more contrasted color pattern of the female. This pattern is occasionally seen in the male but is never lacking in the female. Fourteen among a series of 93 males more than 42 mm. long, have almost typical female coloration, while a few others possess it to a limited extent. Not a single female among 23, also more than 42 mm. in length, shows the duller masculine coloration. This character seems to be a feminine one seen occasionally in the opposite sex.

2.—The greater rugosity of the males. In this sex, the warts are not only more numerous but each wart carries a number of dark tubercles on its apex. Females frequently have tuberculated warts, so this character appears to be a masculine one of common occurrence among females. It is extremely difficult to measure, even though a smooth female differs noticeably from a typical male. The tubercles appear in all degrees of development, either pigmented or unpigmented. A greater number of the smaller females were smooth; more of the larger ones were rough.

I fail to detect any correlation between degree of rugosity and development of either type of color pattern.

Stejneger (1925) examined his series of *raddei* for color pattern and likewise failed to find a female with the male type of pattern, but found males with both types. His conclusions, though based on comparatively few data, agree essentially with mine.

In determining the relative lengths of the sexes, I have used only specimens from one locality in order to avoid confusion through mixing of possible local races. So much of the country inhabited by *raddei* is extremely barren that the toad probably varies much in size according to its immediate surroundings. The series selected consists of 190 toads from Mai Tai Chao. Seventy-four juvenile specimens less than 43 mm.

in length were thrown out. Unfortunately, only 23 of the remaining 116 were females. The 12 largest females ranged from 58 to 72 mm. in length, averaging 67.5 mm. No very accurate figure for the feminine size can be arrived at from such meagre data, but surely the females reach a larger size than the males because three females among only 23 are larger than the largest male among 93, while the average size for the 12 largest males is only 64.7 mm. or some 3 mm. less than that for the opposite sex, in spite of the great difference in numbers of individuals. The males are remarkably constant in size, the 12 largest ranging only from 62 to 68 mm. in length. Some 78 per cent of the 93 males are from 50 to 60 mm. long, while the actual figure for the modal length is 56, many more individuals being of this length than any other.

## Hylidæ

### HYLA<sup>1</sup>

The relationships of the frogs of this genus inhabiting China have never been clearly worked out because of lack of comparative material. Even when specimens are at hand it is no easy matter. This is due to the extreme structural stability of the Eurasian members of the genus. The differences are often relative and therefore difficult to define. Color patterns are of importance in showing relationships, as well as in making keys for convenience, but unfortunately, colors change and fade in museum specimens. The whole matter was reviewed by Stejneger in 1907, and it is my purpose not to repeat or alter his conclusions but merely to supplement them.

The most interesting thing in the study of Chinese tree toads is the evolution of the development or disappearance of black pigment on the sides and lateral aspects of the limbs of the various species. It is along the line of transition from the green of the back to the yellow or white of the ventrum that noticeable changes are taking place. This lateral region of transition almost invariably has a certain amount of black pigment. For example, in the Japanese form *H. a. japonica*, this black may be diffuse or it may take the form of weak, irregular spots. In *immaculata* of central China, it is often distributed much as in *japonica* but never, however, in the form of spots. Turning to *chinensis* we find this dark pigment concentrated into black lines over the tympanum and intense black spots on the sides and legs.

<sup>1</sup>The following discussion is based on the conviction that all the forms of *Hyla* found in China belong to the *arborea* group. *H. abboteniata* Vogt, 1927, and *H. bambusicola* Barbour, 1920 (new name for *Hyla monticola* Barbour, 1912, not of Cope, 1876), the only species seemingly not of this group, have been wrongly identified, both being polypedatids belonging to the genus *Polypedates*. Dr. G. K. Noble has examined the type of *abboteniata* (B. M. No. 24118) and I have dissected that of *bambusicola*.



It should be noted that whenever it is thus concentrated on the sides, black spots appear on the lateral aspects of the femur and tibia (*chinensis*, *sanchiangensis*, and *annectans*). The greatest development of black is found in *sanchiangensis*, for in this form the loin and leg spots are profuse and small ones even occur regularly on the forelimbs. Here, too, the breeding males develop the most conspicuous dark brown areas covering the nuptial asperities of the inner fingers. Curiously enough, however, in this highly spotted form, spots never appear along the anterior half of the side, though they are always found in the axilla and loin. This unspotted area is covered by highly diffuse, blackish shading instead of spots.

In *H. a. japonica*, I find not only greater variability of pattern but more of it than in any other form, for it is in this species alone that black frequently encroaches upon the green, and numerous examples with conspicuous dorsal spotting and dark bars across the limbs are found. It is just as if this black color had become separated from the dorsal green, disappearing from the European form and certain Chinese ones, only to reappear on the sides of others such as *chinensis*, *sanchiangensis*, and *annectans*.

Since the chief questions that concern us here are the relationships of the species under discussion, we must see what help may be derived from this study of patterns. Boulenger considers the Japanese form as ancestral to the European, because he takes the loin spot of the latter to be a remnant of a more complicated dorsal pattern similar to that regularly found in *japonica* and even evident at times in *arborea arborea*. Preserved specimens of *immaculata* from Anhwei very rarely show leg bars, but perhaps these would be present at times in living specimens and we might take this as additional evidence of the relationship of *japonica* and *immaculata*. Structurally, these forms are much alike. Specimens from Shantung and Kiangsu are greatly needed but they should be studied in life. In fact, I believe that in the variable and rich pattern of *japonica* we find the ground plan for the lateral spots of *chinensis*. The relationship here is much less obvious because structural differences come into consideration.

A comparative study of patterns convinces me that *sanchiangensis* is nothing but a high altitude form of *chinensis* in which the lateral and limb spotting has reached its highest development and there is little to contradict this conviction, thanks to the structural similarity of these species. Coming to *simplex*, we get a decided loss of spotting and, in fact, the pattern of this species strongly suggests that of *immaculata*,

The size of the digital discs and extent of webbing and proximity of ranges, speak clearly for its alliance to *chinensis* rather than to *immaculata* and there are, moreover, definite differences in color pattern to distinguish it from *immaculata*. *H. annectans* combines characters of *immaculata* and *chinensis* and its relationships will be clearer when the ranges and life histories of the three forms are better known and the tadpoles of *annectans* and *immaculata* have been described.

These data on color patterns have been given what might appear to be an undue amount of space and weight here, but this is only because I think they have been neglected in the past. I am fortunate in having more material for study than anyone else and have taken such a fine opportunity to make the most of an aspect to me quite as interesting as any other. Even though I have water-colors made from life at my disposal, a study of living specimens would be much more profitable. Under the different specific headings, detailed results of my comparisons of scores of specimens will be found.

It is anything but pleasant to admit that many lines of evidence cannot even be considered in this paper, due to almost complete lack of life-history data of the proper sort. Noble and Noble (1923) have shown what value may be derived from a thorough field study of any one species, and it is hoped that Chinese students will bestir themselves and give to the herpetological world full accounts of these *Hylas*, at least one species of which should be found breeding on the campus or in the country immediately surrounding almost every Chinese university, not to mention the yards and vicinity of innumerable students' homes.

LARVÆ.—These are included in the key just following the genus *Rana*, page 484.

#### ***Hyla immaculata* Boettger**

With the exception of a specimen from Lushan, near Kiukiang (A. M. N. H. 23779), secured through exchange, there is no material in addition to the series of 49 specimens from Wuhu and 32 from Ningkwo reported by Schmidt in 1927.

Boettger described this form from Shanghai in 1888 as *Hyla chinensis immaculata* but some years later, upon securing additional material from Lushan, he referred to it as *Hyla arborea immaculata* (Boettger, 1892 and 1894). Gee (1919) lists *immaculata* from Soochow, where it would, of course, be expected to occur. Barbour (1912) reports two specimens that came either from Ichang or Szechwan. There are various other records of *Hyla* from China that cannot be relied upon and it is,

at any rate, safest to build upon a firm foundation now that the various species have been more clearly defined and the chance of error correspondingly lessened. It might even be best to start with a still cleaner slate!

I feel that Schmidt is well justified in giving *immaculata* full specific rank, admitting, however, its alliance with the Japanese form. I also agree with Stejneger (1925) who considers Stone's<sup>1</sup> Mongolian specimens as distinct from *immaculata*. Material from the region between the Yangtze Valley on the south and Mongolia and Manchuria on the north is badly needed.

The Anhwei series at hand is remarkably constant in form and pattern, as Schmidt has already stated. The presence of faint, dark bars on the limbs of a single specimen is significant, indicating, together with the form of hand and foot, relationship to the Japanese form. A careful study of living individuals should be made in order to ascertain whether or not dark bars appear periodically and, if so, on what percentage of individuals. Examination of the tadpole, thus far undescribed, certainly would throw additional light on the obscure relationships of these Chinese tree toads. Okada's 1925 description of typical Japanese *japonica* larvæ indicates that they are not very similar to those of *simplex*, *sanchiangensis*, and *chinensis*, so the question arises, does the larva of *immaculata* resemble that of typical *japonica*, or, let us say, that of *chinensis*? The answer to this comparatively simple question might do more to solve our problem than pages of detailed descriptions of adults.

Sixty specimens of the original series of 84 have been retained in the collection of the American Museum but, unfortunately, most of these remaining specimens are only half grown, so it is impossible to determine the maximum size of the sexes. Other sexual differences cannot be detected either, but this is probably because none of the specimens was collected during the breeding season.

*H. immaculata* is evidently a large species. The type, a male, measured 35 mm., while Stejneger records the length of two specimens as 29 and 40 mm. He does not give the sexes. The three largest females among the 60 Anhwei specimens measure 34.5, 34.5, and 33.5 mm., the three largest males, 30, 28.5, and 28 mm. Sexual dimorphism in size is indicated even in these specimens that are scarcely to be considered as fully mature. This lot of Anhwei tree toads made up of 27 males and 33 females, collected at an off season, illustrates a point of general interest

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<sup>1</sup>Stone, 1899.

to collectors: i.e., when a species, whose males are very conspicuous while breeding, is collected during its breeding period, care must be taken to secure females or else nearly the entire catch will be made up of males. On the contrary, no such precaution is necessary if the specimens are taken at random here and there at any time other than the mating period.

### ***Hyla chinensis* Guenther**

Plate XXII; Figure 7

Ninety-three specimens represent this species: one from Foochow (A. M. N. H. 30844), five from Futsing Hsien (A. M. N. H. 29429-33), 43 from Yenping (A. M. N. H. 28422-64), 29 from Ch'ungan City (A.

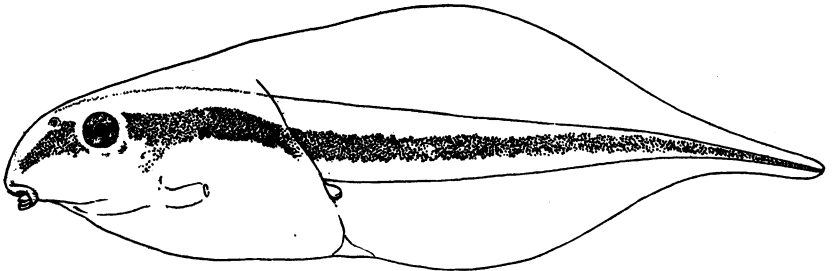


Fig. 7. Larva of *Hyla chinensis* from Yenping, Fukien (A. M. N. H. No. 31071): lateral aspect.

M. N. H. 30142-70), and 15 from Ch'ungan Hsien (A. M. N. H. 28930-5 and 28937-45). A series of tadpoles was secured at Yenping (A. M. N. H. 31071).

Schmidt (1927) recorded 11 specimens of *annectans* from Yunnan as *chinensis* (see *annectans*). In addition, he correctly reported eight examples of *chinensis* from Fukien. A. M. N. H. 577 from Kagi, Formosa, has not been previously recorded.

This species was described and figured in 1858 from "China" by Guenther. Since then, it has been reported from Kwangtung (Vogt, 1914); Shiuchow, in Kwangtung; and the Hunan-Kwangtung boundary (Mell, 1922); Amoy (Steindachner, 1869); Foochow (Wolterstorff, 1906, and Stejneger, 1925); Futsing (Stejneger, 1925); the region of Ningpo (Boettger, 1892 and 1894, and Wolterstorff, 1906); Soochow (Gee, 1919); and Lushan, near Kiukiang (Boettger, 1892 and 1894). It was long ago collected on Formosa (Guenther, 1864) and more recently reported from there by Van Denburgh (1912). The British Mu-

seum contains much additional Formosan material (Stejneger, 1907), Blackwelder collected *chinensis* in the Tsing Ling Mountains, Shensi, which Stejneger has seen (Stejneger, 1907). Yunnan records are discussed under *annectans*, and I am sure that David's Szechwan report requires confirmation (David, 1873). Due to the difficulty of identifying the Chinese Hylas, their ranges are far from clear. *H. chinensis* is probably a true southeastern form but its distribution cannot be defined until many additional data, including altitude records, are available. I prefer to remain skeptical in regard to all specimens of *chinensis* from northwestern China.

In Fukien, I found it to be common in the low country of Futsing Hsien and Foochow; about Yenping, where it ranged to some little altitude in the mountains; and on the Ch'ungan Hsien plateau. It was replaced by *sanchiangensis* in the high mountains of the northwestern border, the San Chiang-Kuatun region. Mell recorded it as common from 600–800 m. on the Kwangtung-Hunan boundary and, since the Ch'ungan plateau is at an altitude of about 1200 feet and the Yenping mountains reach 4000, it probably ranges from sea-level to some 3000 feet in Fukien. It would not be expected to occur at very low altitudes near the southern extremity of its range and the Kwangtung mountains probably are not high enough to allow it to reach its upper limit there.

The possession of so fine a series makes me feel somewhat obligated to record and discuss certain characters that seem to be especially trustworthy, thus supplementing former descriptions.

A fine black line extends from the anterior corner of one eye to that of the other, passing just above the nostrils. Except for an island of green on the side of the upper jaw below and anterior to the eye, this line delimits the extent of green on the snout and upper jaw. The end of the snout is brown. *H. sanchiangensis* agrees in this respect but other forms do not. Special notice should be taken of the next point because I find it absolutely diagnostic of *chinensis*. The tympanum is included in a brown, black-edged triangle whose base is the posterior border of the eye and whose apex lies above the insertion of the forelimb and is often continuous with the lateral row of black spots. I have not seen a specimen of *chinensis* that lacks this triangle nor have I found it present in any other form. Among 42 Yenping individuals, I find spots invariably present in the axilla. They may, however, be more or less joined to form a line. Five of these 42 had one tiny black spot on the upper arm of one side. Spots are always present on the side and loin and posterior face of the femur. They are only very rarely absent on its anterior face and

on the tibia. In *sanchiangensis*, although spots are nearly always present in the axilla and are never lacking from mid-side to the insertion of the leg, they are never present in the intervening area, small though it be. Obviously, then, the distribution of spots on these species follows a definite plan and is variable only within certain limits. I have examined, in addition to the series of 42 from Yenping, 29 Ch'ungan specimens, most of which are juveniles, without detecting the slightest trace of dark, dorsal spots or limb bars such as are generally found on *H. a. japonica* and very rarely on *immaculata* from Anhwei. This point should be confirmed by constant examination of living material because a knowledge of the possible occurrence of such an element of the pattern is of importance in working out relationships.

In *chinensis*, sexual dimorphism of color is found in two dark patches, one on either side of the lower jaw just at the anterior base of the loose skin covering the subgular vocal sac. These two patches sometimes meet in the midline, thus becoming very conspicuous. The small, slightly raised nuptial pads, situated on the inner side of each first finger in the males, are smooth and either light brown in color or unpigmented. The arm of the breeding male is not enlarged. Females attain the greater length. A series of 43 adults taken in the breeding season at Yenping contains 35 males but only eight females, the latter ranging in length from 29 to 38 mm. and averaging 34.1 mm. The large series of males ranges from 25.5 to 32.5 mm., 16 individuals measuring 30 to 31.5 mm. The 12 largest average 31.3, ranging only from 31 to 32.5 mm. Remarkable uniformity in size among the males is shown by these figures. Unfortunately, adult females are almost absent in the rest of my series, but one specimen from Futsing measures 37 mm., agreeing well with the largest Yenping specimens.

*H. chinensis* was first found in the mountains near Yenping, May 16, 1925. A specimen kept alone in a bottle deposited a batch of eggs May 21. These eggs ranged from 1 to 1.5 mm. in diameter and were partly pigmented. A gravid female was collected five days later and the following year males, apparently still in their breeding season, were taken at Ch'ungan City, July 25. Tadpoles, the smallest of which had a body only 3 mm. in length, the largest leg buds 1 mm. long, were taken in the Yenping rice fields May 26, 1925 and serve as evidence that the breeding season began certainly before May 16. The month of May is probably the height of the Yenping egg-laying period, while farther north at Ch'ungan City, this period no doubt begins later than at Yenping. Our data are too incomplete for further conclusions.

I observed *chinensis* to be abundant on roadside bushes at Hsing Ts'un, a tea-collecting center some seven miles southwest of Ch'ungan City. The Yenping specimens were taken on bushes of varying height.

DESCRIPTION OF TADPOLE.—Length of body twice its width; tail one and a half to two times as long as body; one and a half to two times as long as deep. Nostrils slightly nearer to eyes than to tip of snout, almost as far apart as the eyes which are lateral and slightly nearer to spiraculum than to tip of snout. Spiraculum without tube and equidistant from snout and base of tail. Vent dextral, situated just above lower border of subcaudal crest. Tail acutely pointed, crests extending only a short distance along back even in immature individuals. The body of a specimen with leg buds 1 mm. long, measures just 8 mm.

The teeth of the upper lip are in one long, continuous and one long, narrowly interrupted row; those of the lower in three long interrupted rows. A double row of papillæ borders the lips but is broadly interrupted along the middle of the upper lip. Extra papillæ are present in the corners of the mouth.

The color is black above with two broad, light bands extending from the snout backwards between the eyes and along the back on to the upper edge of the muscular part of the tail. Here they may either disappear or extend on to the tip. The muscular part of the tail is distinctly light-edged ventrally. The skin of the belly is unpigmented, the tail crests only sparsely spotted. Probably in life this tadpole, when immature, is jet black with gold dorsal bands just as *simplex* is. I failed to make a special note of this point but seem to remember such to be the case.

Comparing the tadpoles of *simplex*, *chinensis*, and *sanchiangensis*, I find that in size they are about equal, while the lips and teeth are quite similar in form. The only marked structural differences are:

- (a).—The greater extent of the dorsal tail crest over the back in *simplex*, especially in immature individuals.
- (b).—The greater depth of the tail compared to its length in *chinensis*.
- (c).—The greater length of the tail compared to the body in *simplex*.

In coloration, too, they are alike, all having the same fundamental pattern, but there are definite differences as follows:

- (1).—*H. simplex* is alone in lacking the light border to the ventral edge of the fleshy part of the tail.
- (2).—*H. sanchiangensis* is the only one with pigmented belly skin.
- (3).—The posterior narrowing of the dorsal bands is found only in *sanchiangensis*.

A comparison of large series of fresh material should be made by way of confirmation of proportional measurements and color changes accompanying growth. I am able to go into accurate details of color change in *simplex*, thanks to a series of water-colors made from life. Proportionate length and depth are hard to determine with precision in preserved specimens.

The question of adaptation to pond and stream life in tadpoles may properly be brought up here because one of our three species is clearly a

mountain form (*sanchiangensis*) and another probably a lowland dweller (*simplex*). The third (*chinensis*) appears to inhabit both mountainous and level country. Have the tadpoles of *sanchiangensis* become modified so that they may live in swift water? This question must be answered in the negative because no clear case can be made out for adaptive modification, when we recall that in both *simplex* and *sanchiangensis* the tail is two and a half times as long as deep. This conclusion is further borne out by a study of breeding habits, for *sanchiangensis* breeds in level, irrigated fields at San Chiang, just as *simplex* does at Nodoo. The responsibility of finding quiet water has been assumed by the adult, the tadpoles remaining incapable of living in swift streams in spite of their abundance and the relative scarcity of quiet water. In fact, all my observations convince me that these *Hyla* tadpoles are peculiarly sensitive to even a slight current and are utterly helpless in the face of a strong one. The greater extent of the dorsal tail crest forward along the back of immature *simplex* might be considered advantageous in quiet water, while it would be anything but helpful to tadpoles occasionally subjected to currents as *chinensis* or *sanchiangensis* undoubtedly are.

### ***Hyla sanchiangensis* Pope<sup>1</sup>**

Plate XV; Figure 8

TYPE.—A. M. N. H. 30198; adult ♂; San Chiang, Ch'ungan Hsien, northwestern Fukien Province, China; 3000–3500 feet altitude; April–May, 1926; Clifford H. Pope, collector.

DIAGNOSIS.—A mountain form closely allied to *chinensis* but differing conspicuously in coloration and in having more extensive webbing of the fingers and toes.

DESCRIPTION OF TYPE.—Vomerine teeth two-thirds behind line joining anterior edges of choanæ, nearer to each other than to choanæ. Diameter of tympanum two-fifths that of eye; diameter of finger discs slightly greater than that of toe discs. Tibiotarsal articulation reaching center of eye. Fingers half webbed; toes fully webbed.<sup>2</sup> Skin smooth. Length, from snout to vent, 34 mm.

The back is purplish brown (leaf-green in life), the belly uniformly light. There are numerous black spots on the posterior side, both sides of the upper leg, and the inside of the lower leg; also on the arm and around its insertion. A fine, black line starts at the tip of the snout, passes over the nostril, through the eye, immediately above the tympanum, and along the upper side to join the first black spots of the posterior side. A similar line, beginning below the nostril, skips the eye and skirts the tympanum, extending parallel to the first line as far as the base of the arm, where it meets the black spots of that region. In alcohol, the color of the area between these two lines is not markedly different from the general color of the side. The upper jaw is weakly and irregularly bordered with black. The type,

<sup>1</sup>With one important correction, as designed in footnote 2, below, the original description (Amer. Mus. Novitates No. 352, May 20, 1929) is, for the sake of completeness, repeated here in full.

<sup>2</sup>In the original description, this sentence reads, "Fingers with small webs; toes two-thirds webbed," but careful re-examination establishes the fact that my first observation was inaccurate.



taken during the breeding season, has conspicuous, dark nuptial pads on the inner fingers and a large, grayish subgular vocal sac.

NOTES ON PARATYPES.—The 30<sup>1</sup> paratypes come from the type locality (A. M. N. H. 28936, 30171-97, and 30199-200.

In regard to the distinctive color pattern of this species, there are several points to be noted. First, the black line from the anterior corner of one eye, passing forward and just above the nostrils to the corner of the other eye, is strongly suggestive of the corresponding line found in *chinensis* but differs in its tendency to form a point on the tip of the snout (in *sanchiangensis*). As in *chinensis*, this line delimits the extent of green on the snout and upper jaw, unless a small isolated patch of that color is found below and anterior to the eye. Second, *chinensis* lacks the faint mottling found on the edge of the upper lip of *sanchiangensis*.

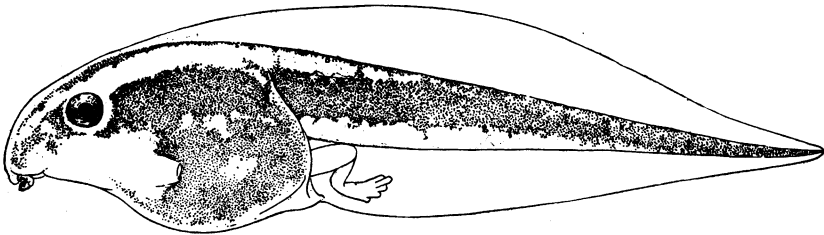


Fig. 8. Larva of *Hyla sanchiangensis* from San Chiang, Fukien: lateral aspect.

In the type, this mottling takes the form of an irregular black border to the upper lip. Third, there is no tendency in *sanchiangensis* for the fine black lines extending backward from the posterior border of the eye to converge after passing the tympanum. Instead of coming to a point behind the tympanum to form a triangle, as in *chinensis*, the upper continues backward high up along the side until it joins the mid-side spots, while the lower turns downward to join the spots in the axilla. Fourth, *sanchiangensis* always lacks spots in the area behind the axilla and anterior to the mid-side, while the spots of *chinensis* form a continuous, if sometimes broken series from base of arm to base of leg. Fifth, the upper arm in *sanchiangensis* always has at least one spot on its posterior side, and such spots are generally present on both sides. Spots are only rarely present on the forelimb in *chinensis* and, when present, are very small. Sixth, there is a profusion of large spots in *sanchiangensis* from the middle of the side to the base of the hind limb, on both

<sup>1</sup>An additional specimen has been found since the appearance of the original description which listed but 29 paratypes.

sides of the femur, and on one side of the tibia. The side and leg spots of *chinensis* are smaller and much less profuse. They are rarely absent on the anterior face of the femur and the tibia. Seventh, I fail to find very dark nuptial pads on the thumb of any of my large series of *chinensis* but such are very conspicuous in nearly all of the specimens of *sanchiangensis*.

Structurally, *chinensis* and *sanchiangensis* are quite similar, the only significant difference being in the extent of webbing. The fingers of the former have only small webs, while those of the latter are half webbed; the toes of *chinensis* are half webbed, those of *sanchiangensis* fully webbed. The following table gives further comparisons. All measurements are in millimeters.

A. M. N. H. No.	<i>chinensis</i>		<i>sanchiangensis</i>	
	♀	♂	♀	♂
	28457	28426	30172	30178
Length, snout to vent	39.0	30.0	39.5	31.0
Diameter of tympanum	2.0	1.4	1.5	1.5
Diameter of eye	4.5	3.5	4.0	3.4
Width of finger disc	2.2	1.6	2.2	1.7
Width of toe disc	2.0	1.5	2.0	1.5

Sexual dimorphism in color is found in the darkened membrane of the subgular vocal sac of the breeding male, the throat of the female being unpigmented at all times. The amount of color on the vocal sac varies greatly in individuals, but the pigment, instead of being confined to the anterior base of the sac, as in *chinensis*, is spread more or less over it. The nuptial pads are well developed and slightly rough, covering almost the entire inner side of each first finger. In 23 cases out of 25, the pads are dark brown, the brown extending, in its extreme development, from the inner base of the finger to the end of the last phalanx. The forelimb is not noticeably enlarged in these males. The 31 types are made up of 6 females, 38.5, 38, 37.5, 37, 34, and 34 mm. in length, and 25 males ranging in length from 29 to 34 mm., 13 of the 25 measuring 30.5 to 31.5 mm. The nine largest males range from 32 to

34 and average 32.8 mm. in length. The females are thus seen to be appreciably larger than the males.

In the spring of 1926, I first heard these frogs in the flooded rice fields at San Chiang on the night of April 29. They were floating about on the water with distended legs, calling violently. Great numbers of them would call in unison for approximately two minutes, after which a complete silence of about the same duration would follow. I was able to count no less than eight successive and remarkably constant alternate periods of calling and silence. The performance became very irregular upon the appearance of the moon, its light, no doubt, making me more visible. Breeding in these fields continued at least until May 25, on which date I last heard the sharp, trilled whistle of this species. I did not find any tadpoles until May 16 of this same year when they were very abundant and up to 14 mm. in total length. Their striped pattern rendered them conspicuous.

On July 16, I first found a metamorphosing individual and soon afterwards they were very numerous. These data indicate that in 1926 the breeding season was under way by the last of April and continued at least through May. I did not arrive at San Chiang in 1926 until April 25, but the absence of tadpoles of any size in the rice fields upon my arrival means that the breeding season had only just begun then. That the mating period may continue well on into June is shown by a lot of tadpoles from San Chiang with minute leg buds, dated July 14, 1925.

**DESCRIPTION OF TADPOLES.**—Four series were secured at San Chiang (A. M. N. H. 29022, 30700, and 30702-3).

Length of body twice its width; tail about one and a half times as long as body, two and a half times as long as deep. Nostrils nearer to eye than to tip of snout, nearly as far apart as eyes, which are lateral and slightly nearer to spiraculum than to end of snout. Spiraculum without tube and about as far from snout as from base of tail. Vent dextral, situated above the lower border of subcaudal crest. Tail acutely pointed, dorsal crest extending forward to middle of back in the immature individuals from which this description was made. The body of a typical specimen with minute leg buds is 7 mm. long.

The teeth of the upper lip are in one long, continuous and one long, narrowly interrupted row; those of the lower lip in three long, unbroken rows. A double row of papillæ borders the lips but is broadly interrupted along the middle of the upper side. Extra papillæ are present in the corners of the mouth.

The tadpole is black above and below, save for (a) two longitudinal dorsal bands, wide in the region of the eyes, but becoming much narrower about the middle of the back, and continuing along the upper edge of the muscular part of the tail to, or nearly to its tip, (b) a light, ventral border along the muscular part of the tail and, (c) a conspicuous light band extending forward over the belly from the base of the tail, narrowing rapidly and coming to an end near the center of the belly. The tail crests are sparsely and irregularly spotted, especially along their borders.

I did not secure full data on the amount of color change undergone by these tadpoles but probably the black becomes less intense as they mature and the dorsal stripes, if originally gold, lose their brightness and become dull green just as in *simplex*.

It is interesting, if only coincidental, that the larval form, as well as the adult of *sanchiangensis*, should display decidedly more black pigment than either *simplex* or *chinensis*.

#### **Hyla annectans** (Jerdon)

Thirty-two specimens (A. M. N. H. 30886-917) were collected on Kunyang Hai, near Yunnanfu, at an altitude of 6400 feet, by Walter Granger, October, 1926.

A. M. N. H. 5304-6, 5430-5, and 12944-5 from Yunnanfu, and 6590 from Wutsingchow District were reported as *H. chinensis* by Schmidt in 1927. They were collected by John Graham for the American Museum. An additional specimen (A. M. N. H. 5765), is of uncertain origin. It was not included in Schmidt's report.

This frog was described from the Khasi Hills as *Polypedates annectans* (1870) and has since been recorded from elsewhere in Burma (Boulenger, 1887 and 1893); and from Tonkin (Parker, 1925). Anderson (1878) reported *Hyla chinensis* common at Momien, (Tengyueh) Yunnan, but I strongly suspect that he really found *annectans*. Annandale (1911) probably made the same mistake in recording *chinensis* from an altitude of 4500 feet at Pupiao (a locality in western Yunnan about midway between Yungchang and the Salween River), and Tengyueh. Vogt (1924) reports two specimens from Washan,<sup>1</sup> Szechwan. *H. annectans* may be taken as the common *Hyla* of the extreme west of central and southern China.

I find that in a specimen from Yunnanfu, 30 mm. long from snout to vent, the largest finger disc measures 1.5 mm. in width, while the disc of the longest toe measures 1.4 mm. Measurements of additional specimens confirm the proportion shown by this example. Comparing these figures with those taken from *chinensis*, I find that the discs of *annectans* are slightly smaller than those of *chinensis* of equal size, but distinctly larger than those of *immaculata*. *H. annectans* possesses distinct but small webs between the toes and in this respect resembles *chinensis*, but the webbing of the toes is smaller than in *chinensis* and more like that of *immaculata*, though the difference here is slight. Again, *annec-*

<sup>1</sup>A mountain in Szechwan about 35 miles southwest of Mt. Omei (as the crow flies). The altitude is given on H. R. Davis' map of Yunnan as 10,550 feet.

	<i>simplex</i>		<i>immaculata</i>		<i>annectans</i>		<i>arborea japonica</i>	
	♂	♀	21803	21800	5432	5435	24960	25073
A. M. N. H. No.	26958	26968	31	32	30	33	31	35
Length, snout to vent	2.0	1.8	1.5	1.5	1.5	1.9	1.8	1.6
Diameter of tympanum	3.5	4.0	3.5	3.5	3.5	3.8	4.0	3.8
Diameter of eye	2.0	1.5	1.1	1.4	1.5	1.6	1.8	2.0
Width of finger disc	1.5	1.2	1.0	1.0	1.4	1.5	1.6	1.9

*tans* has a shorter leg than either of the other two species, and it alone possesses the tuberculate fold from eye to shoulder. Correlated with this fold, is a general extreme development of ventral and lateral rugosity.

Comparative measurements (in millimeters) of *simplex*, *immaculata*, *annectans*, and the Japanese form will be found below. Those for *chinensis* and *sanchiangensis* are given under the latter species.

Turning to color, I find that *annectans* differs from all the other Chinese forms in one very significant respect, i.e., its tympanum is not involved in the brown band that extends posteriorly from the eye. In *annectans*, this band coincides anteriorly with the thick, tuberculate fold and could not, under such conditions, include the thin tympanic membrane. The upper jaw and snout are consistently green, save for the narrow band from nostril to eye, which never extends anterior to the nostril. This is especially diagnostic of *annectans* also. Examination of the series of 32 specimens from Kunyang Hai shows that the lateral spots are found neither in the axilla nor on the anterior part of the thigh, where they are invariably present in *chinensis*. One among every six specimens has a small spot on the upper arm, a condition somewhat comparable to that met with in *chinensis*. Loin spots are lacking in one out of every four *annectans*, while such spots are constantly present in *chinensis*. Coming to the legs, I find that, while both of these species almost invariably have at least one spot on each aspect of the femur, these leg spots are nearly always more numerous and conspicuous in *chinensis*. The tibia of *annectans* lacks spots in every fourth example, that of *chinensis* only very rarely. These species further show similarity in having the green of the upper forearm stop at the wrist, that of the upper side of the tibia at the tibiotarsal articulation. Boulenger (1890) describes the males as having black nuptial excrescences on the thumb, but my series, which includes some breeding males, fails to show this character, the asperities being small, smooth, and entirely colorless.

I have gone into great detail here in order to establish definitely the identity of these species. Color distribution is quite as reliable as slight differences in the position of the vomerine teeth, shades of leg length, and degrees of webbing. Moreover, color pattern may be correlated with habits, as I have noticed that species lacking green pigment below the wrist and tibiotarsal articulation and above the forearm seem to assume habitually resting postures that leave these areas unexposed. My observations are not definite enough to be set down in detail but field workers may confirm or disprove such a correlation.

I have never observed this species in the field but Mr. Granger tells me that he collected the present series in swampy areas along the west shore of Kunyang Hai (or Lake) where they were found sitting on grass and rushes. This checks well with observations made on other species, the young examples of which are often found in grass rather than bushes. Mr. Granger's series has already been described as composed largely of immature individuals. Annandale (1911) quotes Brown who states that Anderson's Tengyueh *chinensis* (considered here as *annectans*) were found on bushes, so we have evidence that *annectans* does frequent bushes as well as grass and rushes.

So far as I am aware, the tadpole has not been described. This is most unfortunate, because undoubtedly a comparison of the tadpole with those of the allied Chinese forms will help a great deal in establishing the relationship of the species.

### ***Hyla simplex* Boettger**

#### Figure 9

One hundred and fourteen specimens (A. M. N. H. 26779-859, 26946-77, and 27378), all from Nodoo, make up the series of this species. Numerous tadpoles were secured at Nodoo (A. M. N. H. 27445).

Boettger described this as *Hyla chinensis simplex* from Annam in 1901.<sup>1</sup> My Hainan specimens agree well with the description of the type and it is not surprising that Hainan tree toads should turn out to belong to a southern rather than a northern form. The Hainan fauna is well known to be closely related to that of Indo-China.

As remarked by Boettger (1901) and Stejneger (1907), previous records of *Hyla* from Hainan undoubtedly belong here (Swinhoe, 1870, *H. chinensis*, and Cope, 1895, "*H. arborea* var.").

The individuals of this series are remarkably constant in pattern, none of them showing traces of the black spots of *chinensis*, so I am giving the form specific rank. *H. chinensis* possesses the black lateral spots and characteristic tympanic pattern just as invariably as *simplex* lacks them.

The hands and feet of *simplex* are very similar in degree of webbing and size of discs to those of *chinensis*. I have measured five typical specimens of each for comparison and every specimen has slightly wider finger than toe discs. Two specimens of *simplex* measure 32 mm. from snout to vent and their finger and toe discs are, respectively, 1.5, 1.6 and 1.2, 1.3 mm. in width. Boettger's original account need not be repeated, but he did not give full details of pattern, so I will supplement his color description.

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<sup>1</sup>*H. simplex* also occurs in Tonkin (Boulenger, 1903).

The lateral band begins at the nostril and, after crossing the eye, involves the tympanum, immediately beyond which it turns slightly downward before becoming very diffuse and indefinite in its lower border. Thus, the snout and upper jaw are not effected and, save for the narrow band from nostril to eye, exhibit green color similar to that found on

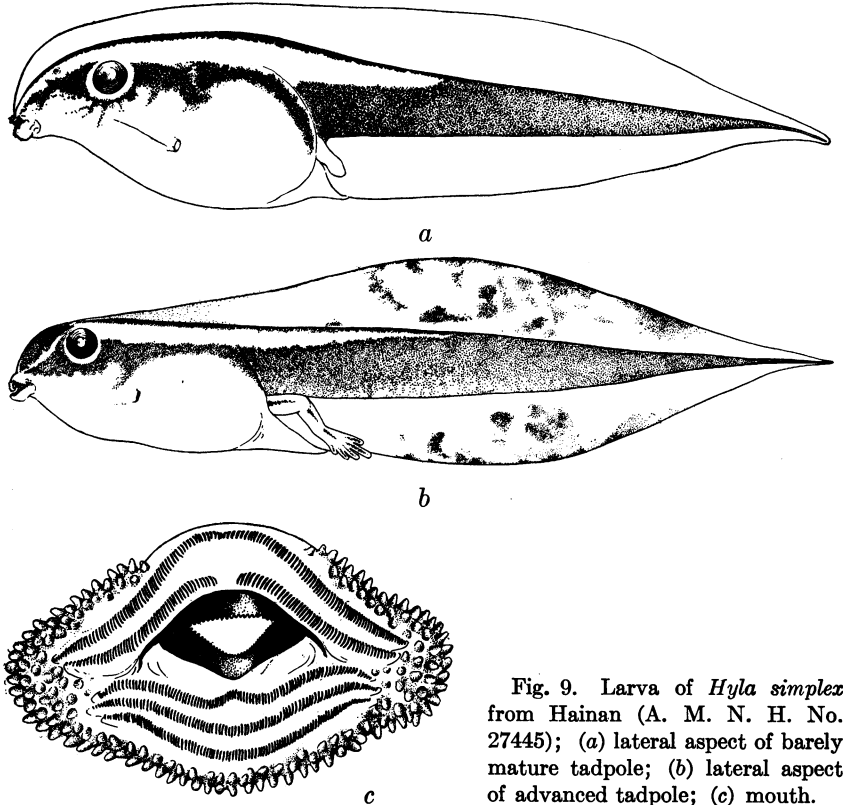


Fig. 9. Larva of *Hyla simplex* from Hainan (A. M. N. H. No. 27445); (a) lateral aspect of barely mature tadpole; (b) lateral aspect of advanced tadpole; (c) mouth.

the back. This green is definitely delimited on the wrists and at the tibiotarsal articulations and does not extend on to the digits or upper sides of the hands and feet. Black spots are never present on the sides or limbs. The pattern is still more simple than in *immaculata* because *simplex* does not even possess such a well-developed, white border to the dorsal green as that found in *immaculata*.

Eighty-three individuals among the series of 114 are immature and less than 22 mm. long. The remaining 31 are made up of 16 males and



15 females. The ten largest males range from 30 to 34 mm. in length, averaging 30.2 mm., the ten largest females from 34 to 39, averaging 36.1 mm. The sexual difference in size is definite if not great. The males bear small, slightly raised, nuptial pads on the inner side of each first finger. These pads are smooth and entirely unpigmented. The type, however, is described by Boettger as having brown nuptial pads, so my males were probably not at the height of their breeding season when taken, a conclusion substantiated by the lack of any great amount of loose skin on the throat. As might be predicted under such circumstances, their forelimbs are not enlarged, nor can I detect any sexual difference in color.

DESCRIPTION OF TADPOLE.—Length of body twice its width; tail about twice as long as body, two and a half times as long as deep. Nostrils slightly nearer to eye than to tip of snout, almost as far apart as eyes. Eyes lateral, about as far from snout as from spiraculum, which is without a tube and equally distant from snout and base of tail. Vent dextral, situated above the lower border of the subcaudal crest. Tail acutely pointed, crests extending over back to snout in immature individuals, not as far forward in more advanced specimens. Even when the legs are 8 mm. long, the crest still extends a short distance along the back. The body of a typical individual with leg buds some 2 mm. long measures 10 mm.

The teeth of the upper lip are in one long, continuous and one long, narrowly interrupted row; those of the lower lip in three long, uninterrupted rows. A double series of papillæ borders the lips but is broadly interrupted along the middle of the upper lip. Extra papillæ are present in the corners of the mouth.

In life, this tadpole, previous to the budding of the hind limbs, is jet black above with two broad, gold bands extending from the snout backward between the eyes and along the back on to the edge of the muscular part of the tail, where they become narrow and soon disappear. The belly and lower side are unpigmented. The crests are transparent and colorless and some silver is present on the coils of the intestines. As the tadpole matures, the black of the back and tail grows much less intense and the bands become greenish, while the tail crests develop dark spots and become less transparent.

Adult *simplex* were common at Nodoa as early as the first part of January, so they must be more or less evident all the year round. Their tadpoles were abundant in flooded rice fields and the more permanent pools so numerous throughout the rolling country about Nodoa. I have a metamorphosing individual that was killed April 23 and another with leg buds only 1 mm. long killed June 11. These data indicate a protracted breeding season and certainly do not, by any means, show its extreme limits, for the specimens were collected only at random.

It was interesting to note that the jet-black, immature tadpoles were remarkably delicate and seemed unable to rest on the bottom of an aquarium due to their very deep tail crests. They were compelled to

swim about constantly and, being weak, soon succumbed to a life of confinement. Certainly they are adapted to an existence in quiet pools containing abundant vegetation. On the contrary, mature examples were quite hardy and extremely sluggish, even to the extent of leaning against objects or lying on their backs for some minutes. They were not handicapped by the large crests of the immature specimens. Their behavior, too, is well suited to life in sluggish water. Thus, we see that the change in color and form is accompanied by one in behavior.

### Ranidæ

#### OÆIDOZYGA

Smith (1916) has described the differences between tadpoles of the two forms treated below and the following key is based upon his data.

- I.—Upper tail crest extremely well developed and conspicuous anteriorly where it is festooned and about four times as deep as the lower. . . . . *O. lima*.  
 II.—Upper tail crest low anteriorly and, at its highest point, scarcely deeper than lower. . . . . *O. lævis martensi*.

#### *Oæidozyga*<sup>1</sup> *lævis martensi*<sup>2</sup> (Peters)

A large series of specimens from Nodoa represents this form (A. M. N. H. 25971–26219).

Although this frog was recorded by Boulenger from Bhamo, a locality in Upper Burma near the Yunnan border, as long ago as 1887, it was not known from Chinese territory until Smith reported it from Hainan in 1923.

Boulenger called his Bhamo material *Oxyglossus lævis*. Smith (1916) has proposed that the larger form from the Malay Archipelago and Philippines be thus designated, the smaller mainland one, ranging through the Malay Peninsula, Siam, Burma, and Indo-China to southern China, as *lævis martensi*.<sup>2</sup> The two forms are distinguished chiefly by size, the mainland frogs (from Siam), according to Smith, seldom exceeding 28 mm. in length from snout to vent, the insular specimens reaching a length of 42 mm. Van Kampen (1923) gives the maximum length of *lævis* as 51 mm. and it may be assumed that he refers to an insular specimen. Data given below indicate that the greatest length reached on Hainan is 27 mm. Smith's conclusions in regard to size are thus well substantiated.<sup>2</sup>

I find that breeding males have a small nuptial pad with minutely granular surface on the inner side of each first finger. These pads are at

<sup>1</sup>Stejneger (1925) substituted *Oxydozyga* for *Oxyglossus* preoccupied, but Smith (1927) has shown that *Oæidozyga* Kuhl and Van Hasselt, 1822, is the correct form.

<sup>2</sup>Smith (1930) now considers this subspecies invalid.

best poorly developed and inconspicuous in the specimens before me. There seems to be no enlargement of the forelimbs correlated with these nuptial asperities.

The series of 249 individuals from Nodoa contains 184 specimens 18 mm. and less in length, the remaining 65 being made up of 51 females and only 14 males. These males range from 18 to 21.5 mm. in length, averaging 19.7 mm. The corresponding figures for the 14 largest females are 23 to 27 and 24.1 mm., respectively. Twenty-six of the entire series of 51 females range from 20 to 22 mm. in length. Sexual dimorphism in size is thus seen to be marked.

*O. laevis martensi* was abundant in the flooded fields about Nodoa. Smith (1923) found it as high as 1000 m. on Five Finger Mountain, Hainan.

No larvæ were secured. Smith (1916) records that they closely resemble those of *lima* but differ in having a low upper tail crest that is not folded like the large and conspicuous dorsal crest of that species. According to Van Kampen (1923), the distance between the eyes is twice as great as that between the nostrils in *laevis*, three to four times as great in *lima*. This point should be carefully checked because Smith states that the distance between the eyes is twice as great as that between the nostrils in *lima* and my material corroborates his statement rather than that of Van Kampen.

### *Oeidozyga*<sup>1</sup> *lima* (Gravenhorst)

#### Figure 10

One hundred and seventeen specimens were secured: 102 from Nodoa (A. M. N. H. 26234-335), 14 from Futsing Hsien (A. M. N. H. 29296-309), and one from Foochow (A. M. N. H. 30845). A series of tadpoles was collected at Nodoa (A. M. N. H. 27446).

Van Kampen (1923) gives the range of *O. lima* as from Bengal and southern China to the Malay Archipelago. I find the following records for China: Hainan (Boettger, 1888 and 1894, and Smith, 1923); Lilong (Müller, 1878); Canton (Boettger, 1888, and Stejneger, 1925); Lofao-shan (Boettger, 1887-8); Kwangtung (Vogt, 1914); Amoy (Wu, 1929 as *Osteosternum amoyense*); and Futsing (Stejneger, 1925). Mell (1922) gives Kwangtung localities, some of which are not easily found because he has used German names, omitting Chinese characters. "Logong," 75 km. east of Canton, and "Tsogokwahn," a village in the Shuichow region some distance east of that city, are the only places that I can

<sup>1</sup>See note one under *Oeidozyga laevis martensi*.

identify. There are two records for Hongkong (Hallowell, 1860, and Stejneger, 1925).

Wu (1929) based a new genus and species, *Osteosternum amoyense*, on specimens of *O. lima* from Amoy. Boulenger assumed that all species of the genus *Oxyglossus* possess a cartilagenous sternum, and Wu's genus is based upon this error. He admits that his new form cannot be distinguished from *O. lima* by external characters.

*O. lima* apparently reaches its northern limit at Foochow where it seems to be rare. I did not find it abundant in Futsing Hsien. About Nodda, it is the common rice-field frog and must be as abundant there

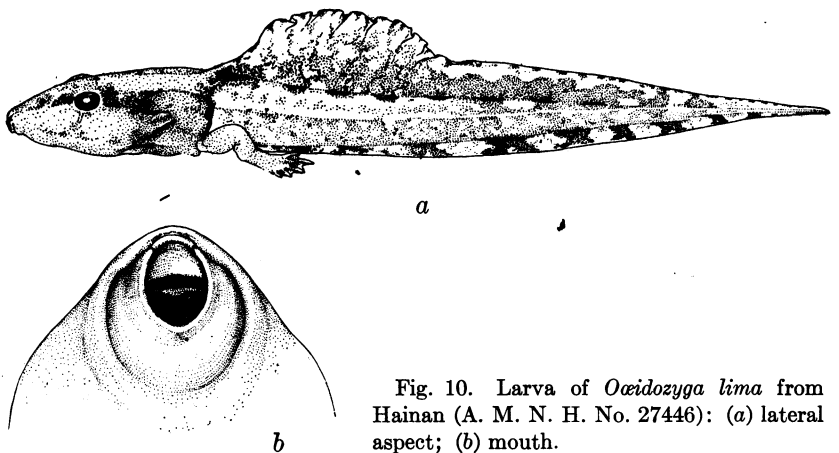


Fig. 10. Larva of *Oeidozyga lima* from Hainan (A. M. N. H. No. 27446): (a) lateral aspect; (b) mouth.

as at Bangkok (Smith, 1916). Mell states that it reaches an altitude of 300 m. in Kwangtung.

An examination of the large series from Nodda fails to reveal any enlargement of the forearm or modified skin on the first fingers of the males. Individuals of this sex may frequently be recognized by longitudinal folds of skin on the throat. The following data show that the females attain the greater size. After 31 juvenile individuals 12 or less millimeters in length had been discarded, 15 males and 56 females made up the remainder of the original series of 102 Nodda specimens. The 15 males ranged from 19 to 22.5 mm. in length, averaging 20.7 mm., while the 18 largest females ranged from 26 to 31 mm. and averaged 27.9 mm. In fact, only one female measured less than 19 mm. and 29 were from 24 to 27 mm. in length.

Smith (1916) has written an interesting paper on frogs of the genus now under partial consideration and emphasized, among other things, the thoroughly aquatic habits of *O. lima*. I found these frogs content to remain for days floating without support on the surface of water contained in a vessel with vertical sides. This fact may be taken as confirmatory of Smith's statements regarding their aquatic habits.

The tadpoles of *lima* were carefully figured and described by Smith who gives their total length as 33 mm., head and body 11 mm. The Hainan specimens, when mature, measure 23 mm. from the tip of the snout to the end of the tail, which is 17 mm. long. At this stage, the leg buds have reached a length of 2.5 mm. The largest tadpoles have leg buds 8 mm. long and measure 39 mm. from tip to tip, the tail alone being just 29 mm. long. These data illustrate the importance of designating the EXACT length of the leg buds at the time measurements are made. Many other tadpoles as well as this one grow a great deal after reaching maturity, i.e., between the time that the leg buds are quite evident and the imminent appearance of the forelimbs or commencement of caudal absorption. In the case of *O. lima*, the total length is almost doubled after the well-formed leg buds have reached a length of 2.5 mm.

It would be unnecessary to re-describe the unique form and habits of *O. lima* larvæ. In regard to the latter, Smith has brought out the following points: (a) sluggishness, (b) bottom-frequenting habits, (c) early use of larval legs, (d) carnivorous nature. I have confirmed all of these but the last and would like to add one, i.e., when alarmed, they often make short darts for safety in a characteristic way, a habit doubtless correlated with their sluggishness, sombre colors, and large but exceedingly limp, dorsal tail crest. If several specimens are placed in a vessel of water containing a small amount of débris or remnants of leaves, twigs, etc., and allowed to remain undisturbed, it will be noticed that they distribute themselves about, soon becoming completely concealed. How much of this interesting result is due to their form and color and how much to their behavior, it is impossible to say, but the result is, nevertheless, striking. If a single individual is annoyed, it will dart to another place and suddenly stop to remain motionless as before, the result being its disappearance as if by magic. If, however, the whole contents of the vessel is stirred, but without violence, the larvæ will be seen to float about turning over and over as if lifeless, their colors and limp tail crests causing them to resemble bits of débris floating around with them. This description fails to do justice to the unusual behavior of a char-

acteristic tadpole, but it at least assigns a use for its unique form and color. The high dorsal tail crest is not rigid enough to be of service in maintaining a balance and it is colored and formed unlike any other homologous structure that I know of.

I found these tadpoles abundant about Nodoa in grass-grown sections of flooded fields and irrigation ditches. They were collected only with some difficulty because of their sombre colors and bottom-frequenting habits.

### RANA

With the exception of *Rana rugulosa*, which is readily identified by the key preceding the "Annotated List of Species," the following synopsis includes all the larval forms of *Hyla*, *Rana*, *Polypedates*, and *Philautus* treated in this paper.

Tadpoles are notoriously hard to describe because they are soft and their body proportions change with growth. I do not believe that every specimen can be determined by use of the following key, but if habits and distribution are taken into consideration, no great difficulty should be encountered. The synopsis is specific rather than general and should not be disregarded or severely maligned if it does not always work. I hope that errors and misleading sections will be pointed out to me so that corrections and changes may be made.

#### KEY TO THE TADPOLES OF CERTAIN SPECIES OF *Hyla*, *Rana*, *Polypedates*, AND *Philautus* INHABITING FUKIEN AND OTHER PARTS OF CHINA

##### I.—Two rows of teeth in the lower lip.

A.—Lower lip bordered by a single series of papillæ which is uninterrupted; individual papillæ uniform in length; a single row of teeth in the upper lip. . . . . *Rana plancyi*.

B.—Lower lip bordered by two series of papillæ; individual papillæ of the outer series very long and fringe-like and well separated from those of the inner series; a single row of teeth in the upper lip.

*Rana macrodactyla*.

##### II.—Three rows of teeth in the lower lip.

A.—Not more than two rows of teeth in the upper lip.

1.—Body and muscular part of tail longitudinally striped (coloration most vividly contrasted in the youngest individuals); tail crest extending well on to back (especially in immature examples); mouth bordered by a double row of papillæ which is broadly interrupted in the center of the upper lip but continuous on the lower; many extra papillæ in corners of lips; all the papillæ about uniform in length.

- a.—Muscular part of tail largely pigmented (jet black in immature specimens), its lower border entirely lacking a light margin; lower sides and belly unpigmented. . . . . *Hyla simplex*.
- b.—Muscular part of tail partly pigmented (jet black in immature specimens) but possessing a distinct, light ventral margin; lower sides and belly unpigmented. . . . . *Hyla chinensis*.
- c.—Muscular part of tail partly pigmented (jet black in immature specimens) but having a distinct, light lower margin; sides and belly largely pigmented. . . . . *Hyla sanchiangensis*.
- 2.—Body and muscular part of tail not longitudinally striped; tail crest not or scarcely extending on to back; only the extremities of the upper lip bordered by papillæ which are never in a double series there; papillæ of lower lip continuous or interrupted but, if interrupted, either in a single series of short papillæ, or a double series of unequal length, those bordering the lip long and fringe-like.
- a.—Papillæ distinctly interrupted in the middle of the lower lip; long, bordering fringes never present (Central and southern China).  
*Rana limnocharis*.  
 (Northwestern China). . . . . *Rana n. mongolia*.
- b.—Papillæ of lower lip uninterrupted and about equal in length; arranged in a single series, the individual papillæ of which may be rarely crowded together.
- (1).—Size small, with measurements of a typical Ch'ungan Hsien specimen as follows: total length 28, body 9.5 and leg buds 5.5 mm. . . . . *Rana kuhlii*.
- (2).—Size large, with measurements of a typical Ch'ungan Hsien specimen as follows: total length, 59, body 22, and leg buds 10 mm. . . . . *Rana nigromaculata*.  
 (See page 515 for differences between the larvæ of the subspecies of *nigromaculata*.)
- c.—Papillæ of lower lip in a double series, those of the outer series long and fringe-like, very irregular and variable in number.
- (1).—A poison gland behind the mouth and one on either side of the belly posteriorly; teeth of upper lip in one continuous and one broadly interrupted row.  
*Rana latouchii*.

- (2).—No poison glands on belly; teeth of upper lip in a single row which is often broadly interrupted (due to wearing away).....*Rana adenopleura*.
- (3).—No poison glands on belly; teeth of upper lip in one long, continuous and one short, broadly interrupted row, which is often barely evident.

*Rana guentheri*.

B.—Three or more rows of teeth in the upper lip.

1.—Papillæ of lower lip interrupted in the middle.

- a.—Posterior half of tail, including crests, black; five rows of teeth in the upper lip. .*Philautus doriae*.
- b.—Posterior half of tail not black.

- (1).—A metallic spot (dull white in preserved specimens) on the tip of the snout; four or five rows of teeth in the upper lip. (Mainland of southeastern China and Formosa.)

*Polypedates l. megacephalus*.

(Hainan) . .*Polypedates l. leucomystax*.

- (2).—No metallic spot on the tip of the snout.
- (a).—Five rows of teeth in the upper lip; tadpole entirely devoid of pigment.

*Polypedates* species?

- (b).—Three, rarely four, rows of teeth in the upper lip; a black stripe, very irregular in outline, extending along the muscular part of the tail and produced forward along the upper side where it is less distinct. .*Philautus vittatus*.

2.—Papillæ of lower lip uninterrupted.

- a.—Papillæ of lower lip in a single series, the individual papillæ of which may be crowded together; usually three, rarely four, rows of teeth in the upper lip.....*Rana japonica*.

- b.—Papillæ of lower lip in a double series; a shallow notch in the middle of the lower lip; at least four rows of teeth in the upper lip.

*Polypedates dennysi*.

- c.—Papillæ of lower lip in more than two series; five rows of teeth in the upper lip.

- (1).—Papillæ of lower lip crowded and set close together in very poorly defined series.

*Polypedates oxycephalus*.



- (2).—Papillæ of lower lip in a double outer series, which is well separated from the single inner one; papillæ of single inner series set farther apart than those of the double outer one.

*Rana spinosa.*

III.—Four rows of teeth in the lower lip.

A.—Lower lip bordered by a single, uninterrupted series of papillæ; four rows of teeth in the upper lip..... *Rana asiatica.*

B.—Lower lip bordered by a double series of papillæ.

- 1.—Body and tail, including crests, sparsely and irregularly spotted with small areas of dark pigment variable in size and shape and irregular in outline; tadpole large, with measurements of a typical Ch'ungan Hsien specimen as follows: leg buds, 4, body 13, tail 25 mm.

*Rana* (species?).

- 2.—Body and tail not spotted as described above; size small, with measurements of a typical Ch'ungan Hsien specimen as follows: leg buds 2, body 9, tail 18.5 mm.

*Rana montivaga.*

**Rana rugulosa** Wiegmann

Plate XXII; Figure 11

A series of 156 specimens of this species was secured: one from Hok'ou (A. M. N. H. 30729), 24 from Ch'ungan Hsien (A. M. N. H. 28744-50, 28979-81, and 29490-503), two from Yenping (A. M. N. H. 28420-1), 41 from Futsing Hsien (A. M. N. H. 29026-66), one from Foochow (A. M. N. H. 30846), 86 from Nodoa (A. M. N. H. 26436-95, 26978-98, and 27177-81), and one from Yuankiang (A. M. N. H. 30955). Two lots of tadpoles were collected at Nodoa (A. M. N. H. 27440-1).

Schmidt's 1927 report included 37 additional specimens from Yenping, Ningkwo, and Changsha; but one of the Changsha frogs (No. 13151) is *Rana nigromaculata*, evidently included by mistake in the lot of *rugulosa*.

This species and its allies have been intensively studied by Boulenger and Annandale who do not agree on all the points in regard to them. This question does not interest us here because *rugulosa* is the only form at all widely distributed on Chinese territory, its nearest ally, *tigerina* (Boulenger's *forma typica*), being known in China only from southern Yunnan (Annandale, 1917, and Boulenger, 1920). I am following Stejneger (1920) and Schmidt (1927) in using the name *rugulosa* instead of *tigrina pantherina* (Boulenger, 1920). Exclusive of China, this form occurs in Burma, Siam, Indo-China, and Formosa, while Annandale has

reported it from Koh Samuie Island off the northeast coast of the Malay Peninsula, and the city of Madras, India (Boulenger, 1920).

Stejneger (1925) has made a careful study of the distribution and synonymy of *rugulosa*. The following records for Chinese localities are based upon his summary, although a few have been taken from more recent reports:

“Cap Syng-more,”<sup>1</sup> type locality of *rugulosa* (Wiegmann, 1835); Hainan (Boettger, 1888 and 1894, as *tigrina*; Smith, 1923, as *tigrina*

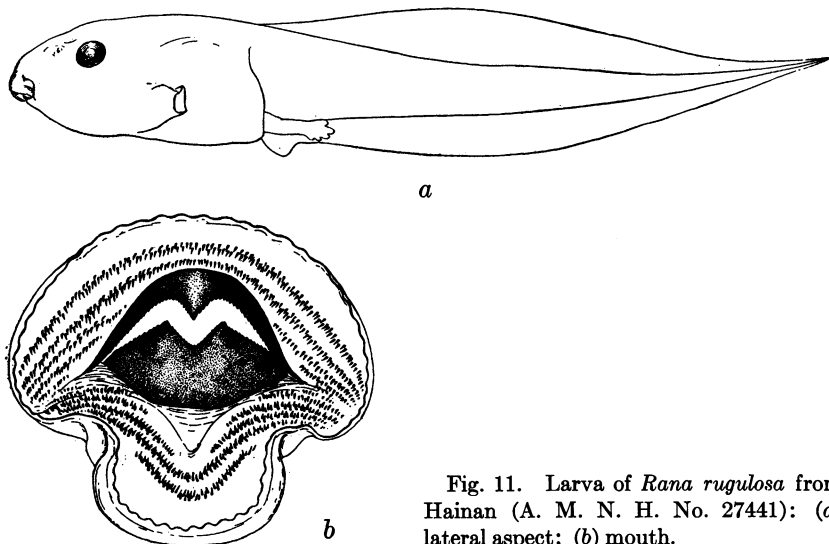


Fig. 11. Larva of *Rana rugulosa* from Hainan (A. M. N. H. No. 27441): (a) lateral aspect; (b) mouth.

*pantherina*); Canton (Boettger, 1885 and 1888, Wolterstorff, 1906, Mell, 1922, and Vogt, 1924, as *tigrina*); Kwangtung (Vogt, 1914, as *tigrina*); Fukien (Annandale, 1917); Foochow (Stejneger, 1925); Wenchow, southeastern Chekiang (Stejneger, 1925); Ningpo (Guenther, 1855, and Boulenger, 1882 as *tigrina*; and Boulenger, 1920, as *tigrina pantherina*); Shanghai (Boulenger 1882, Werner 1903, Wolterstorff 1906, as *tigrina*; Boulenger, 1920, as *tigrina pantherina*; Fitzinger, 1861, and Stejneger, 1925); Soochow (Gee, 1919, as *tigrina*); Kiukiang (Wolterstorff, 1906, as *tigrina*); Pinghsiang (Wolterstorff, 1906, as *tigrina*); Ichang (Barbour, 1912, as *tigerina*); Mt. Omei (Vogt, 1924, as *tigrina*); “Hotha” (Anderson, 1879, as *tigrina*).

<sup>1</sup>Apparently this is a locality on the northern coast of Lantao Island (or Tahsüshan) lying immediately west of Hongkong Id. It is spelled Syng-mun by Meyen in his ‘Reise um die Erde,’ Berlin, 1835, II, p. 189, etc.

Hongkong records are as follows: (Hallowell, 1860, Steindachner, 1869, Parenti and Picaglia, 1886, Boettger, 1894, Stejneger, 1907, as *tigrina*; Steindachner, 1869, as *tigrina pantherina*; and Fitzinger, 1861). Wiegmann's *vittigera* from Macao (1835) is included in Stejneger's synonymy. Formosan records are numerous (Stejneger, 1907, and 1925, etc.).

In Fukien, *rugulosa* is abundant from the lower valleys of Futsing Hsien to the base of the high mountains of Ch'ungan Hsien. It is common on the open plateau about Ch'ungan City, for some of our specimens were secured only a few miles to the southwest at Hsing Ts'un, but we saw no signs of it at San Chiang. We collected it again at Hok'ou on the Kiangsi plateau. The Yenping specimens were taken in the large valley near the city and not in the mountains where most of our work was done in that region. Apparently, then, it shuns mountains rather than altitude, a fact indicated by its presence on the Ch'ungan plateau at an elevation greater than we were able to find it in the Yenping mountains.

The external vocal sacs, moderately enlarged forelimbs, and comparatively small nuptial pads on the first fingers of the breeding males, have been described (Boulenger, 1920). In determining the sexual difference in size, I find that the series at hand are anything but well divided among the sexes, and this fact has necessitated examination of several series. (It should be noted that the Futsing and Ch'ungan lots have been omitted because of the great number of immature specimens included in them.) The resulting data, even though anything but uniform, show clearly that there is a fairly constant sexual difference in size, the females being the larger. Instead of attempting to write out these rather heterogeneous measurements, I will put them down in tabular form. The figures by the sex signs indicate the number of specimens of each sex more than 70 mm. in length contained in the various series, while the total lengths in millimeters of the largest individuals are written below in the columns. Locality names head each pair of columns.

There is little difference in size between the females from the various localities but the Hainan males are decidedly the largest, those from Formosa the smallest. I have failed to find any color dimorphism correlated with this one in size, as a careful comparison of specimens from all the series reveals only an average difference in the conspicuousness of the dorsal spotting, those from Ningkwo and Changsha being the most vividly marked in this respect. Schmidt has already noted this. Combining the various series, I find that the ten largest females range from 114

NODOA		FORMOSA		NINGKWO		CHANGSHA		YENPING	
20 ♀	6 ♂	0 ♀	14 ♂	10 ♀	5 ♂	11 ♀	2 ♂	0 ♀	2 ♂
122	99		82	119	89	118	84		81
121	97		78	119	89	113	84		77
121	97		78	100	89	111			
121	96		78	100	85	109			
118	87		78	98	76	97			
118	72		77	96		90			
114			75	96		90			
113			75	92		82			
113			75	92		82			
113			72			78			

to 122 mm. in length and average 119.1 mm., while the corresponding figures for the ten largest males are 84 to 99 mm. and 91.2 mm.

The voracious habits of this and allied forms are well known, and it was interesting to see recently metamorphosed individuals feed on the tadpoles of *Microhyla pulchra* and *ornata* which they picked out of shallow water with great alacrity. This observation was made on a series of young *rugulosa* kept in confinement at Nodoa where the form is extremely abundant.

I can confirm Smith's (1917) statement that there are normally two uninterrupted rows of teeth in the upper lip of the *rugulosa* tadpole. Examination of 79 Nodoa specimens fails to reveal a single one in which the second row is not continuous. In the Nodoa series, the maximum size is reached when the legs are quite long. The total length is then 62 mm., while the head and body together measure 19 mm. Smith gives the total length as 65-70 mm., that of the head and body 25 mm. The Hainan tadpoles must have proportionally longer tails but the difference is not great. Tadpoles with leg buds 3 mm. long measure only 15 mm. from tip of snout to base of leg buds. Smith describes two forms, one shorter than the other. I find that the width of the body is contained

about one and three-fourths times in its length, while the nostril is separated from the eye by a distance varying from one-third to one-fourth the space between the nostril and the tip of the snout.

As far as my knowledge goes, the larvæ of *rugulosa* (and certain of its allies?) are unique among ranids in possessing double sets of more or less alternating teeth to each row. This interesting fact seems to have been entirely overlooked in all descriptions, but Noble (1927) has mentioned it in his discussion of the value of life-history data. He also gives a figure.

### ***Rana limnocharis* Gravenhorst**

Plates XV and XXII; Figure 12

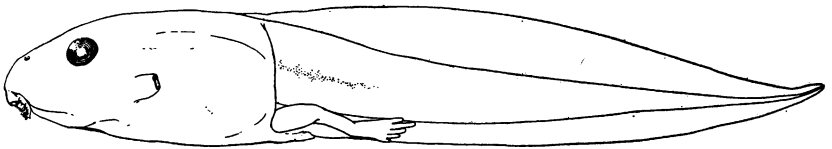
An enormous lot of 438 specimens represents this species: 62 from Ch'ungan Hsien (A. M. N. H. 28613-25, 28724-43, and 29435-63), 94 from Yenping (A. M. N. H. 28258-351), 46 from Futsing Hsien (A. M. N. H. 29190-7 and 29258-95), 100 from Nodoa (A. M. N. H. 26336-435), 35 from Yuankiang (A. M. N. H. 30920-54), and 101 from Tsinan (A. M. N. H. 27901-59, 28006-46, and 32944). In addition, there is a series of immature individuals from Ch'ungan Hsien (A. M. N. H. 29478). Numerous tadpoles were secured at Nodoa (A. M. N. H. 27439), and in Ch'ungan Hsien (A. M. N. H. 30627), while a single larva was collected in Futsing Hsien (A. M. N. H. 32955).

Schmidt's 1927 report included 266 additional specimens from Fukien; Futsing Hsien; Yenping; Wanhsien; Yenchingkao, near Wanhsien; Yochow, northeastern Hunan; Changsha; Chikungshan, southern Honan; Ningkwo; Wuhu; and Nanking. The collection of the American Museum also contains an adult and a series of tadpoles from Hongkong, Nos. 7571 and 7569, an adult from Pinghsiang (A. M. N. H. 905), and one from Fukien (A. M. N. H. 37108).

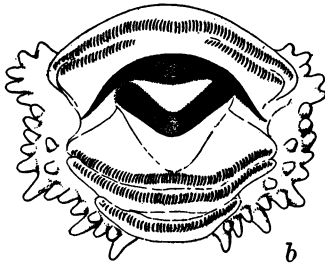
*R. limnocharis* is said by Boulenger (1920) to range "from Japan and China to India, Ceylon and the Malay Peninsula and Archipelago, eastward to the Philippines, Borneo and Lombok." It has been reported from "7000 ft. in Sikkim," and, "is, after *R. cyanophlyctis*, the commonest and most universally distributed of the Indian frogs." Numerous Formosan records may be found (Stejneger, 1907, etc.).

In China, this species has been reported from the following localities: Hainan (Boulenger, 1882, Boettger, 1888, and Vogt, 1913, as *gracilis*; Boettger, 1894, Boulenger, 1920, and Smith, 1923); Canton (Boettger, 1888, as *gracilis*; Vogt, 1924); Lilong (F. Müller, 1878, as *vittigera*); Whampoa (Hallowell, 1860, as *gracilis*); Kwangtung, to an altitude of

800 m. (Mell, 1922); Foochow (Wolterstorff, 1906, and Stejneger, 1925); Futsing (Stejneger, 1925); upper Min Basin, Fukien (Stejneger, 1925); Nimrod Sound, east of Ningpo (Wolterstorff, 1906); Ningpo (Guenther, 1858, as *vittigera*; Guenther, 1864, and Boulenger, 1882, as *gracilis*; Boulenger, 1920); Hangchow (Stejneger, 1925); Chusan (Boulenger, 1882, as *gracilis*); "Da Laen San, s. w. of Ningpo,"<sup>1</sup> Ketau Point,<sup>2</sup> and Dazeh Valley,<sup>3</sup> three Chekiang localities (Boulenger, 1920); Hangchow<sup>4</sup>; Shanghai (Steindachner, 1869, and Boulenger, 1882, as *gracilis*; Boettger 1894, Werner 1903, Stejneger 1925); Kiangyin,



a



b

Fig. 12. Larva of *Rana limnocharis* from Hainan (A. M. N. H. No. 27439): (a) lateral aspect; (b) mouth.

Kiangsu (Stejneger, 1925); Soochow (Gee, 1919); Tsingtao (Wolterstorff, 1906); Nanking (Wolterstorff, 1906, and Stejneger, 1925); Kiu-kiang and region (Wolterstorff, 1906); Pinghsiang (Wolterstorff, 1906); Hankow (Boettger, 1894, and Werner, 1903); "Jotschou," Hupeh,<sup>5</sup> (Vogt, 1924); Ichang (Swinhoe, 1870, as *gracilis*); Szechwan (Boulenger, 1882, as *gracilis* and 1920 as *limnocharis*); Suifu (Stejneger, 1925); Mt. Omei (Stejneger, 1925); Yachow (Guenther, 1896, as *gracilis*); Chengtu (Vogt, 1924); Kwanhsien (Vogt, 1924); "Hotha" and "Ponsee," Yunnan (Anderson, 1869, as *gracilis*); and Kwangsi (Vogt, 1930). The

<sup>1</sup>Mr. H. W. Parker has been unsuccessful in an attempt to find specimens in the British Museum from such a locality, so it would best be left out of future reports.

<sup>2</sup>Written "Katang" by Boulenger, which Mr. Parker believes to be a misprint for "Ketau" (Kitao) or Ningpo Point, a headland directly east of Ningpo.

<sup>3</sup>Mr. Parker finds that this valley lies 50 miles inland from 'San Moan Bay,' which is undoubtedly the same as San Men Bay, located a little south of Nimrod Sound.

<sup>4</sup>My authority for this record is Mr. Parker's letter stating that the British Museum has a specimen from "Hang Chau," which certainly is a slightly inaccurate spelling of Hangchow.

<sup>5</sup>So designated by Vogt. I am unable to identify this locality.

following records really belong above: Hongkong (Guenther, 1858, as *vittigera*; Steindachner, 1869, and Boulenger, 1882 as *gracilis*; Boulenger, 1920); Kowloon (Wolterstorff, 1906); Teinzo and Me-tan-jà, in the Kakhien Hills near the Yunnan-Burma frontier (Boulenger, 1887, as *gracilis*); and the Man-Son Mountains of Tonkin, near the Kwangsi frontier (Boulenger, 1920).

I found *limnocharis* common about Nodoa, and Smith (1923) collected it at an altitude of 1000 m. on Five Finger Mountain, Hainan. Mell (1922) states that it is the commonest small frog of Kwangtung where it ranges to 800 m. Certainly there is no more abundant or universally distributed species throughout northern Fukien, where it ascends to at least 4000 feet in the larger valleys about San Chiang. The northern limits of its range in China seem to be Tsingtao and Tsinan in Shangtung; Chikungshan in southern Honan; Wanhsien in eastern Szechwan; and Kwanhsien and Chengtu in central Szechwan.

The largest specimen among 42 from San Chiang measures 46 mm. from snout to vent, exactly matching in size the largest among 101 from Tsinan, and being only 1 millimeter longer than the largest among 94 Yenping specimens. Thus, in spite of great differences in latitude and altitude, remarkable agreement in size for mainland eastern China is indicated. The maximum length in the Hainan series of 100 individuals is 52 mm. Boulenger (1920) gives measurements of 81 specimens from widely separated localities, and I find that the maximum size recorded by him is 67 mm., the length of a specimen from Malacca, while only 14 of his measurements exceed 52 mm.

The forelimbs of breeding males are enlarged and nuptial pads present on their first fingers, while the sides of their lower jaws are, as a rule, conspicuously pigmented. Some color is always evident there in this sex. These points have been summarized by Boulenger (1920) also. Sexual dimorphism in size is moderately developed. The series of 94 specimens from Yenping includes 47 females and 33 males more than 25 mm. in length from snout to vent. The seven largest individuals of the former sex range in length from 43 to 45 mm., those of the latter from 32 to 37 mm., averaging 33.8 mm.

Annandale, Smith, and others have given accounts of the habits of this frog, and I do not intend to repeat by recording my own observations that agree well with theirs, but I would like to state what I believe to be the method of egg deposition. This method is especially interesting to workers in China because it differs from that of any other Chinese species with which I am familiar. *R. limnocharis* is a gregarious breeder.

The sexes gather in great numbers in quiet water such as that of flooded fields and, after pairing off, float about on the surface. At intervals, the females duck their heads and, as their vents reach the surface of the water, eject the ova upon it. After some time, a large area becomes covered with the floating eggs which extend in a single layer and are barely adherent in small groups. Each egg is enclosed in a spherical, transparent mass about the size of a buckshot. A little later, all the eggs sink to the bottom. On July 4, 1926, at San Chiang, I attempted to count a mass of *limnocharis* eggs that had just been deposited in shallow water at the edge of a rice field. I had arrived just as the rising sun was dispersing the revelers, so I was not able to determine how many pairs were involved. The eggs numbered approximately 8000, even though my patience gave out when 4500 had been counted. They were spread over an area of perhaps 12 square feet.

A detailed study of this species would doubtless reveal interesting facts, some indication of which I discovered by constructing a low mud wall around a mass of eggs at San Chiang on June 8, 1926. Some time before the nineteenth, more eggs were deposited within the wall, while a second addition was made on that date, and a third on July 5. Obviously, the mud barrier did not stop return visits, and who knows but that it was the same frogs that came back to their initial breeding site? Why should newcomers select a spot hidden from their water-level view by the raised mud? It should be added that the site was not readily accessible to large numbers of these frogs for the area enclosed by the wall was only a few square feet in the midst of an expanse of flooded fields.

My tadpoles from Ch'ungan Hsien with leg buds 9–11 mm. long measure 13–15 mm. from tip of snout to origin of leg buds. Hainan specimens of the same age are some 2 mm. shorter and of a more slender build. I find no other difference. In both Ch'ungan Hsien and Hainan tadpoles, the row of papillæ bordering the lower lip is broadly interrupted. In this respect, they agree with tadpoles from Siam (Smith, 1916) but differ from Indian specimens (Annandale, 1918). Van Kampen (1923) states that the tail is less than twice as long as the body and that the spiraculum is equidistant from the tip of the snout and the base of the tail. I find that in the tadpoles from Hainan, as well as those from Ch'ungan Hsien, the spiraculum is distinctly nearer to the base of the tail, while in the Hainan specimens the tail is frequently twice as long as the body.

The following data on the rate of development were secured through examination of a developmental series collected at San Chiang in 1926.



The eggs, supposedly deposited on the night of June 7, were still perfectly spherical at 4 P.M. of the eighth, although development was obviously progressing. The tail bud was quite evident at 10 o'clock the following morning, while adhesive discs were present at the same hour, June 10, and gill buds were just appearing on the morning of the eleventh. Two days later, at 8 A.M., the external gills were gone, the lips partly formed, and the edges of the mandibles pigmented. The outer row of the upper, the inner row of the lower labial teeth, were well formed at 6 P.M., June 15, but the final rows were not present even by 2 P.M. of the nineteenth when the larvæ measured 5 mm. from snout to vent. At 11 A.M. of June 23, the dental formula was complete and the larvæ had increased in body length to 6.5 mm. The last larvæ of the series, dated July 5, have leg buds 2 mm. long even though they measure only 8.5 mm. from snout to vent, or 2.5 mm. less than an individual of the same stage in the series of larvæ collected at San Chiang. The above data show that larval *limnocharis* reaches maturity within 28 days, but the small size of these larvæ, raised as they were in semi-natural conditions, indicates that development may not have been entirely normal. This attainment of maturity at a small size may be explained by the probably higher temperature of the water in which the larvæ developed, a result of its isolation from that of the surrounding field.

Undoubtedly, many factors have worked together in producing a species as successful as *limnocharis* and certainly quick larval growth is not the least of these. Rapid development insures successful reproduction in countries where, at all altitudes, large areas of land are repeatedly flooded every year and irrigation ditches of universal distribution. It is obvious that at San Chiang *limnocharis* has followed native rice culture, because such regions do not naturally afford ideal mating sites for quiet water breeders.

### ***Rana kuhlii* Duméril and Bibron**

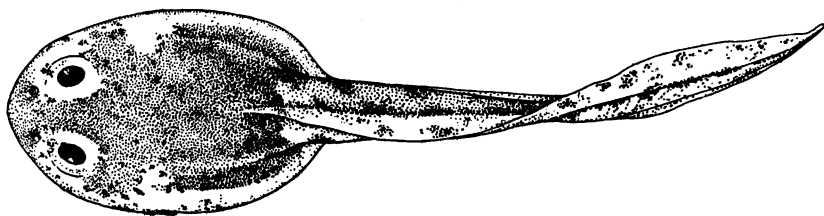
#### Plate XVI; Figure 13

A series of 99 specimens of this species was secured: 97 from Ch'ung-an Hsien (A. M. N. H. 28954-78, 29464-75, and 29685-744), and two from Yenping (A. M. N. H. 28467-8). Tadpoles were collected in Ch'ung-an Hsien (A. M. N. H. 29017 and 30607-8).

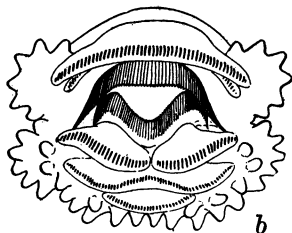
Boulenger (1920) and Van Kampen (1923) give the range of *kuhlii* as southern China, Loo Choo Islands, and Formosa to the Malay Peninsula and Archipelago. In doing this, they consider Stejneger's *namiyei*, described from the Loo Choo Islands, as synonymous with *kuhlii*. Van

Denburgh (1912) described and [discussed Formosan specimens but left the question of their exact identity "for future consideration."

In China, *kuhlii* is known from the following localities: Hainan (Smith, 1923); Lafaoshan, Kwangtung (Peters, 1882, described as *Nyctibatrachus sinensis*; Mell, 1922); "Ding-wu-shan" and "Nam-gong," localities near Canton (Mell, 1922); northern Kwangtung (Mell, 1922); Kuatun (Boulenger, 1899); Soochow (Gee, 1919); Kuling<sup>1</sup> (Annandale, 1917, as *namiyei*); the region of Talifu (Mell 1922); and "Hotha," western Yunnan (Anderson, 1879). Both Anderson (1879)



a



b

Fig. 13. Larva of *Rana kuhlii* from Ch'ungan Hsien, Fukien: (a) dorsal aspect; (b) mouth.

and Boulenger (1887) have reported *kuhlii* as common in the Kakhien Hills near the Yunnan-Burma frontier, and Annandale (1917) recorded it from Hongkong.

In Fukien, I found *kuhlii* one of the commonest frogs of the high San Chiang Valley. We saw no sign of it in Futsing Hsien and found only two specimens at Yenping. Mell (1922) found this frog rare at low altitudes near Canton ("Nam-gong," 100 m.) but abundant from 600–700 m. in northern Kwangtung.

The female of this species is unusual in being smaller than the male. After the individuals of the series of 97 specimens from Ch'ungan Hsien measuring less than 35 mm. from snout to vent had been discarded, 47 males and 67 females remained. The 11 largest specimens of the former

<sup>1</sup>A summer resort in the mountains a few miles south of Kiukiang, much frequented by foreigners living in China. These mountains are the famous Lushan, also called Kuniu Ling and Chiu Ling.

sex ranged in length from 52 to 67 mm., averaging 55.6, while the corresponding figures for the latter sex are 48 to 58 mm. and 50.8 mm. Boulenger (1920) gives measurements of 43 specimens from widely separated localities and I find that the four longest individuals listed by him are males 87, 82, 81, and 76 mm. in length. These data fully corroborate mine. An explanation of this reversal in relative size of the sexes may be found in the well-known fact that male *kuhlia* possesses a very large head, a condition so pronounced that it more than makes up for a smaller body. This fact is clearly shown by the following table which gives measurements in millimeters of three examples of each sex. The head length was determined by placing one arm of the instrument behind the posterior extremity of the lower jaw, the other at the tip of the snout, while the body length is given as the distance from the posterior extremity of the lower jaw to the vent, measured diagonally. The total length is here taken as the sum of the head plus body length, a figure that comes to slightly more than the usual direct snout to vent measurement.

A. M. N. H. No.	SEX	TOTAL LENGTH	BODY LENGTH	HEAD LENGTH	HEAD WIDTH	HEAD LENGTH DIVIDED BY BODY LENGTH
28956	♂	71.0	39	32.0	28.0	0.82
29715	♂	63.0	35	28.0	27.0	0.80
29703	♂	60.0	33	27.0	25.5	0.82
29711	♀	62.5	41	21.5	21.0	0.51
29706	♀	55.0	35	20.0	18.5	0.57
29719	♀	53.5	34	19.5	17.5	0.57

Looking at this table one sees that a male 71 mm. long has a slightly shorter body than a female only 62.5 mm. in length, while a male measuring 63 mm. possesses a body 5 mm. shorter than this same female of approximately equal length (62.5 mm.). Considering the facts in a different way, it may be stated that in male *kuhlia* the head is fully four-fifths or 80 per cent as long as the body, while in the female it is only slightly more than half as long. It should be noted that the length of the head compared to its width is about the same throughout the series regardless of sex. In addition to a larger head, the males also have the pair of bony prominences in the front of the lower jaw developed to a much greater degree than the females. Boulenger (1920) states that the fingers of breeding males do not bear nuptial excrescences and that their arms are

not thickened. Such is not the case in the series before me for distinct pads are evident on the first fingers of the breeding males and their arms are slightly larger than those of the females.

This frog is especially interesting from an ecological point of view because, though obviously an aquatic form of the mountains and high altitudes (*vide* Boulenger, Smith, Mell, etc.), at San Chiang, it frequents neither the typical mountain streams nor the quiet waters of the flooded fields but is found in trickles, small quiet pools, open roadside ditches and drains (Plate XVI, fig. 1). It shuns cold springs, large mountain streams, swift water, and heavily shaded places on the one hand, the stagnant water of isolated pools on the other. Its local name "Ni Lin" suggests its habits, for this "ni" means mud. It is often seen in irrigation ditches extending along the edges of flooded fields where the water is usually in gentle motion, but I have never seen it abroad in the still water of the open fields. While it avoids the heavy shade of forests, it rather prefers the protection afforded by overgrowing grass and bushes because it is extremely secretive and subdued in its actions. When picked up, it can make only weak efforts to escape and its short hops are in strong contrast to the great leaps of the cascade species.

I heard *kuhlii* call only once and that was at San Chiang on the night of May 23. The call was weak but deep and sounded like the word "cocoa" repeated several times in a guttural fashion.

The eggs of this frog were found in the places ordinarily inhabited by the adults. They are laid in clusters of from two to twelve eggs each and, as a rule, adhere lightly to each other and grass stems or trash in the pools. They do not float on the surface but lie on the bottom when unsupported. Each egg is enclosed in at least two transparent sacs, the outermost 6 to 7.5 mm. in diameter, the one within this about 5 mm. in diameter. Sometimes as many as several hundred eggs are to be seen scattered about in a small area. On April 29 and 30, May 1, 4, 6, 10, and 21 and on June 5, 1926, newly deposited eggs were found in various places at San Chiang. The eggs are heavily and almost uniformly pigmented and about 2.5 mm. in diameter. In studying the early stages of larval development, I fail to detect any sign of typical adhesive discs.

Tadpoles just emerging were seen on April 29, 1926, near San Chiang, while a series ranging in age from immature specimens measuring only 6 mm. from snout to vent to individuals with leg buds 1 mm. long were collected there on June 3 of the same year (A. M. N. H. 30608). Two specimens with leg buds 5.5 and 3 mm. long, were taken at this same locality, July 14, 1925.

Smith (1917) has described the *kuhlii* tadpole, and my specimens agree with his description except that, instead of having a broadly interrupted inner row of teeth in the upper jaw, they have merely a rudiment of this row consisting of a trace on either side.

The habits of *kuhlii* at San Chiang become most interesting when compared to those of the various cascade forms also found there, for *kuhlii* shows no sign of similar sexual dimorphism in size or development of hard excrescences on body or limbs exhibited at least to some degree by all of them. It entirely lacks the sharp spines and shows only a trace of the enormous forelimb development of the males of *spinosa*, while the female, instead of being large, is reduced in size. Yet immature *spinosa* and adult *kuhlii* are so much alike that only a close examination will serve to distinguish them. These sexual differences are not the only ones, for the legs of *kuhlii*, though of large girth and provided with well-webbed toes, lack the strength exhibited by those of *spinosa*. Could *kuhlii* possibly mate successfully in a swift stream? Its lack of swimming power would be one handicap, the necessity of a small female bearing a large male, another, and the lack of a secure method of clinging together a third. If this is true, may not (male) *spinosa* with their spines and powerful forelimbs, (male) *andersonii* and *graminea*, with their reduced size, be "adapted" to life in cascades?

#### ***Rana phrynoides* Boulenger**

Walter Granger secured a single specimen of this species at Yunnanfu (A. M. N. H. 30847).

Schmidt's 1927 report included four additional examples, two collected at Yunnanfu and two in the Wutingchow District of Yunnan.

Previous to Schmidt's report, this species was known only from the type specimens described by Boulenger in 1917. Since the type locality is Tungschanfu, a locality in northeastern Yunnan, this frog, so far as known, is confined to that section of the Province. It will be interesting to see how the ranges of eastern *spinosa* and western *phrynoides* extend throughout the intervening provinces, Hunan, Kwangsi, Kweichow, and Szechwan. The former is already known to occur as far west as Ichang.

Few data on relative sexual length are available but adding measurements of the two Yunnanfu specimens listed above to those given by Boulenger, I find that the four males measure 109, 91, 90, and 70, the females 110, 93, 90, and 75 mm. from snout to vent. Such figures indicate that, as in *spinosa*, there is no sexual difference in size and that the two species reach approximately the same size.

The similarity between *spinosa* and *phrynoides* is striking, but my study of these forms substantiates some interesting differences brought out by Boulenger. I find that the breeding males of *spinosa* always possess spines on the inner surface of the first three fingers and that the breast spines are never divided into patches. Boulenger describes male *phrynoides* as having the spines only on the two inner fingers and in two patches on the breast, and one of the two Yunnanfu specimens before me has numerous spines distributed in just this manner. The absence of digital discs in *phrynoides* may indicate a choice of habitat different from that of *spinosa* but the spinous rugosities and enormous forelimbs of the breeding males more definitely indicate similarity of habitat. Field observations alone will settle this point which, in view of a recent discussion of the structure and function of digital pads in arboreal frogs (Noble, 1928), is of importance. It is idle to speculate on this particular case until field data are available.

#### *Rana spinosa* David

Plates XIII, XIX to XXII; Figure 14

A series of 187 specimens represents this species: 166 from Ch'ungan Hsien (A. M. N. H. 28888-97, 28901-29, 29479-89, 29575-684, and 29745-50), 14 from Yenping (A. M. N. H. 28170-7, 28465-6, 28540 and 30822-4), and 7 from Futsing Hsien (A. M. N. H. 29198-9 and 29406-10). Numerous larvæ were secured from Ch'ungan Hsien (A. M. N. H. 29009-10, 29024, 30604-5, 30610-1, and 30667-74), Yenping (A. M. N. H. 31074 and 31091) and Futsing Hsien (A. M. N. H. 29416).

In addition, Schmidt's 1927 report included one specimen from Pinghsiang; six from Futsing Hsien; and eight from Yenping. There are two tadpoles collected near Yenping by Caldwell in 1920 (A. M. N. H. 32945).

The history of this species, though short, is complex, a complexity due to the remarkable similarity between immature individuals and *kuhlii*, as well as the great variability in body and limb proportions and secondary sexual characters of adult *spinosa*.

Although Guenther listed *spinosa* from Ningpo as *kuhlii* in 1858 and 1864, it was really discovered by David in "Cascades of Kiangsi" and called *R. latrans* (1872), a name preoccupied (Steffen, 1915). David referred to it again in 1875<sup>1</sup> as *latrans* and *spinosa* from "Ouang-maotsae," a mountain village in Kiangsi near the Fukien boundary, east and a little north of Kienchangfu.

<sup>1</sup> 'Journal de mon Troisième Voyage,' II, pp. 250 and 253.

Guenther (1889) described *Rana boulengeri* from Ichang. Boulenger (1899) reported additional examples from Kuatun, while Wolterstorff (1906) secured it at Kuling,<sup>1</sup> near Kiukiang. In his 1920 Monograph, Boulenger placed *boulengeri* in the synonymy under *spinosa*<sup>2</sup> and listed new material from "Pingho"<sup>3</sup> and the Man-Son Mountains, Tonkin, thus not only clarifying matters but considerably extending the range of *spinosa*. Finally, Mell (1922) reported it as *boulengeri* from the Hunan-

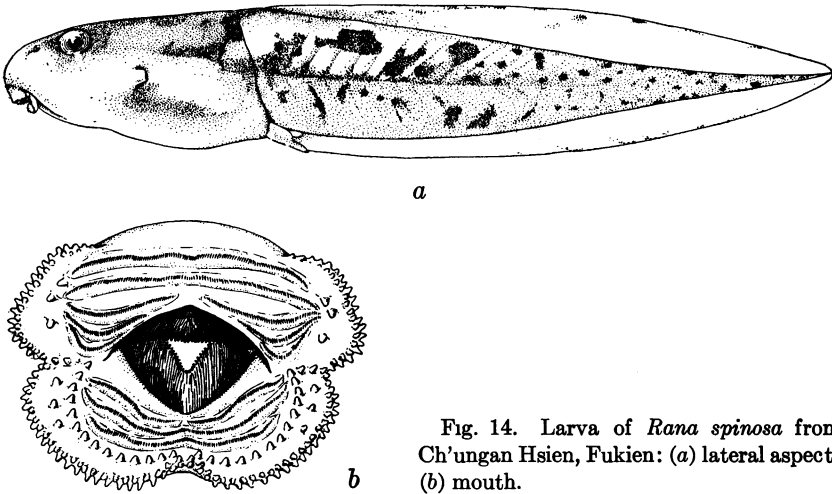


Fig. 14. Larva of *Rana spinosa* from Ch'ungan Hsien, Fukien: (a) lateral aspect; (b) mouth.

Kwangtung boundary; and the region east of Shiuchow, northern Kwangtung.

Annandale (1917) described tadpoles secured by himself on Hongkong as *kuhlii* larvæ but Smith (1924), after collecting material there, showed that Annandale's specimens really represented *spinosa*. Stejneger (1915) listed this species from the upper Min Basin, Fukien; Foochow; and Yenping. *R. spinosa*, then, is definitely known from Hupeh, Kiangsi, Chekiang,<sup>4</sup> Fukien and Kwangtung in China, as well as from Hongkong and Tonkin.<sup>5</sup>

*Rana courtoisi* Angel (1922) is, so far so I can determine, identical to

<sup>1</sup>See note under *Rana kuhlii*, p. 496.

<sup>2</sup>Boulenger states that the type locality of *iatrans* is Ichang, but Stejneger (1925) considers it to be "Cascades of Kiangsi."

<sup>3</sup>Probably an erroneous record. Mr. H. W. Parker has looked up the specimen ascribed to "Pingho" and informs me it was secured by Kreyenberg whose collections were described by Wolterstorff. No mention of such a place is to be found in Wolterstorff's reports.

<sup>4</sup>Fang and Chang (1926) described a frog as "*Rana* species" from Wenchow, which I believe was later identified as *spinosa* in a reference that I cannot place. If such is the case, this species is known from Wenchow as well as Ningpo in Chekiang.

<sup>5</sup>Two Szechwan frogs were doubtfully identified as *boulengeri* by Despax in 1913.

*spinosa*. The type locality of the former is Chiki, a town in southeastern Anhwei about ten miles northeast of Hweichow. Having failed to find any difference between the two forms in question, I have no results of my comparison to set down. If *courtoisi* is synonymous with *spinosa*, the range of the latter is extended somewhat to the northeast.

Vogt's *Rana duboisreymondi* was described in 1921 from Kuling, near Kiukiang, a locality whence *spinosa* had already been reported. Even though I have before me two specimens of this alleged new form from Mell's Kwangtung collection, I cannot find a single point distinguishing it from *spinosa*. I assume that these two individuals have been examined by Vogt who reported jointly with Mell on his Kwangtung material. Two of the points used to distinguish the new form from *spinosa* are just those in which the latter is most variable, i.e., leg length and arrangement of nuptial asperities. I fail to find a trace of Vogt's "Saugzscheibe" on the forelimbs, in the Kwangtung material. Judging by Vogt's reports (1921 and 1922), the range of his new species coincides with that of *spinosa*, a most unusual fact when it is remembered that closely allied forms are in question. Mell reported *duboisreymondi* as common in Kwangtung, but *spinosa* (called *boulengeri* by him) as rare there. Angel (1928) listed a form from Langson, Tonkin, as *R. duboisreymondi*. I found *spinosa* extremely abundant in northern Fukien where, as already remarked, it was extraordinarily variable, so much so, indeed, that the Chinese called it by two names.

In view of the above details, I do not consider it necessary to go farther into the matter and, until new evidence to the contrary has been presented, I prefer to consider *spinosa* the sole giant cascade frog of eastern China, the male of which develops nuptial asperities on the breast during the breeding season.

Mell found *duboisreymondi* in southern as well as northern Kwangtung but states that it was most abundant from 500 to 900 m. altitude. He gives definite records for "Ding-wu-shan" and "Lo-fau-shan," the former west, the latter east of Canton.

*R. spinosa* shows little or no sexual dimorphism in size. The series of 166 specimens from Ch'ungan Hsien includes only 92 individuals measuring more than 47 mm. from snout to vent. Fifty-one of the 92 are male, the remaining 41 female. The ten largest males range from 82 to 125 mm. in length and average 95.6 mm., while the ten largest females range from 81 to 118 mm., averaging 93.2 mm. The largest male (A. M. N. H. 28888) seems to represent the maximum size attained by the species, for I find none appreciably larger among my series or in



printed records.<sup>1</sup> On the other hand, A. M. N. H. 29575 measures only 52 mm. from snout to vent but is in possession of a full set of black-tipped rugosities across the breast, indicating sexual maturity. A male 75 mm. long shows no signs of roughness on the breast and this, together with the general lack of uniformity in development of the spines in a large series of males, is sufficient evidence to prove that these spines are a by-product of testicular activity. Their extreme development is met with in two males of my Ch'ungan Hsien series, one only 89 mm. long (A. M. N. H. 29655), the other 125 mm. in length and the largest of the entire series, No. 28888. In the latter, even the third finger bears some 30 black-tipped spines, while rugosities are present on the throat to within 18 mm. of the tip of the snout, and on the belly to a point only 52 mm. from the vent. The two extreme spines are 59 mm. apart. The greatest diameter of the enormously enlarged forelimb just equals that of the tibia, 22 mm. In the smaller male (No. 29655), the distribution of the rugosities is much the same but they are even larger in proportion and much more profuse. The seasonal development of these sexual characters must be very rapid or else more cases of extreme stages would be met with. For the present, it is interesting to consider *spinosa* the culmination of adaptive sexual dimorphism, coupled with digital development found to a certain degree in *phrynooides* of Yunnan. That western form lacks digital swelling and its spines do not meet across the breast or develop on the third finger as in *spinosa*. A wider distribution of the spines must render the mating process more sure, while terminal finger and toe pads should enable the frogs to progress on the slippery rocks of their mountain streams.

A. M. N. H. 29658 is an albino that, in life, was light yellow with pink eyes.

Adult *spinosa* rivals *ricketti* in abundance throughout the mountain streams of northern Fukien from the low coastal ranges of Futsing Hsien to the highest mountains about Kuatun. I heard *spinosa* calling in the Wu I Hills on the Ch'ungan plateau, near Ch'ungan City. There, low hills stand isolated on the open plateau and are completely deforested, so the presence of *spinosa* there may be taken as indication of its ability to survive long after forests have disappeared. I have no evidence that *ricketti* is able to do so and an explanation of this difference may lie in the habitat preferences of the two species. *Rana spinosa* is a lover of protected pools and deep recesses among boulders, *ricketti* of slippery,

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<sup>1</sup>The type of Angel's *R. courtoisi* measures 126 mm. from snout to vent thus rivaling my largest specimen in size, while Angel (1923) records another male *courtoisi* as 130 mm. long.

forest cascades and shaded stretches of water flowing swiftly over and among countless rocks and boulders. The destruction of forests not only reduces the flow of water but allows the sun to enter and dry out every unsubmerged spot, thus eliminating the habitat niche that *ricketti* seems to require. The pool- and recess-loving *spinosa*, on the other hand, can find suitable retreat wherever water flows downward, over and among rocky formations, for there pools and cavities are sure to be found. About Kuatun, *spinosa* was so much in its element that it was found in every stream, large as well as small. The highest streams, often too small to afford sufficient shelter for the bigger individuals, were inhabited by small to medium-sized examples and these went by the local name of "Kao K'ung Tze," which is to say, the high cavity "thing" or form. The largest specimens from the valley streams were called 'Shih Lin,' this Shih signifying rock. The Kuatunites insist that two distinct forms occur, stating that one is small and yellow, the other large and black. This yellow hue is, I am sure, a sign of youth. I hope that future collectors will try to recognize this distinction so explicitly believed in by the Kuatun Chinese, because there is still a possibility that they are right.

*Rana spinosa* is prized as an article of diet and may be bought in all the mountain towns of northern Fukien. It brings a much higher price than *rugulosa* and is, therefore, consistently persecuted. The art of frogging is so well established at Kuatun that special paraphernalia, consisting of a basket for kindling and an iron fire-basket supported by a long handle, have been devised and are kept in constant use. (See Plate XVII, fig. 1.) Needless to say, *spinosa* is the principal booty brought in from the nightly excursions of these energetic Fukienese. The fact that it has successfully resisted its human enemies for so many centuries speaks for its vigor. Long before the coming of the Chinese, in the days when Fukien was but sparsely inhabited by mountain tribes, *spinosa* must have made the primeval forests resound with its trilled base notes, a sound rivalling in volume and depth that of any frog I have ever heard. Another note is often given but it is a weak monosyllable and reminds one of the sound of a hammer brought down upon a small but long pipe filled with water. In 1871 (pp. 76-77) David wrote, "La *R. latrans* mérite ce nom à cause de son cri qui imite de loin un aboiement profond."

The eggs of *spinosa* are laid in mountain streams but the exact site of deposition varies considerably with altitude. For example, in the highest part of the comparatively level but greatly elevated Kuatun valley, egg masses were found in patches of grass growing in a stream,

while those seen at much lower altitudes were carefully placed near or in cascades. This greater carelessness at high altitudes is only what would be expected because there the streams are virtual springs, without exception leading to swift streams and the larvæ are sure to eventually reach cascades. On the other hand, at low elevations, such carelessness might result in the larvæ's hatching out in quiet water and being washed into ditches or pools from which they could never escape. Humidity, air and water temperature, and relative abundance of individuals are also important factors in choice of egg-laying sites.

I saw no less than 36 clusters deposited in almost as many places, so, in order to give a definite idea of the adaptability of the species in choice of breeding site, I will append the following details:

7 clusters: attached to roots under the bank of a cascading stream. These clusters were observed in three sites, two of which had been revisited.

5 clusters: attached to the exposed, bare surface of solid rock forming either the bottom of a depression near the main current or that of a side pool.

4 clusters: attached to the lower surface of boulders lying directly over the main current.

3 clusters: attached to rubbish or vegetation of a side pool.

2 clusters: attached to the lower side of boulders covering side pools. (See Plate XIII, figs. 1 and 2.)

2 clusters: attached to rocks and rubbish in a spring; also to the banks.

2 clusters: attached to vegetation of a side stream.

2 clusters: attached to small stones in the main stream.

1 cluster: attached to the lower surface of a boulder over a side stream.

The only generalizations that I can draw from my observations are: (1) the eggs of *spinosa* are always deposited under water; (2) they are usually placed under some solid object bathed by the water of a mountain stream or spring. The details enumerated above serve to show how many exceptions there are to the second generalization, but it should not be forgotten that concealed clusters are found only with difficulty, while exposed ones are readily seen.

Every cluster examined was made up of numerous eggs, each inclosed in an outer sac or capsule about 18 mm. in diameter and an inner one only 13 mm. in diameter. These sacs are transparent and vary greatly in size but the above dimensions represent rather large ones. I also have records of outer sacs 20 mm. in diameter, as well as very much smaller ones. Much mucus is held in the sacs. Every egg is attached to some object by a thick mucous cable and may also be joined to adjacent capsules by additional cables. If the eggs are thickly set, as frequently is the case, the cables are more or less continuous near their points of attachment to their common base. The cables are approximately 20

mm. in length but they may be much longer or shorter. The area of rock covered by the central mass of one cluster measured two feet by eight inches, while the most extensive mass seen was eight feet long by one to two feet across. It was, however, made up of eggs in two stages of development. None of the clusters examined by me was contained in a single, continuous mass and they were often widely scattered. It was possible to make out small groups of eggs but such groups varied in size, some containing as many as a dozen eggs but others were made up of only one or two. The number of eggs included in a whole cluster seemed to range from a few score to more than 800. I made counts and estimates as follows: 836 (an actual count), 500, 475, 300, 200, 100, 100, 88, and 65. I have shown elsewhere that *spinosa* becomes sexually mature before attaining full size, so it may be concluded that the low counts represent clusters deposited by small adults. One female was found to contain 410 ripe ova as well as a lot of smaller ones obviously immature. A second specimen held only 124 mature ova together with a batch of smaller ones in an earlier stage of growth. Here is an explanation of the frequent discovery of clusters containing eggs apparently deposited at different times. The same female doubtless returns to her initial breeding site when more of her ova have matured. Individual eggs are partly pigmented, both before and after deposition, and are of anything but a constant size. The largest seen were about 5 mm. in diameter, but 4 mm. may be taken as the average size because I have measurements of eggs from two sets, the larger 4 mm., the smaller 3.5 mm. in diameter.

I was repeatedly surprised at the great effort required to dislodge *spinosa* egg capsules from their moorings of mucus, so it is little wonder that floods do not wash them away. Then again, the individual attachment of each egg means that it must be removed separately. The capsules cannot be torn off in bunches. This method of attachment may be considered vastly superior to that described under *graminea*, for there is no comparison between the effort required to dislodge the two types of clusters. It is necessary to literally gather the eggs of *spinosa*, while those considered under *graminea* may be removed in groups of hundreds.

Embryonic and larval development are extremely slow. This is shown by examination of a developmental series (A. M. N. H. 31106), the eggs and embryos of which grew under normal conditions at Kuatun. The first eggs were taken July 6, 1926, and showed little sign of cell division. The head and tail buds were not very evident until the eleventh when the embryos were still no longer than the diameter of the large yolks. Two days later, the embryos had greatly increased in length,

while, on the eighteenth, their external gills, though short and poorly branched, were well developed. On July 28, the larvæ had assumed their final shape, the edges of the mandibles were pigmented, and the lips partly formed, but no teeth had appeared. At this stage, one of the tadpoles measured 18.5 mm. from tip to tip, the tail alone being 12 mm. long. Finally, on August 9, at least five weeks after deposition of the eggs, the lower lips had received their full complement of teeth but the upper held only three of the normal five rows. One of the larvæ then measured 24.5 mm. from tip to tip, the tail alone occupying 16 mm. There was, of course, no sign of leg buds in this tadpole, for, as shown below, they do not appear until the head and body measure 20 mm.

I first found the eggs of *spinosa* in the San Chiang-Kuatun region on May 30, 1926 (Plate XIII), and saw the last cluster there just before my departure on August 28. About 68 per cent of the 34 clusters recorded in this region were seen from July 1 to 17, most of the others during the last part of June. The only Yenping record of eggs is for May 23, 1925, while the extent of the season in Futsing Hsien is indicated by the discovery on September 21, 1925, of capsules from which the larvæ had only recently escaped. These eggs, however, had been deposited at least two weeks before they were found.

The embryonic and larval development of *spinosa* is so slow that I doubt if evidence of the extent of the breeding season based upon the size of tadpoles is of great value. It seems to me that I rarely looked into a pool of a mountain stream in northern Fukien without seeing larvæ of this species and I am convinced that, even in Ch'ungan Hsien, one would find *spinosa* tadpoles abundant throughout the winter months. I have a tadpole with leg buds 4 mm. long that was taken near Kuatun May 30, 1926, and am quite certain that we found numerous other mature ones through May. On this same day, larvæ at least a week old were collected, so it may be assumed that eggs were being deposited during at least the last two weeks of May, 1926.

The first four Ch'ungan Hsien specimens with leg buds 1.5 mm. long picked at random from a large series measure 21.5 to 22 mm. from snout to origin of leg buds. If a tadpole takes five weeks to attain a body and head length of 8.5 mm. (see foregoing developmental data) many more weeks must be required for it to reach maturity at the sprouting of the leg buds, for in the meantime the body has had to more than double its length.

DESCRIPTION OF TADPOLE.—Length of body one and two-thirds times its width; tail two to two and a fifth times as long as body, three and a quarter to three and a

half times as long as deep. Nostril a little nearer to eye than to tip of snout; eyes laterodorsal, as far from spiraculum as from tip of snout; the distance between nostrils equal to five-sixths of that between eyes. Spiraculum sinistral, ending in a short tube, directed upward and backward, barely visible from above, plainly so from below, its tip twice as far from insertion of leg buds as from eye. Vent dextral, opening under a large fold of skin which overlies and is continuous with the ventral tail crest. Tail thick-set, with crests about equal in depth and very low anteriorly, not extending on to back; its end pointed, but not acutely so.

Mouth ventral, its width equal to the interocular space. Lower lip bordered by three rows of papillæ, the two outer rows arising from one base and separated from the third and inner row by a distinct space which disappears in the middle of the lip where the three rows come together. The double outer row is continued alone past the corners of the mouth and for a short distance along the edges of the upper lip. A few extra papillæ are present in the corners of the mouth. There are five rows of teeth in the upper lip, the first continuous, the second slightly longer than the first and very narrowly interrupted, the remaining three successively shorter and broadly interrupted. The lower lip contains three rows of teeth, the outer a little the shortest, the inner narrowly interrupted. The mandibles are black-bordered and with serrated edges.

The body is dark above but the middle of the back is often a little lighter than the rest of it. The belly is usually quite black, the tail conspicuously dark-spotted. In very young tadpoles there is a light area on the back just anterior to the origin of the tail, while a whitish spot shows through the skin on the upper right side, and the outer coil of the intestine, also plainly visible through the skin, is distinctly whitish.

Smith (1924) has described the tadpoles collected by him on Hong-kong but there are so many points of disagreement between my large series of well-preserved material and his description, that I have written out the characters as seen in my tadpoles. The present description is based upon several specimens with leg buds just appearing. They are remarkably uniform in size and form. A typical one with leg buds 5.5 mm. long measures 26 mm. from tip of snout to origin of leg buds and 83 mm. total length. There is, however, considerable difference in the size of metamorphosing individuals. One such specimen measures only 20 mm. from tip of snout to the posterior side of the hind legs, another, in the same stage of transformation, 35 mm., and yet the two were taken in the San Chiang region. Smith based his description upon a tadpole only 50 mm. in total length but I have large numbers of mature specimens 70 and more millimeters long.

The larvæ of *spinosa* inhabit pools of mountain streams. They were the most abundant tadpoles in the mountain streams visited by me in Fukien, and I always found them among the rocks and débris forming the bottom of the pools. The size of the stream and depth of the water seemed to make little difference because they were always present wherever a sufficient volume of water had gathered to form a pool.

***Rana plancyi* Lataste**

## Figure 15

A series of 27 specimens represents this species: one from Hok'ou (A. M. N. H. 30755), the rest from Tsinan (A. M. N. H. 28047-72).

Schmidt's 1927 report included a lot of 25 specimens from Wuhu and Ningkwo, and one individual from Changsha.

*R. plancyi* was described from Peking in 1880. Boulenger recorded specimens from Shanghai, Chusan, Ningpo, and Formosa in his 'Catalogue' 1882. His Formosan specimens undoubtedly represent *fukienensis* as shown on pp. 512-3. Boettger (1894) reported specimens from Hankow; Lushan, near Kiukiang; Shanghai; and the Ningpo region. Wolterstorff (1906) added Nimrod Sound, east of Ningpo; and Pinghsiang to the list of localities and included a specimen from the Kiukiang region. Annandale (1917) found it at the Tai Hu, near Soochow, a report confirmed by Gee's 1919 Soochow record. Jacot, in his article on Shantung Herpetology, 1923, lists two specimens, presumably from the Tsinan region. Stejneger (1925) states that the National Museum has specimens from Futsing; Foochow; Shanghai; Kiangyin, in Kiangsu; and Formosa. These Futsing, Foochow, and Formosan specimens of course represent *fukienensis*. Shaw (1929) describes six Peiping (Peking) specimens and lists an additional one from Nanking, while Slevin (1925) gives data on specimens from four Korean localities. It is most satisfactory to find that *plancyi* does not reach Foochow and Formosa, because very few frogs have a range that includes the coastal plains of Fukien and Formosa, essentially tropical in their affinities, and the distant Peking region with its temperate and northern fauna. Stejneger noticed in 1907 the differences between what he called Formosan *plancyi* and the Shanghai material that he used for comparison. My large series has merely enabled me to prove how constant the differences are. A detailed exposition of the characters distinguishing *fukienensis* and *plancyi* will be found under the former.

Even though the Hok'ou specimen is small, I feel sure of its identification. It is not surprising to find typical *plancyi* on the northern section of the Kiangsi plateau because the high ranges between Fukien and Kiangsi doubtless serve as an efficient barrier to many species. If *plancyi* and *fukienensis* intergrade, they probably do so in the lower plains and valleys of the eastern seaboard.

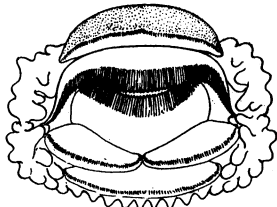


Fig. 15. Larva of *Rana plancyi* from Peking: mouth.

In spite of the fact that I have so many *plancyi* before me, I cannot give definite sexual differences in length because there are only two males of any size, one measuring 53, the other 51 mm. from snout to vent. The three remaining males are only 38, 37, and 33 mm. long. All five come from Tsinan. Eleven of the 21 Tsinan females exceed 40 mm. in length and measure 72, 70, 69, 67, 62, 60, 57, 56, 48, 47, and 44 mm. from snout to vent. The 12 Ningkwo and Wuhu frogs more than 31 mm. long are females, measuring 61, 61, 61, 58, 58, 55, 55, 51, 49, 48, 42, and 39 mm., averaging considerably less than the northern series. These data indicate that the females attain a size much greater than the males, which have, however, a moderately developed nuptial pad on each first finger, a point recorded by Boulenger in his Monograph (1920). The arm of the male is not enlarged.

The ripe ova of a female 69 mm. long (A. M. N. H. No. 28048) are 1.5 mm. in diameter, partly pigmented and approximately 3200 in number. A Tsinan specimen only 56 mm. long contains ripe ova.

DESCRIPTION OF TADPOLE.—Dr. Stejneger has very kindly allowed me to describe a larval *plancyi* secured at Peking by Dr. Alice M. Boring (U. S. N. M. No. 76173). Unfortunately, this tadpole is just enough mutilated to prevent the taking of some measurements and to make the determination of certain proportions difficult. The mouth, however, appears to be in full possession of its teeth but the following description, while not complete, should serve to establish the identity of the *plancyi* larva. No date accompanies the specimen which measures 14 mm. from tip of snout to origin of leg buds. The leg buds themselves are 8 mm. long.

Nostrils about equidistant from tip of snout and eyes, half as far apart as the latter. Spiraculum sinistral, slightly nearer to eye than to origin of leg buds. Vent dextral, its large orifice situated at the outer edge of ventral tail crest. The lower lip, corners of the mouth, and extremities of upper lip are bordered by a continuous row of even papillæ. There are a few extra papillæ in either corner of the mouth. The teeth of the lower lip are arranged in two rows, the inner, narrowly interrupted, the outer, continuous but a little the shorter. The single row of the upper lip is continuous and borders the lip between the ends of the lateral papillæ. The teeth of the lower lip, in contrast with those of the upper, are set on rather high, fleshy ridges.

It should be noted that this larval *plancyi* is characterized by fewer rows of teeth than found in any other toothed tadpole described in this paper. This point should be carefully checked and my entire description amplified by field workers.

### *Rana fukienensis* Pope<sup>1</sup>

Plate XXII; Figure 16

TYPE.—A. M. N. H. 29182; adult ♀, Futsing Hsien, northeastern Fukien Province, China; August–October, 1925; Clifford H. Pope, collector.

<sup>1</sup>The original description, which appeared in Amer. Mus. Novitates No. 352, May 20, 1929, is repeated here in full for the sake of completeness.





Fig. 16. *Rana fukienensis*, A. M. N. H. No. 29182, type: dorsal aspect, natural size.

DIAGNOSIS.—A species combining the characters of *nigromaculata* and *plancyi*. Its relation to *plancyi* is shown through the white stripe along the back of the thighs so characteristic of that species, the lack of an external vocal sac in the males, etc., while in general habitus and coloration it strongly suggests *nigromaculata*.

DESCRIPTION OF TYPE.—Vomerine teeth in two rounded groups between the choanæ, their distance from the latter about equal to the distance between them;

nostrils distinctly nearer to the tip of the snout than to the eye; toes fully webbed; tips of digits tapering, rounded, not at all expanded or grooved; subarticular tubercles distinct but small; inner metatarsal tubercle medium, its length half that of the fifth toe; an indistinct outer tubercle, no tarsal fold; an inconspicuous dorsolateral fold. The skin is generally smooth but finely granular on the posterior region of the back.

The color of the back in alcohol is grayish olive with a faint, middorsal, longitudinal stripe from the tip of the snout to the vent. The ventrum is light with very faint, gray mottling more distinct on the thighs. There are a few black spots on the posterior region of the back and irregular bars across the tibia. A distinct white band extends along the back of the thighs above which they are boldly mottled. A black band starts at the base of the thigh and extends forward along the side. It breaks into spots before reaching the insertion of the arm but is continued as a band along the posterior side of the arm to the palm. There is another black line from the shoulder to the angle of the jaw.

NOTES ON PARATYPES.—There are 15 paratypes from the type locality (A. M. N. H. 29183-9 and 29420-7) and four from Ch'ungan Hsien (A. M. N. H. 28946-9), all collected in 1925.

The American Museum also contains 16 specimens from Horisha, Formosa, previously identified as *plancyi*, that obviously belong here (A. M. N. H. 11597-601, 11615-7, 11628-32, 11634, and 11641). In the first appearance of this description, I included A. M. N. H. 30001, from Ch'ungan Hsien, among the paratypes. Re-examination of this juvenile specimen shows that it is *nigromaculata*.

As stated under *R. plancyi*, Stejneger's 1925 record of that species from Futsing, Foochow, and Formosa undoubtedly belong here.

The new form is distinguished from *plancyi* by the following characters:

1.—The metatarsal tubercle of *plancyi* is both longer and higher than that of *fukienensis*. Moreover, in *plancyi*, this tubercle is set at a distinct angle to the line of the toe, while in *fukienensis* it is almost parallel to this line. The following table shows the length of this tubercle compared to that of the toe in several females from localities as indicated. The toe length is taken as the distance from the outer base of its tubercle to its extremity. Measurements are in millimeters.

	LENGTH OF TUBERCLE	LENGTH OF TOE	LOCALITY
<i>plancyi</i>	5.5	8.0	Tsinan
	6.5	8.5	Tsinan
	4.5	8.0	Anhwei
	5.0	8.0	Anhwei
<i>fukienensis</i>	5.0	10.0	Futsing
	4.5	10.5	Futsing
	4.0	10.0	Formosa
	4.2	10.0	Formosa

It should be noted that Anhwei *plancyi* have relatively smaller tubercles than those from Shantung. Unfortunately, the height of the tubercle and its angle are not easily indicated in tabular form.

2.—The leg of *fukienensis* is distinctly longer than that of *plancyi*. The tibio-tarsal articulation of the former reaches to the center of the eye, while that of the latter barely reaches the tympanum. This difference is also shown by the following measurements of eight females taken in millimeters. The foot is measured from the inner base of the metatarsal tubercle to the tip of the longest toe.

	A. M. N. H. No.	TOTAL LENGTH	LENGTH OF TIBIA	LENGTH OF FOOT	LOCALITY
<i>plancyi</i>	28050	70	30	38	Tsinan
	28048	69	32	39	Tsinan
	21957	61	27	33	Anhwei
	21550	61	28	37	Anhwei
<i>fukienensis</i>	29184	70	34.5	41	Futsing
	29185	70	37	43	Futsing
	11599	70	36	41	Formosa
	11597	61	30	35	Formosa

The foot length in one Anhwei specimen rivals that of *fukienensis*, so again we see that Anhwei *plancyi* approaches *fukienensis*.

3.—There is a distinct difference in the dorsolateral folds of the two forms, for in *plancyi* they are uniformly broad, low and usually flaring, while in *fukienensis* they are either narrow or broad, high or low, and nearly parallel.

4.—Differences in coloration are the most marked of all. First, the light, mid-dorsal stripe extending from snout to vent, is uniformly present and often very conspicuous in all of the 36 specimens of *fukienensis*, while it is evident in only two juveniles among 45 examples of *plancyi*. Secondly, the back of the thighs above the stripe characteristic of both species is always boldly mottled in *fukienensis*, while this mottling is absent in three-fourths of the cases in *plancyi*, and present to only a limited degree in the remainder. Thirdly, in about half the specimens of *fukienensis*, the belly is faintly mottled, but this mottling is evident in only one of the 26 Tsinan *plancyi* and four of the 19 from Anhwei. An examination of living material will undoubtedly reveal additional color differences, but I am unable to find any in the preserved specimens. Jacot (1923) says that in life the belly of *plancyi* from Shantung is yellow, and I feel sure that if such had been the case in *fukienensis*, I would have noticed it.

A study of the above comparison is sufficient to convince one that Anhwei *plancyi* is a short step in the direction of *fukienensis*, and it is entirely possible that the acquisition of additional material from intermediate territory will furnish proof of complete intergradation. When seen in the field, *fukienensis* and *nigromaculata* resemble one another, especially in dorsal pattern and general habitus. Additional life-history data should show just how fundamental this similarity is. In the mean-

time, the following characters may be used in distinguishing the two forms: (a) the larger metatarsal tubercle of *nigromaculata*, (b) the numerous and conspicuous glandular ridges found between the dorsolateral folds of *nigromaculata* but not of *fukienensis*, (c) the presence of external vocal sacs only in *nigromaculata*, and (d) the light stripe along the back of the thighs, characteristic of *plancyi* and *fukienensis*, but entirely lacking in *nigromaculata*. There are minor color differences that need not be taken up here.

Six of the 20 Fukien specimens of the new species are less than 30 mm. in length. The remaining 14 are made up of six males and eight females. The males measure 47, 44, 39, 38, 37, and 36 mm., the females 73, 70, 70, 70, 63, 63, 61, and 58 mm. in length. The rapidly decreasing size of these males indicates that they are not fully grown, but well-developed nuptial pads on all but two prove them to be sexually mature. The two individuals lacking these pads were taken in the late summer, a fact, no doubt, accountable for their absence. Nine of the 16 specimens from Formosa are male and seven female. The former measure 50, 48, 45, 45, 44, 41, 40, 39, and 36 mm., the latter 70, 68, 61, 60, 55, 55, and 42 mm., from snout to vent. All of these males bear nuptial pads on the first fingers but, like the Fukien series, they are not uniform in size. Combining the four series and averaging the five largest of each sex, I find that the males average 47, the females 70.6 mm. in length. The figure for the females is probably a little nearer the true one than that for the males, but these results are based upon sufficient data to permit the conclusion that there is marked sexual dimorphism in size. Male *plancyi* are even more scarce, but, from the few available data, it seems that these two species have about the same degree of sexual differences in body length. The maximum size reached by females of the two species is almost identical and in both forms the males develop moderately large nuptial pads on the first fingers. In *fukienensis*, the forelimb of the breeding male is enlarged, a condition not detected in the meagre *plancyi* material. No sign of external vocal sacs can be seen in any of the Formosan males of the new form. Formosan females only 55 mm. long contain ripe ova, while the ova of a 68 mm. specimen are 1.3 mm. in diameter and half pigmented.

It is interesting to note that the tympanic membrane of the males from Formosa possessing nuptial pads equals that of the females in diameter, in spite of the great difference in size between the individuals on which the measurements were taken. In five males 45–50 mm. long, this membrane ranges from 5.5 to 6.0 mm. in diameter, while in five

females from 60–70 mm. in length it has almost the same range, 5.5 to 6.3 mm. Is this a seasonal development in the males or is this membrane of a constant size in the species, regardless of sex and body length?

***Rana nigromaculata nigromaculata* Hallowell**

Figure 17

A series of 284 specimens represents this form: 204 from Peking (A. M. N. H. 27504–707) and 80 from Tsinan (A. M. N. H. 27960–28005, 28073–102, and 28106–9).

Schmidt's 1927 report listed 135 specimens and a series of tadpoles from 26 miles south of Hsing Lung Shan, region of the old Imperial Hunting Grounds, northeast of Peking; and 50 additional frogs from Tsinan. The collection of the American Museum also includes examples from Manchuria, Nos. 5171–8.

Schmidt discussed in detail the subdivision of *nigromaculata* and published his data in the form of a table and a key to the three forms recognized by him. I find that, while all of his characters are not reliable in every case, it is possible to distinguish the subspecies by his key. Moreover, an examination of three series of larvæ, one from Chinszu, one from the region of Hsing Lung Shan, and the other from Ch'ungan Hsien, vindicates his subdivision.

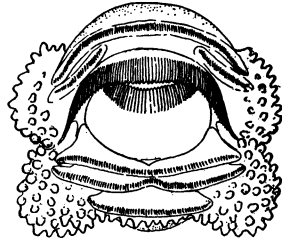


Fig. 17. Larva of *Rana nigromaculata nigromaculata* from Chihli (A. M. N. H. No. 14819): mouth.

Annandale (1917) and Okada (1926) have figured as well as described *nigromaculata* larvæ from Japan, so it is not necessary to repeat details already given by them. Suffice it to say that the Hsing Lung Shan tadpoles closely agree with their accounts, a fact virtually predicted by Schmidt in calling the northeastern form *nigromaculata nigromaculata*. The data enumerated below will serve to show the differences that I have found between tadpoles of the three series named above. These differences, as would be expected from the general similarity known to exist among *Rana* larvæ, lie chiefly in the structure of the lips and not at all in the arrangement of the teeth. (Figs. 17–19).

TADPOLES OF *R. n. nigromaculata* FROM THE REGION OF HSING LUNG SHAN.—These larvæ are distinguished from the other two forms by lips that flare outward laterally and ventrally and bear numerous papillæ that are never separated in the middle of the lower lip by more

than a notch. The chief point of variation is in the degree of ventral flaring. In the series of eight tadpoles, the papillæ never fail approximately to meet in the middle of the lower lip, even though they may or may not be mounted on an inward extension of the lateral expansion there. The skin of the belly seems to be more opaque than in either of the other forms. Unfortunately, the specimens are in such poor condition that body proportions cannot be determined with accuracy, but the maximum size is not great.

TADPOLES OF *R. n. mongolia* FROM CHINSZU.—The larvæ of this series are distinguished from those of typical *nigromaculata* by the lack of the marked lateral and ventral outward flaring of the lips and from typical *nigromaculata* as well as *reinhardtii* by the frequent absence of papillæ in the middle of the lower lip.

An examination of 28 *mongolia* larvæ shows the following results:

17 specimens possess a single, continuous row of normal papillæ bordering the lower lip.

4 specimens possess a broadly interrupted row of papillæ bordering the lower lip.

3 specimens possess a narrowly interrupted row of papillæ bordering the lower lip.

2 specimens possess a continuous row of very short papillæ bordering the lower lip.

2 specimens possess a single but very crowded row of papillæ bordering the lower lip.

Obviously, then, this form exhibits a strong tendency toward reduction of the lower lip papillæ. The frequent absence of bordering papillæ along this lip is not a character that varies with age, because examples with teeth entirely absorbed still retain a continuous row of papillæ there.

Two tadpoles of *mongolia* show the following dimensions in millimeters:

LEG BUDS	TOTAL LENGTH	LENGTH OF TAIL
4	39	25
12	46	28

TADPOLES OF *R. n. reinhardtii* FROM CH'UNGAN HSIEN.—These larvæ do not possess the outwardly flaring lips of typical *nigromaculata* nor are the central papillæ of the lower lip frequently absent as in *mongolia*. In fact, the papillæ bordering the lower lip in *reinhardtii* are not only constantly present in a single, unbroken row but they are never crowded, variable or uneven in length, and are always set upon a base which is continuous in line with the rather narrow, lateral aspects

of the lip. The above data are based upon 14 specimens in excellent condition (A. M. N. H. 30646). Although size is not a reliable character in defining larval forms, I venture to say that *reinhardtii* tadpoles attain a greater size than those of either typical *nigromaculata* or *mongolia*.

The following dimensions of *reinhardtii* larvæ will, when compared with those of *mongolia* given above, illustrate my point.

LEG BUDS	TOTAL LENGTH	LENGTH OF TAIL
3	47	30
19	67	41

The Ch'ungan Hsien larvæ are more conspicuously spotted and mottled dorsally than those from the North, a difference at least due in part to better preservation.

The youngest tadpole of the series taken in the Hsing Lung Shan region August 12, 1921, has a body 15 mm. in length and leg buds equally long, while fully half of the specimens are far advanced in their metamorphosis. Shaw (1929) states that, at Peking, these frogs appear about the middle of March, breed for the most part in April but also in May, and are rarely seen in October. He records advanced larvæ with four legs for June 30, 1929. It is not surprising that, in the region of Hsing Lung Shan, these frogs should have a rather more extended season than at Peking, because the mountains and forests near the former locality undoubtedly modify its climate.

#### ***Rana nigromaculata mongolia* Schmidt**

##### Figure 18

This form is represented by a series of 99 specimens from Chinszu, a locality about ten miles south and a little west of Taiyuanfu (A. M. N. H. 25667-85 and 25700-79). Tadpoles were secured from the same locality (A. M. N. H. 25614 and 32949).

Nineteen specimens from Niangtzekwan in Shansi, near the Chihli boundary, east and a little north of Pingting (A. M. N. H. 25801-19), may be considered as intergrades between the present form and typical *nigromaculata* found in the northeastern provinces.

The type locality of *mongolia* is Mai Tai Chao in northern Shansi, between Kweihsa and Saratsi. In his description, Schmidt (1927) listed 28 paratypes from the type locality; Kweihsa; and the base of Tei Pei Shan, Tsing Ling Mountains, Shensi.

A tadpole collected at Chinszu on July 17, 1922, measures 39 mm. from tip to tip but has leg buds only 4 mm. long, while another secured

three days earlier was beginning to metamorphose when taken, the forelimbs having just appeared. These meagre data give but little idea of the time breeding occurred at low altitudes in central Shansi that year.

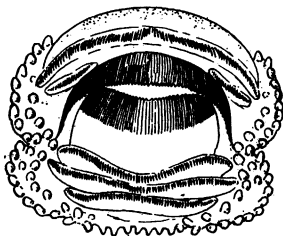


Fig. 18. Larva of *Rana nigromaculata mongolia* from Shansi (A. M. N. H. No. 25614): mouth.

The tadpole of the present form is compared to that of *reinhardtii* and typical *nigromaculata* under the latter.

The intensively irrigated plain at Chinszu affords an excellent illustration of the dependence of some amphibia upon man in the Far East. As one walks along paths leading through flooded fields of the famous Chinszu rice, hundreds of *mongolia* leap into the shallow water, members of an enormous and thriving population made possible only through the industry of the rice cultivators.

#### ***Rana nigromaculata reinhardtii* (Peters)**

##### Figure 19

A series of 70 specimens represents this form: 28 from Yenping (A. M. N. H. 28178-205), one from Kienning (A. M. N. H. 30812), 26 from Ch'ungan Hsien (A. M. N. H. 28831, 29434 and 30001-24) and 15 from Hok'ou (A. M. N. H. 30730-44). Tadpoles were secured from Yenping (A. M. N. H. 31070) and Ch'ungan Hsien (A. M. N. H. 30613 and 30646-7).

In addition, Schmidt's 1927 report listed 106 specimens from Pinghsiang; Yenping; Fukien; Yenchingkao, near Wanhhsien; Wanhhsien; Wuhu; Ningkwo; and Changsha. A. M. N. H. 13151, also from Changsha, was inadvertently listed under *R. rugulosa* by him.

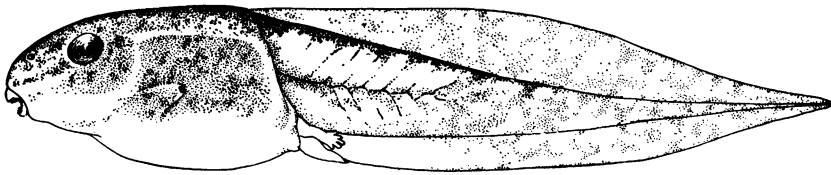
It is futile to try to work out the ranges of the forms of *nigromaculata* from the literature, but a few records showing the southern extent of the present form should be of special value: in Fukien, Foochow (Wolterstorff, 1906, as *esculenta chinensis*, and Stejneger, 1925); in Kwangtung, "Mahntsishan" near the Hunan border, north and a little east of Shiuchow (Mell, 1922); southwestern Hunan (Stejneger, 1925); and in Szechwan, Suifu (Stejneger, 1925).

The new series of 70 specimens from northern Fukien and north-eastern Kiangsi is made up of five juveniles less than 34 mm. in length from snout to vent, 44 males and 21 females. The 13 largest males range in length from 66 to 71 mm., averaging 67.0 mm., while 33 of the entire series of 44 are from 59 to 68.5 mm. long. The 12 largest females



range from 72 to 88 mm. in length and average 78.2 mm. Even though only two females are less than 62 mm. long, one measuring only 62 mm. contains ripe ova. Sexual dimorphism in size is thus seen to be marked. Breeding males bear a rather large, minutely granular nuptial pad on the inner side of each first finger. Their forelimbs are only slightly enlarged.

These frogs are widely distributed throughout northern Fukien where I found them common in the flooded fields at Hsing T'sun on the plateau and at San Chiang in the high mountains of the northwest. They were also abundant where we worked near Yenping. Records for Foochow have already been given. It would be interesting to know



a

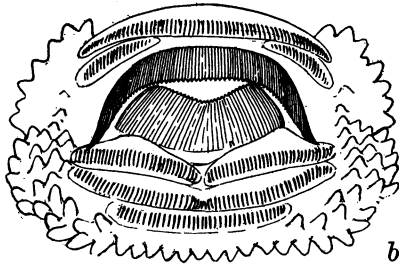


Fig. 19. Larva of *Rana nigromaculata reinhardtii* from Ch'ungan Hsien, Fukien: (a) lateral aspect; (b) mouth.

whether or not they actually descend to sea-level at Foochow, for it is entirely possible that the specimens forming the basis of Foochow reports were taken in the nearby mountains. I cannot understand why we did not secure examples in Futsing Hsien if they are so common on the Foochow plain. One would expect to find a northern form at high altitudes near the southern limit of its range. Very few species common as far north as Peking reach the sea-level plains of Futsing Hsien unmodified. *R. planeyi* long stood as an exception to this rule but is herein shown to be absent in Futsing Hsien where its place is taken by a near ally, *fukienensis*.

Six tadpoles with leg buds only 0.5 to 1 mm. long were collected in the rice fields at San Chiang on May 26, 1926. The largest individual

measured 10 mm. from tip of snout to origin of leg buds. On the tenth of July, three metamorphosing specimens were secured at the same locality. The tail was only half absorbed in the youngest but almost completely so in the most advanced larva. These data indicate an early mating period at San Chiang. The single tadpole from Yenping was found May 27, 1925, and measures 51.5 mm. from tip to tip, the leg buds being 6 mm. long, and shows that breeding at Yenping is still earlier than in Ch'ungan Hsien.

The tadpole of the present form is compared to that of *mongolia* and typical *nigromaculata* under the latter.

#### ***Rana noblei* Schmidt**

No additional specimen of this species has been received since its description in 1927. The type locality is Yunnanfu and the type (A. M. N. H. 5285) remains unique. It was diagnosed as follows: "Allied to *Rana nigromaculata*, from which it is distinguished by its more rounded snout, absence of dorsal folds between the dorsolateral folds, smaller metatarsal tubercle, and very different coloration." The specimen measures 91 mm. from snout to vent.

Schmidt suggests that this form may represent *Rana nigromaculata* in the Yunnan area.

#### ***Rana amurensis* Boulenger**

There is no new material in the present collection. Schmidt reported on the large series of 119 specimens from Hsing Lung Shan, a mountain village in the region of the old Imperial Hunting Grounds, northeast of Peking (A. M. N. H. 14570-681 and 14820-6).

*R. amurensis* was described from Kazakevitch, a locality a little above the junction of the Ussuri River with the Amur, Amur Province (Boulenger, 1886). Stejneger (1907) quotes records for Lake Khanka, directly north of Vladivostok; Chemulpo, Korea; and Nikolayevsk, Amurland. In addition, he includes the Kokonor specimens identified by Nikolsky (1905) as *amurensis*. Obviously, then, he has carried the range of *amurensis* far westward and practically beyond that of *asiatica*. In 1925, he again discussed *amurensis*, substituting for it the name *chensinensis*, a term applied by David in 1875 to frogs from the Tsing Ling Mountains of southern Shensi. The type locality of *chensinensis* is removed from that of *amurensis* by a distance of nearly 2000 miles, and it is my belief that Stejneger is not fully justified in substituting the former name for the latter. It is not within the scope of this paper to take up

such a difficult problem in detail but it is imperative that I set down certain reasons for refusing to follow Stejneger and attempting to retain, for the present at least, the name *amurensis* as applicable only to frogs from regions, let us say, east of 114° east longitude. In the first place, I have examined Stejneger's Shensi material as well as a specimen in the National Museum from Kokonor and fail to find any distinction between the former and my Shansi *asiatica*, while the latter, in my opinion, represents a distinct form, probably Nikolsky's *kukunoris* (1918). David's *chensinensis* I would place in the synonymy of *asiatica*. He refers to the brilliant red and yellow color of the ventrum, a condition apparently matching perfectly that recorded in my water-color of typical *asiatica* from northern Shansi. I find that the frogs from Hsing Lung Shan do differ from my northern Shansi specimens and would venture to say that the former are terrestrial, the latter aquatic.

I have purposely refrained from quoting certain locality records in order to avoid possibility of error. I believe that it is impossible to identify properly these grass frogs of northern China until more material is available because so many of the reports in the literature are not to be relied upon. Among the least reliable of the more doubtful ones are: Boettger (1894), specimens from Chinhai, near Ningpo; Mell (1922), Kwangtung-Hunan border, and Talifu, Yunnan.

Schmidt has already stated that the frogs from Hsing Lung Shan have a smaller web and narrower dorsolateral fold than the series of *asiatica* from northern Shansi. Unfortunately, the Hsing Lung Shan specimens are largely juvenile, only seven individuals exceeding 35 mm. in length from snout to vent. Four of these are females measuring 62, 57, 53, and 39 mm., the remaining three males 42, 42 and, 39 mm. in length. The males possess nuptial pads similar to those found in *asiatica* but not so well developed. The skin is comparatively smooth in both sexes and I fail to find hard tubercles such as those often seen in female *asiatica*.

### ***Rana asiatica* Bedriaga**

#### Figure 20

An even hundred specimens represent this form: 30 from Ma Ying Hai, near Ningwu (A. M. N. H. 30975-31004), nine from Kolan (A. M. N. H. 31013-21), one from Tsinglo (A. M. N. H. 25820), one from Chinszu, near Taiyuanfu (A. M. N. H. 25613), 39 from Sohuang, 5 miles south of Pingting (A. M. N. H. 25852-90), and 20 from Niangtze-kwan (A. M. N. H. 25780-99). In addition, there are two large series of

tadpoles: one from Ma Ying Hai, near Ningwu (A. M. N. H. 31012), the other from Kweihwa (A. M. N. H. 18095). All of the above localities are in northern and central Shansi, only two of them, Chinszu and Pingting, being as far south as Taiyuanfu.

Schmidt's 1927 report listed 103 specimens: 14 from Kweihwa, and 79 from Mai Tai Chao, a monastery between Kweihwa and Saratsi, as *asiatica*. I am also doubtfully including here a frog from Chikungshan, southern Honan, called *japonica* auct. by Schmidt (A. M. N. H. 13229).

For reasons outlined under *amurensis*, I am considering the range of *asiatica*, the type locality of which is Kansu and Ordos, to be restricted to an ill-defined region including eastern Kanzu, Ordos, and most of

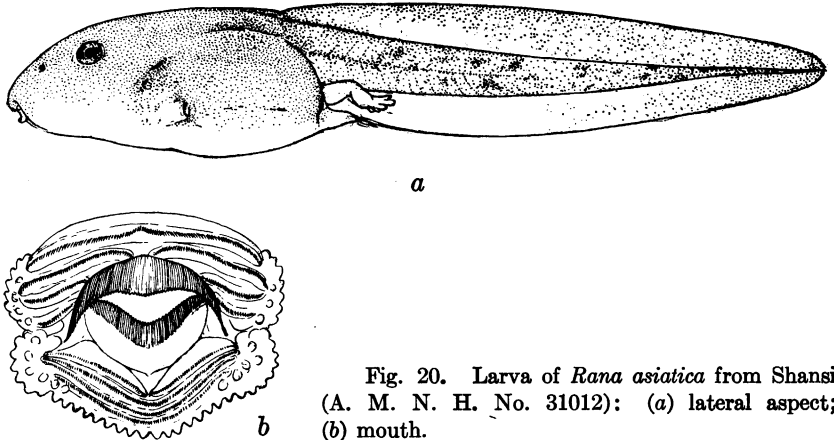


Fig. 20. Larva of *Rana asiatica* from Shansi (A. M. N. H. No. 31012): (a) lateral aspect; (b) mouth.

Shansi and Shensi. With this part of northern China as a center, the distribution of *asiatica* will have to be determined as additional material accumulates and is properly identified. Present records for China are for the most part too uncertain to be relied upon. Stejneger (1925) has discussed the distribution of this and allied forms but I cannot agree with his conclusions and therefore am not including his records, even though most of them are doubtless perfectly good. As I have said under *amurensis*, it is not within the scope of this paper to take up such a difficult problem in detail but, in order to do my share toward the attainment of a solution, I will describe the material before me which, though abundant, comes from a rather restricted area.

*Rana asiatica* is subject to great variation in northern Shansi. This is best illustrated by a series of 90 specimens, 60 males and 30 females,

from Kweihwa and Mai Tai Chao, localities removed from one another by only a few miles, the latter being between Kweihwa and Saratsi. In order to forestall the possible description of odd variants as new forms, I am describing the range of variation exhibited by this series in some detail. Almost any taxonomist would base new species upon certain specimens contained in this series, were they given to him in selected lots, each containing a definite type of variant, yet fully five-sixths of the entire series were taken in the immediate vicinity of Mai Tai Chao.

**SIZE.**—The males of this series are remarkably constant in size, the entire lot of 60 ranging only from 34 to 57 mm. in length, while among the 35 largest individuals the smallest seven are 42 mm. long. The ten largest males are from 52 to 57 mm. long with 53.4 as the average length. The females are not nearly so constant in size, the series of 30 measuring from 30 to 64 mm. from snout to vent, thus exhibiting a degree of variation more than twice as great as the males. The ten largest range in length from 43 to 64 mm. and average 53.8, or almost exactly the same as the males, in spite of the fact that four females among only 30 are longer than the largest of 60 males! It is also surprising to find a gravid female 38 mm. in length, or only slightly more than half as long as the longest individual.

**RUGOSITY.**—This is the most variable character detected in this series and, oddly enough, it is correlated with sex. Among the ten largest females only three are smooth, while seven show various degrees of roughness. The extreme development of rugosity is found in No. 18115. In this specimen, the lateral aspect of the body to the dorsolateral folds, the sides of the belly and the proximal half of the posterior face of the thighs are covered with numerous hard, rounded, whitish tubercles reaching their greatest size on the sides of the belly. Nine of the remaining 20 females show this rugosity to some degree. Thus, 70 per cent of the larger females and 45 per cent of the remainder are more or less rugose, but only one among 60 or 1.7 per cent of the entire lot of males exhibits any degree of rugosity. Examination of the series from Ma Ying Hai and Pingting fails to reveal a repetition of this remarkable roughness seen in the Kweihwa-Mai Tai Chao series, for in the former lots the rugosity is found only occasionally and to such a limited and variable degree that its correlation with sex is no simple matter. It seems probable that some local condition causes the extreme development of tubercles but it is impossible to say why they should appear in the females rather than the males.

**COMPARATIVE LENGTH OF METATARSAL TUBERCLE, FIRST TOE AND TIBIA.**—The tibotarsal articulation in the ten largest males reaches from the anterior corner of the eye to the tip of the snout, usually to a point between the eye and the nostril. In the ten largest females, it reaches from the center of the eye to between the eye and nostril.

The following table records some comparative measurements of these 20 longest individuals. The length of the first toe is measured from the outer base of the metatarsal tubercle to the tip of the toe. The length of this tubercle is taken along its base. All measurements are in millimeters.

A. M. N. H. No.	SEX	SNOUT TO VENT	LENGTH OF TIBIA	LENGTH OF TUBERCLE	LENGTH OF TOE
18120	♂	57	31.0	3.0	6.5
18150	♂	54	28.0	2.8	7.0
18181	♂	54	27.0	3.1	6.9
18183	♂	54	28.0	2.9	6.3
18221	♂	54	28.0	1.8	6.5
18177	♂	53	29.0	3.0	6.0
18152	♂	52	29.0	2.8	7.0
18154	♂	52	28.0	2.9	7.0
18158	♂	52	27.5	2.5	7.0
18105	♂	52	29.0	3.0	7.4
18187	♀	64	33.0	3.5	7.0
18114	♀	58	29.0	3.5	6.5
18115	♀	58	30.0	3.3	6.5
22073	♀	58	32.0	3.0	5.8
18116	♀	55	29.5	2.5	7.0
18184	♀	54	28.0	2.5	6.7
18208	♀	52	27.0	2.5	6.5
18153	♀	48	26.0	2.5	6.0
18118	♀	48	23.0	2.2	5.5
18159	♀	43	21.0	1.7	5.0

A great deal of variation in relative lengths is shown by this table, which may serve as a standard of comparison for *asiatica* with allied forms.

COLORATION.—I have before me a water-color of a Mai Tai Chao specimen of *asiatica* made from life, No. 22073. The back is dark olive with a weak tendency toward spotting. This same color is present on the dorsal aspect of the limbs which are, however, quite distinctly barred with a darker shade of the ground color. The belly and the ventral aspect of the limbs, including the webbing between the three inner toes, are bright red, brightest on the belly posteriorly. There are dark-edged, white reticulations on the chin. In recording *chensinensis* from western China, Stejneger quotes Sowerby and David as describing the bellies of their specimens as yellow, the underside of the legs red. The red of my water-color contains a shade of yellow which is especially evident anteriorly on the belly and this, as stated under *amurensis*, strengthens my belief that both Sowerby and David really collected *asiatica*.

The ventral aspect of the head in preserved specimens is often faintly mottled along its edge, rarely completely mottled. Ordinarily, it is immaculate.

NUPTIAL PADS.—The inner side of the first finger of breeding males bears a conspicuous, bulbous, gray pad with a granular surface. The pad is more or less completely divided into sections by transverse furrows, one for each joint of the finger. In its extreme development, it consists of four such sections. The forelimbs of breeding males are moderately enlarged.

DESCRIPTION OF TADPOLE.—Length of body one and two-thirds width; tail one and one-third to one and two-thirds times as long as body, four times as long as deep. Nostril slightly nearer to eye than to tip of snout; eyes laterodorsal, slightly nearer to tip of snout than to spiraculum, separated by a space equal to that between nostrils. Spiraculum sinistral, visible from below, scarcely so from above; directed upwards and backwards, not ending in a tube, equally distant from nostril and origin of leg bud. Vent dextral. Tail not ending in a point, crests about equal in depth.

The mouth is ventral and half again as wide as the distance between the eyes. The extreme ends of the upper lip, the corners of both lips, and the entire lower lip are bordered with a continuous, single row of papillæ. There are a few extra papillæ at the corners and ends of the lower lip within the continuous row. The upper lip bears four rows of teeth, the outer long and continuous, the rest interrupted and successively shortened. In the lower lip there are also four rows of teeth, the three outer continuous, the innermost narrowly interrupted. The three inner rows are of equal length but the outer is slightly shortened.

The body is brown above, the skin of the belly transparent but slightly pigmented laterally. The tail crests are clear or very faintly pigmented.

The above description is based upon a large series of well-preserved material from Ma Ying Hai, near Ningwu. A typical specimen, with leg buds 5.5 mm. long, measures 15 mm. in body length and has a tail 21 mm. long. The dental formula is constant in the entire series of 25 specimens. The Kweihwa material consists of 55 tadpoles not as well preserved. In them the dental formula is less constant, four among the 55 lacking the short, innermost row of the upper lip. This is probably the result of preservation. The Kweihwa tadpoles appear to be larger than those from Ma Ying Hai, in spite of the fact that the former are not as advanced in development as the latter. A typical Kweihwa specimen with leg buds 5 mm. long measures 46 mm. from tip to tip, the tail alone being 31 mm. long. Such a slight difference in size is not unusual in tadpoles from widely separated localities.

Some indication of the breeding season in northern Shansi may be found in the following data. The smallest specimens from Kweihwa are immature with bodies only 9 mm. long, while the largest have leg buds 7 mm. in length. All were collected June 1–10, 1922. The Ma Ying Hai series, collected July 10–16 of the same year, contains only mature individuals, the smallest possessing leg buds measuring 4 mm., the oldest just completing metamorphosis.

### *Rana japonica* Guenther

#### Figure 21

Forty-four specimens are referred to this species: six from Hok'ou (A. M. N. H. 30749–54), seven from Ch'ungan Hsien (A. M. N. H. 28719–23 and 29476–7), nine from Kienning (A. M. N. H. 30803–11),

14 from Yenping (A. M. N. H. 28469-80 and 28576-7), three from Yunnanfu (A. M. N. H. 30848-50), two from Kunyang Hai, near Yunnanfu (A. M. N. H. 30884-5), two from Siwo<sup>1</sup> (A. M. N. H. 30973-4), and one from Yuankiang (A. M. N. H. 30919). In addition, there are two series of immature specimens; one from Yenping (A. M. N. H. 28526), the other from Ch'ungan Hsien (A. M. N. H. 30679). One tadpole was secured at Yenping (A. M. N. H. 31069) and several in Ch'ungan Hsien (A. M. N. H. 30680).

Schmidt's 1927 report included 91 additional specimens, all but one of which I place here. That one, No. 13229, from Chikungshan, southern Honan, is considered under *asiatica*.

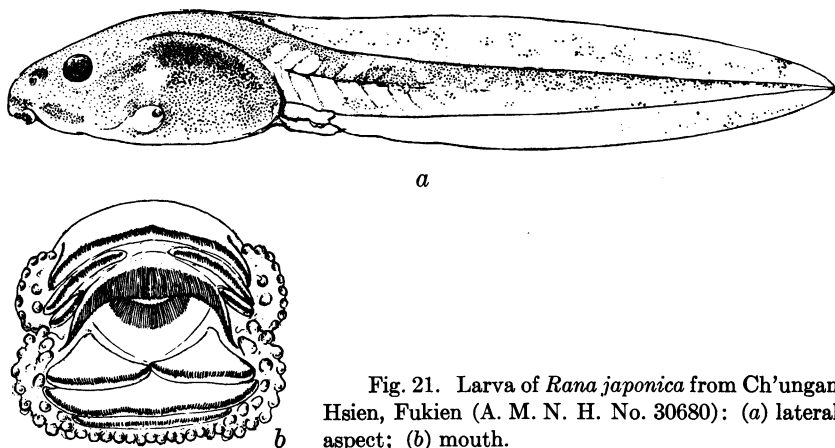


Fig. 21. Larva of *Rana japonica* from Ch'ungan Hsien, Fukien (A. M. N. H. No. 30680): (a) lateral aspect; (b) mouth.

He divided his lot into three groups as follows:

8 specimens from Wanhsien, which he called *japonica*.

77 from Changsha; Nanking; Chikungshan, southern Honan; Ningkwo; and Yenping; listed as *japonica* auct.

6 from Pinghsiang; Yenping; and Fukien; listed as *longicrus*.

A. M. N. H. 37104 from Fukien has not been included in any previous report.

Having studied the literature and carefully examined all the specimens in my new series as well as most of those in Schmidt's, I have come to the following conclusion. The grass frogs of central and southern China belong to a single species divisible into three subspecies:

<sup>1</sup>A locality southwest of Yunnanfu, about midway between the southern end of Kunyang Hai and Yuankiang, but a little nearer the former. It is the Hsi-O Hsien of Major H. R. Davis' map of Yunnan. He gives its altitude as 5,500 feet.



1.—A comparatively heavy-set, short-legged form with a dorsolateral fold curved downward to skirt the tympanum. This frog ranges through the Yangtze Valley as far west as Hunan and Hupeh.

2.—A slender, long-legged form, also possessing a curved dorsolateral fold, occurring in the southeast, especially Fukien and Formosa.

3.—A moderately slender form, with straight dorsolateral folds developed to a much better degree than the curved folds of the other subspecies. It ranges from eastern Szechwan southwestward through Yunnan. Schmidt has noticed this form and it is significant that I find the new Yunnan series in agreement with his six examples from Wanh sien, eastern Szechwan. This frog probably intergrades with its eastern ally between Changsha and Wanh sien.

The second subspecies has been known as *longicrus*, but I find it cannot be separated, specimen by specimen, from the first one. It is also significant to see that typical *japonica* from Japan is still more heavily built than the Yangtze Valley frog. There is, then, a development of slenderness from north to south.

This whole matter should be gone into with great care and, since to do so is not within the scope of this work, I will let the matter stand for the present without attaching names to the subspecies so briefly outlined.

I agree with Stejneger (1925) that the reports of *japonica* in northern China are not to be relied upon, but there is no reason to doubt the following records: Kwangtung-Hunan border (Mell, 1922); Kuatun (Boulenger, 1899); "Ching Fung Lin,"<sup>1</sup> Fukien (Boulenger, 1920, as *longicrus*); Foochow (Stejneger, 1925, as *longicrus*; Wolterstorff, 1906); Ningpo and region (Boulenger, 1882 and 1920, and Boettger, 1894); Nimrod Sound, east of Ningpo (Wolterstorff, 1906); Dazeh<sup>2</sup> Valley, Chekiang (Boulenger, 1920); Hangchow (Stejneger, 1925); Shanghai (Werner, 1903); Tai Hu, near Soochow (Boettger, 1894); Nanking (Wolterstorff, 1906); Lushan, near Kiukiang (Boettger, 1894, and Boulenger, 1920); Ichang (Swinhoe, 1870, as *Rana silvatica*); Szechwan (Boulenger, 1920); Shin-Kai-Si, Mt. Omei (Stejneger, 1925); Washan (Vogt, 1924); Yunnanfu (Boulenger, 1920, and Werner, 1924). Of course, all Formosan records of *longicrus* should be included here because Stejneger (1925) has stated that his Foochow specimen of *longicrus* is inseparable from Formosan material.

In Fukien, I found *japonica* common about Yenping and on the open plateau of Ch'ungan Hsien as well as in the San Chiang region. It probably does not ascend to the highest valleys in the Ch'ungan Hsien

<sup>1</sup>Mr. H. W. Parker writes me that this locality is given as "Ching Fung Lin, Fukien 1500 ft." in the British Museum register and that other specimens in the same collection are from Kuatun.

<sup>2</sup>Spelled "Da Zu" but Mr. H. W. Parker informs me that Dazeh Valley is correct. It is located 50 miles inland from "Sam Moan Bay," which certainly is another spelling of San Men Bay, Chekiang.

mountains but its ability to withstand considerable altitude is shown by its presence at San Chiang. Mell records it from 700–800 m. in northern Kwangtung.

Examination of the Ningkwo series shows that the males have moderately enlarged forelimbs and well-developed, bulbous nuptial pads on the inner side of each first finger. The surface of these pads is finely granular. A series of 55 Ningkwo specimens was sexed and found to be made up of 18 males and 37 females. The 12 largest males range from 36 to 46 mm. in length, averaging 39.0 mm., while the 12 largest females range from 45 to 54 and average 50.5 mm. Sexual dimorphism in size is thus shown to be marked.

Ovarian eggs of a female 54 mm. long measure about 1.3 mm. in diameter and are heavily pigmented.

DESCRIPTION OF TADPOLE.—Length of body twice its width; tail twice as long as body, four times as long as deep. Nostril about equally distant from eye and tip of snout; eyes laterodorsal, slightly nearer to tip of snout than to spiraculum, distance between them equal to that between nostrils but not as great as width of mouth. Spiraculum sinistral, directed slightly upwards and backwards, visible from above as well as from below, not ending in a tube, and as far from origin of leg buds as from nostril. Vent dextral, opening at lower border of ventral tail crest. Tail rounded at end, upper crest long and comparatively uniform in depth, lower similar to the upper but not as deep.

The mouth is ventral and small. The lower lip, sides of mouth and extreme ends of upper lip are bordered with an unbroken row of short papillæ. Extra papillæ are present laterally within this outer row. The teeth of the upper lip are arranged in a long, continuous outer, and two shorter inner rows, both interrupted. The innermost of these three rows is never more than half as long as the middle one, and sometimes remains of a fourth and shorter row can be seen. The lower lip bears three long rows of teeth, the outermost variable in length but, as a rule, distinctly shortened. The innermost is narrowly interrupted, even though the ends may touch in the middle.

Preserved specimens present no distinctive color pattern but the back and anterior sides are minutely spotted with black. The skin covering the intestinal coils is uniform black on the sides and black-spotted laterally on the belly. There is no pigment along the middle of the ventrum. The fleshy part of the tail is black-spotted dorsally and unpigmented ventrally. Small patches of dark spots are present on the dorsal tail crest.

This description is based upon seven tadpoles of equal size collected April 25, 1926, at San Chiang (A. M. N. H. 30680). The total length of one of these is 32 mm.; its leg buds are 2.5 mm. long, while the tail alone measures 21 mm. Additional larvæ, each possessing a mere remnant of its larval tail, were secured at San Chiang on May 30 of the same year. Thus we have definite dates for maturity and metamorphosis at this locality.

Okada (1925) has described the tadpole of typical *japonica* and his characters agree on the whole with those enumerated above. I have written the foregoing description because of the uncertain position held by the Chinese allies of this species.

At San Chiang and Yenping the tadpoles now under consideration inhabited the quiet water of flooded fields and ditches.

### ***Rana guentheri* Boulenger**

Plate XXII; Figure 22

Ninety-seven specimens represent this species: 12 from Nodoa (A. M. N. H. 27013-24), four from Hok'ou (A. M. N. H. 30745-8), ten from Ch'ungan Hsien (A. M. N. H. 28950-3 and 29967-72), two from Kienning (A. M. N. H. 30801-2), 21 from Yenping (A. M. N. H. 28206-26), and 48 from Futsing Hsien (A. M. N. H. 29067-114). Tadpoles were secured from Nodoa (A. M. N. H. 27451 and 27454-5), Futsing Hsien (A. M. N. H. 29418), and Ch'ungan Hsien (A. M. N. H. 30678). Six additional larvæ from Ch'ungan Hsien are placed here provisionally (A. M. N. H. 30648).

In addition, Schmidt's 1927 report included one specimen from Pinghsiang; two from Futsing; and one from Luanshikao, near Wansien.

*R. guentheri* was described and figured from Amoy in 1882. It has since been reported from the following Chinese localities: Hainan (Boettger, 1894, and Smith, 1923); Kwangsi (Vogt, 1930); Canton (Boettger, 1888, and Wolterstorff, 1906); Kwangtung (Vogt, 1914, and Mell, 1922); Foochow, Suifu and Nanking (Stejneger, 1925); Pinghsiang (Wolterstorff, 1906); and near Talifu (Mell, 1922).<sup>1</sup> Exclusive of China, *guentheri* is known from Hongkong (Steindachner, 1869, as *Hylorana malabarica* and Boettger, 1894); Man-Son Mountains, Tonkin, and Chang Nam, Annam (Boulenger, 1920); Thai-Nien, Red River basin, Tonkin (Parker, 1925); and Formosa (Vogt, 1911).

I found *guentheri* common at Hsing Ts'un on the plateau of north-western Fukien, but it was lacking in the mountains about San Chiang. It ranged into the lower valleys of the Yenping mountains.

The Futsing Hsien series of 48 specimens is made up of 21 males and 27 females. The smallest male measures only 43 mm. from snout to vent, while the 13 largest specimens of this sex range in length from 67 to 75 mm., averaging 71.1 mm. The females are longer and more uniform in size, the 23 largest ranging only from 71 to 80 mm. in length, while the 13 largest average 77.7 mm. and range but from 76 to 80 mm. in length.

<sup>1</sup>Probably a misidentification. See Boulenger, 1903.

The smallest female measures 60 mm. from snout to vent. The *Nodoa* series of only 12 specimens represents a larger race, as one of the few males contained in it measures 85 mm. Hainan females may be expected to attain a length of 95 mm. In addition to size, the sexual differences are found in the conspicuous external vocal sacs and shoulder glands of the males, characters included in Boulenger's 'Monograph' (1920). The forelimbs of the males do not exceed in size those of the females, nor do

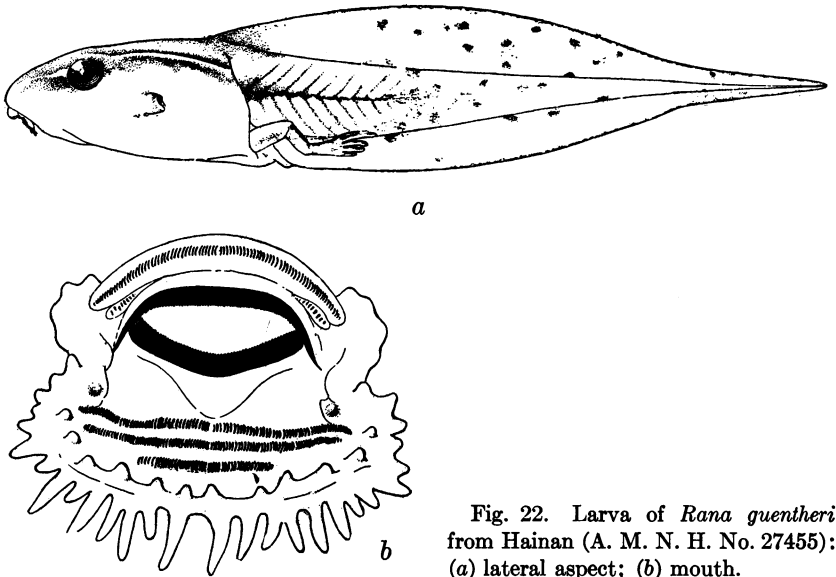


Fig. 22. Larva of *Rana guentheri* from Hainan (A. M. N. H. No. 27455): (a) lateral aspect; (b) mouth.

the first fingers of the former sex develop nuptial pads. In view of the rather large size of *guentheri*, this lack of development of nuptial pads and enlargement of arms is significant.

*R. guentheri* was not abundant about *Nodoa* where I found it in sluggish, grass-grown, field streams. In Fukien, it seemed to be partial to overgrown irrigation ditches and the deeper parts of flooded fields. It is a shy frog. The tadpoles were secured in several small, swampy, rush-grown pools near *Nodoa* where they were not uncommon. Many of them metamorphosed through May. The ripe ova of a 77 mm. female from Ch'ungan Hsien were pigmented on one side, 1.5 mm. in diameter, and approximately 3000 in number, figures indicating a high rate of productivity.

DESCRIPTION OF TADPOLE.—Length of body twice its width; tail twice or a little more than twice as long as body; three and a half to four times as long as deep. Nostril nearer to tip of snout than to eye; eyes lateral, in the middle between tip of snout and spiraculum; distance between eyes nearly twice that between nostrils and twice width of mouth; spiraculum sinistral, visible from above and from below, slightly nearer to eye than to origin of leg bud; vent dextral. Tail pointed, crests deep, upper slightly deeper than lower, extending a very short distance on to back. The general shape of the body is elongate. It is broad in the region of the eyes as viewed from above.

The mouth is small and ventral, the lower lip bordered below by long fringes. A row of narrowly separated papillæ extends parallel to the base of these fringes and between them and the teeth. The lips flare out a little at the corners of the mouth where they are bordered by a single row of papillæ. The upper lip is devoid of papillæ except at either extremity. The teeth of the lower lip are set in one long, narrowly interrupted innermost row, a slightly shorter, continuous middle row, and an outer row much shorter than the middle one. The upper lip carries one long, continuous, outer row, and a very broadly interrupted inner one, which is often almost lacking.

In life, the body of this tadpole is finely mottled with a mixture of brown and dull green, the former color predominating. The skin of the belly in mature examples is unpigmented and opaque. The tail is gaudily mottled with a bold mixture of red-brown and bluish green. The mottling of the tail often encroaches upon the sides of the body.

The above description is based upon a large series of well-preserved tadpoles from Nodoa. The maximum length of body is 16–17 mm., a size attained when the legs are well developed and about 10 mm. in length. The total length then ranges from 46 to 52 mm.

The tadpoles from Fukien are proportionately shorter and broader than those of the Hainan series.

Six larvæ secured in Ch'ungan Hsien (No. 30648) are puzzling because of their large size and heavy build. I could not at first convince myself that they belong here but, failing to find a definite character distinguishing them from the usually much smaller *guentheri* tadpoles I have placed them here pending the acquisition of new material for comparison. They are quite uniform in size, one with 9 mm. leg buds measuring 68 mm. from tip to tip, the tail alone being 46 mm. long. Of course, it is possible that they represent a species whose larval form happens to resemble greatly that of *guentheri*, a common coincidence among ranid tadpoles.

### ***Rana latouchii* Boulenger**

Plate XV; Figure 23

Forty-four specimens of this species were secured: 25 from Ch'ungan Hsien (A. M. N. H. 28851–4 and 29946–66) and 19 from Yenping (A. M. N. H. 28508–25 and 28603). Large series of tadpoles were collected in Ch'ungan Hsien (A. M. N. H. 29012, 30640–1 and 30649).

The collection of the American Museum contains three specimens from Horisha, Formosa (A. M. N. H. 11642-4).

La Touche collected the three types of *latouchii* at Kuatun (Boulenger, 1899). It has since been reported from localities in Formosa as follows: "Fuhosho" (Boulenger, 1909, and Werner, 1913); Kanshirei (Van Denburgh, 1909); and Kankau and Kosempo (Werner, 1909).

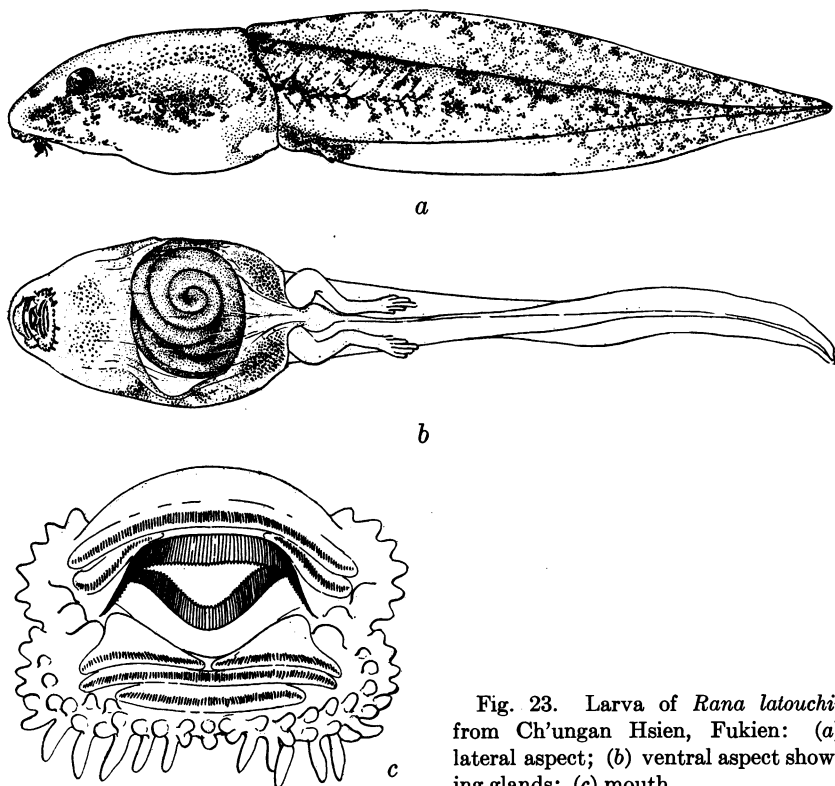


Fig. 23. Larva of *Rana latouchii* from Ch'ungan Hsien, Fukien: (a) lateral aspect; (b) ventral aspect showing glands; (c) mouth.

Gee's (1919) record of *latouchii* at Soochow is apparently uncertain, as he has placed a question mark before it.

This frog was abundant near Yenping and at San Chiang, but I failed to find it in Futsing Hsien.

In his 'Monograph' (1920), Boulenger correctly notes that the males have much thickened forelimbs and a velvet-like pad on the inner side of each first finger, but the measurements given by him do not indicate

marked sexual difference in size. My series of 44 specimens includes 24 males quite uniform in size, only one being less than 34 mm. long, while the ten largest range in length from 37 to 40 mm., averaging 38.4 mm. The remainder of the series, 20 females, includes only one specimen less than 41 mm. long, while the ten largest individuals range from 47 to 51 mm. in length and average 48.8 mm. Thus, sexual dimorphism in size is seen to be marked.

Boulenger (1899 and 1920) and Werner (1913) have both given full descriptions of this frog, so it is not necessary to repeat here. In life, it is very gaudily marked.

DESCRIPTION OF TADPOLE.—Length of body one and a half times its width; tail one and three-fourths to twice length of body, three and a half to four times as long as deep. Nostril equidistant from eye and tip of snout; eyes laterodorsal, nearer to tip of snout than to spiraculum and separated from one another by a space equal to that between the nostrils. Spiraculum sinistral, visible from above and from below, as far from nostril as from insertion of leg buds; vent dextral. Tail pointed, crests variable, sometimes quite deep, the upper always the deeper. Three glands present on the belly, one on either side just anterior to the insertion of each leg bud, the third a short distance behind the mouth. These glands are variable in size but usually quite conspicuous.

Mouth ventral, as wide as distance between nostrils. Lower lip bordered with an outer row of long frills which is sometimes absent, and an inner, double row of papillæ. The upper lip is bordered at either extremity by a row of single papillæ. There are three rows of teeth in the lower lip, the inner narrowly interrupted and the outer slightly shorter than the other two. The teeth of the upper lip are arranged in one long, unbroken, outer row, and a broadly interrupted inner one. The edges of the mandibles are black and serrated.

In life, the back is greenish brown, finely mottled with darker brown. The tail is brown-mottled with a tendency to have a line down the middle of its fleshy part. The crests are dark-mottled. The belly skin is unpigmented and the glands are light yellow.

The above description is based upon a large series of tadpoles in good state of preservation. A typical specimen with leg buds 6 mm. long measures 36 mm. in total length, and 13 mm. from tip of snout to origin of leg buds.

The tadpole of *latouchii* was common in the rice fields at San Chiang, where it was closely associated with the larvæ of *adenopleura* and the other quiet water forms of *Rana*, from which it did not seem to differ materially in habits.

At San Chiang, I found adult *latouchii* only in the immediate proximity of the flooded fields and often actually in the water, so I believe that it is thoroughly aquatic. It was absent from the cold, running water of the mountain streams. The adult is comparatively inactive and

a weak hopper. It is, then, an inhabitant of quiet waters of higher altitudes and is almost certainly confined to mountainous regions because we failed to find it on the Ch'ungan Hsien plateau at an elevation at least as great as that of the Yenping mountains where it was common.

These frogs were very active at San Chiang on May 5 and 6, 1926, where I saw a mated pair on the fifth, the male having the usual axillary grasp. This observation was made at night. The only call I detected was a weak, squeak-like groan repeated two or three times in succession. On June 29 of the same year, I found *latouchii* tadpoles at San Chiang far advanced in their transformation, and a search of the fields on July 3 revealed many more. A series of six specimens, all with fairly long tails, and all but one with four legs out (the forelimbs in that one on the verge of appearing) taken on July 14, prove that metamorphosis was still in progress then. A final search was made the first week in September but no tadpoles were found.

A large, preserved female contains 760 mature, partly pigmented ova. The ripe ova of another female 51 mm. long measure 1.5 mm. in diameter.

Field data on Formosan specimens are scarce but *latouchii* is known from an altitude of 5000 feet at Kosempo, a fact in every way confirmatory of my observations given above.

### ***Rana adenopleura* Boulenger**

Plate XV; Figure 24

Ninety-eight specimens represent this species: 53 from Ch'ungan Hsien (A. M. N. H. 28707-18, 29992-30000, 30025-55 and 32946), and 45 from Yenping (A. M. N. H. 28227-42, 28244-57, 28527-39 and 30818-9). Numbers of tadpoles were secured in Ch'ungan Hsien (A. M. N. H. 30603).

Boulenger described this frog in 1909 from four specimens collected at "Fuhacho," a Formosan village 4000 feet above sea-level. Stejneger (1925) reported a specimen from Yenping secured through Sowerby. The American Museum possesses a series from Horisha, Formosa.

Schmidt (1927) based *Rana caldwelli* upon two Fukien frogs which he distinguished from *adenopleura* by their more projecting snouts, rougher skin and posteriorly broken up dorsolateral glandular folds. A comparison of Schmidt's types with the new series of 98 specimens shows that the characters separating *caldwelli* and *adenopleura* are not diagnostic and *caldwelli* will have to be placed in the synonymy of the original species. In view of the fact that I have Stejneger's confirmation in the



form of his Yenping record of *adenopleura*, I do not consider it necessary to set down detailed results of my examination of the ample material at hand, including, as it does, a series of Formosan specimens of *adenopleura*. Schmidt stated that his types probably came from Yenping and that Stejneger's Yenping *adenopleura* should be placed in the synonymy of *caldwelli*.

Boulenger recorded the fact that male *adenopleura* has internal vocal sacs, a feeble pad on the inner side of the first finger, and a large gland on each side above and behind the shoulder. It is interesting to note that the arms of breeding males are not enlarged. I find that males may also

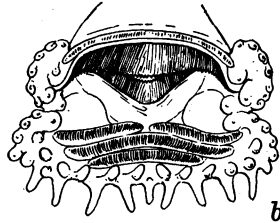
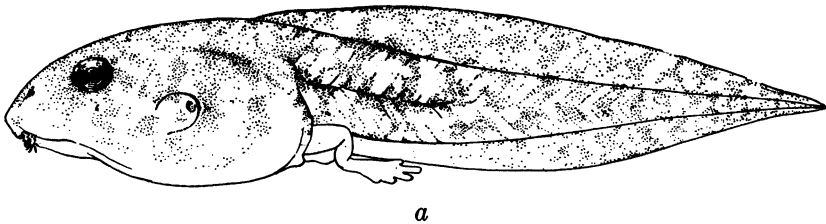


Fig. 24. Larva of *Rana adenopleura* from Ch'ungan Hsien, Fukien (A. M. N. H. No. 30603): (a) lateral aspect; (b) mouth.

be told by a dark area on either side of the lower jaw. This character is occasionally obscured by the presence of pigment over the chin and throat, a condition not in any way correlated with sex.

There is little or no sexual difference in size. Examination of the series of 53 from Ch'ungan Hsien shows that the ten largest, among 29 males more than 32 mm. long, range from 52 to 56 mm. in length, averaging just 53 mm., while the ten largest among the 15 females fulfilling the same requirements have exactly the same range but average 54.1 mm. I find that the large Yenping series agrees remarkably well with the Ch'ungan Hsien one.

In life, the eye of *adenopleura* is characteristic, the upper part being gold, the lower red-gold.

DESCRIPTION OF TADPOLE.—Length of body about one and two-thirds its width; tail one and a half to one and three-fourths times as long as body, about three times

as long as deep. Nostril slightly nearer to tip of snout than to eye; eyes laterodorsal, about in the middle between tip of snout and spiraculum; distance between nostrils three-fourths of that between eyes. Spiraculum not ending in tube, directed upward and backward, visible from above and below and farther from origin of leg buds than from eye; vent dextral, opening at lower border of tail crest. Tail pointed, dorsal crest deeper, ventral crest rapidly decreasing in depth anteriorly.

The mouth is small but it is not so wide as the interocular space. The lower lip is very variable in outline, but it is usually bordered along the middle by a more or less double row of closely set papillæ. The lip is expanded on either end where it is bordered by long fringes sometimes forked, which extend a variable distance toward the middle of the lip outside of the papillæ. This expansion extends around either corner a short distance along each end of the upper lip. The bordering fringes of the lateral expansions are short along the ends of the upper lip and opposite the corners of the mouth. Examination of very small tadpoles shows that the upper lip normally carries one long, continuous row of teeth but not a single specimen among a large series of mature and nearly mature individuals retains more than terminal remnants of this row which must be exceedingly fragile. The lower lip bears three rows of teeth, only the inner narrowly interrupted but slightly longer than the middle one which is much longer than the shortened, outer row. All the teeth are unusually long.

The tadpole is finely mottled above but from a short distance appears to be spotted. The mottling is dark, greenish brown, the ground color much lighter. The tail crests are also mottled. In the younger specimens, the belly skin is transparent but it becomes opaque with age, never developing any color or pattern, however.

The above description is based upon a large well-preserved series. A typical example with leg buds 3 mm. long measures 13 mm. from tip of snout to insertion of leg buds. Its tail is just 21 mm. long.

At San Chiang, these tadpoles were associated with those of *la-touchii* in the flooded rice fields and I could detect no difference in their habits.

In China, it was sometimes difficult to determine just what the original habitat of an amphibian was, because the rice culture of the Chinese has produced a habitat apparently more suitable than the original one. This was somewhat the case with *adenopleura* at San Chiang, for only once did I detect it in what might be called a natural setting, but it was most abundant in the rice fields of the village. On that single occasion, I was crossing the back of a high ridge well above Upper Kuatun and at an altitude of about 5500 feet. I was astonished to hear the familiar croak of *adenopleura* issuing from what appeared to be a level, meadow-like stretch, for the ridge's top was devoid of trees. Investigation showed that one of the cascades had its origin in a spring arising within the level depression on the very summit of the range. These conditions had given rise to a swampy area and it was in this quiet water that *adenopleura* abounded. Such conditions are rarely met with in the high

Kuatun ranges and it is puzzling to know just where *adenopleura* lived before the arrival of the Chinese.

In the San Chiang rice fields, this frog took shelter by day in the crevices between the rocks of the base of the terrace facing, but ventured forth at night and on heavily overcast days, to feed, hunt for a mate, or sit in the mouth of its particular crevice and call incessantly. The call was a high-pitched, guttural "gow" usually repeated with nearly equal strength three times in rapid succession. Sometimes, only one or two syllables were sounded and rarely as many as four, in which case the last was very weak. A sort of purr was occasionally uttered between calls. When a chorus was in progress, each frog called on the average of every ten to 12 seconds and the resulting din drowned out all the other amphibian songs. An individual often called from the same crevice night after night. So much force is put into the sound that the entire throat is inflated and the caller appears to exert great effort.

At San Chiang, *Rana adenopleura* was found to deposit its eggs in the quiet water of the rice fields immediately at the base of the rock-work terrace facing. Many clusters were found, but all in the same position relative to the terraces. A cluster consisted of a lightly and uniformly adherent mass of egg sacs, each sac at first about 5 mm. in diameter but increasing one to three diameters with age. Every sac held from one to four eggs and the whole cluster formed a globular mass, which at first was buoyed up somewhat by the water, but later grew heavier and sank. I detected no point of attachment of any cluster as a whole but each one was usually more or less joined to grass or débris in the water. As the individual sacs grew in size, they became frayed and gradually separated. An examination of three clusters showed that one was made up of 210 sacs containing 357 eggs, another of 209 sacs with 373 eggs, and the third of only 172 sacs with 308 eggs. About 59 per cent of the total number of sacs in these clusters taken together held two eggs each, 32 per cent one egg, while only nine per cent enclosed three eggs. Less than one per cent contained four eggs. The eggs of a fourth cluster were counted and found to be 308 in number, or exactly as many as found in one of the first three clusters recorded. These counts show remarkable uniformity in the size and contents of San Chiang *adenopleura* egg masses.

The first egg cluster definitely identified as that of *adenopleura* was seen at San Chiang on June 3, 1926; the second, two days later. Five more were found on June eighth, two on the tenth, three on the eleventh, five on the seventeenth and twenty-fifth, respectively, and a final one on the twenty-sixth. The five masses seen on June 17 were within a few

feet of each other, and this date may be guessed as marking the height of the 1926 season. Of course, June 3 cannot be taken as the beginning of the season because it is impossible to say how many clusters deposited before this date were overlooked through ignorance. I first recognized the call at San Chiang on May 7, a few days after our arrival, and last heard it in September just before our departure on the third of that month. The calling of the late summer was comparatively weak.

I have no data on the life history of unmistakable *adenopleura* at Yenping but it is abundant in the mountains near that city where we worked. It probably is found there at considerably lower altitudes than at San Chiang, for its absence from the higher Ch'ungan Hsien plateau indicates that it is really a mountain inhabitant. Persistent and detailed observation in the field alone can determine this point.

A developmental series taken entirely from one egg cluster kept under normal conditions was begun at 10 A.M. June 2 when the eggs were still in the early stages of cell division. The eggs were then partly pigmented and 1.8 mm. in diameter. On the fourth, they were slightly elongate and a day later the adhesive pads were conspicuous. By the sixth, the embryo had acquired an elongate, flattened shape, the tail projecting well beyond the yolk. The gills budded on the seventh and had grown to a considerable size by the tenth when the eyes were well formed and pigmented. The gills reached their maximum size on the twelfth and persisted with little change through the fourteenth, but the adhesive organs were practically absorbed by the thirteenth. Absorption of the gills was well underway on the fifteenth when the lips were formed and the edges of the mandibles pigmented. June 18 found tadpoles normal in form with bodies 3 and tails 5.5 mm. long, but mouths devoid of teeth. The operculum closed between the fifteenth and eighteenth. The single row of teeth of the upper lip and the inner, interrupted row of the lower were well formed by the twenty-third, but the middle row of the lower lip was only partly evident then. In this species, too, the rows of the lower lip are added from the mandibles outward. The body had increased to a length of 4, the tail 6 mm. by the twenty-third. The series was ended July 3 at which date the tadpoles were in full possession of their teeth and had bodies 5.5, tails 9 mm. long. The fringes of the lower lip at this stage of development were much more even in size and length and not nearly so slender in form as they later become, while the papillæ were comparatively inconspicuous.

***Rana pleuraden* Boulenger**

Thirty-two specimens represent this species, all collected at Yunnanfu by Walter Granger (A. M. N. H. 30851-82).

Schmidt's 1927 report included 44 additional specimens from Likiang; Yunnanfu; and the Wutingchow District. The collection of the American Museum also contains a single individual secured through exchange, labeled Yunnan (A. M. N. H. 24316).

Boulenger described *pleuraden* from Yunnanfu in 1904, and his 1920 'Monograph' lists only the five types from there and three additional examples from Tungchwanfu, Yunnan. Werner (1924) records numerous specimens from "between" Yungning, "Yungbei" (probably Yungpeh) and Likiang, three Yunnan localities; and from Ningyüan, southern Szechwan.

The external vocal sac of the male recorded by Boulenger (1920) is not evident in my series but the lateral gland confined to this sex is conspicuous. The first fingers have slight pads but the arms of breeding males are not thickened. By using a composite series from Likiang, Yunnanfu, and the Wutingchow District, I am able to get a lot of 13 males and 16 females, all over 36 mm. in length. The ten largest males measure from 49 to 60 mm. in total length, and average 54 mm., the ten largest females range from 50 only to 61 mm., averaging 57 mm., so we may conclude that sexual dimorphism in size is anything but marked.

I notice that there is a strong tendency in Likiang specimens for the ventral aspect of the hind limbs to be sparsely but conspicuously spotted with black, a condition scarcely evident in specimens from Yunnanfu and the Wutingchow District.

Boulenger states that the eggs are very small and gives 1 mm. as their diameter. I find that the ripe ova of a female 59 mm. long are 1.5 mm. in diameter. They are partly pigmented.

A comparison of the habits of this species with those of *adenopleura* would be interesting because, save for the terminal expansions of the digits in *adenopleura*, the two species are remarkably similar. Is this slight structural difference reflected in their choice of habitats? Boulenger (1920) states that *adenopleura* has probably been derived from *pleuraden* and, if his belief is well founded, a close comparison of habitats might throw light upon the question of adaptation to environment in the genus.

***Rana taipehensis* Van Denburgh**

Twelve specimens secured in the region of Nodoa are referred to this species (A. M. N. H. 26222-33). In addition, I place here a large series of small individuals of the same origin (A. M. N. H. 26220).

Van Denburgh described *taipehensis* from Formosa in 1909. Boulenger (1920) placed it in the synonymy of *erythraea*, a widely distributed Malayan frog, but Smith (1923) revived *taipehensis* on the basis of material collected by himself on Hainan and in Annam. I am following Smith here because he has seen both forms in the field and presents convincing data.

Vogt (1913) and Mell (1922) recorded *macroductyla* from Kwangtung. Fortunately, I have one of Mell's specimens, labeled Canton, for comparison (A. M. N. H. 24312) and find that it is a typical example of *taipehensis*, a fact not at all surprising in view of the occurrence of this species on Hainan as well as Formosa. It is, of course, impossible to say just where the rest of Mell's series of "*macroductyla*" should be placed, but most probably true *macroductyla* is also represented in it. Vogt's 1913 report is based upon material collected by Mell and need not be treated separately.

Boulenger considers *taipehensis* as the young of *erythraea* but, as indicated above, Smith (1923) has concluded that such is not the case, a conclusion substantiated by the following data. The average size of gravid female *taipehensis* is 34 mm. This figure is computed from measurements of ten Hainan individuals in the new collection ranging in length from 28 to 41 mm. Smith's largest female containing ripe ova was only 37 mm. long. Boulenger records measurements of 20 female *erythraea* from widely separated regions. These specimens range in length from 55 to 78 mm., averaging 65 mm., so obviously, *taipehensis* has a definite size limit of its own and cannot possibly be considered as immature *erythraea*.

Parker's 1925 record of *erythraea* from Thai-Nien in the Red River basin of Tonkin is of special interest in the present connection, but, unfortunately, he gives no data to form a basis for comparison.

#### ***Rana macroductyla* (Guenther)**

##### Figure 25

Forty specimens from Nodoa represent this species (A. M. N. H. 26716-55). In addition, there are numerous young individuals (A. M. N. H. 26221), a lot of partially transformed larvæ (A. M. N. H. 27452), and a series of tadpoles (A. M. N. H. 27447), all from Nodoa.

*R. macroductyla* was described as a *Hylarana*, two of the types coming from Hongkong, the remaining four from "China" (Guenther, 1858). Boulenger (1920) gives the range outside of China as Tonkin, Burma, Siam and the Malay Peninsula. There are additional reports

for Hongkong (Hallowell, 1860, as *trivittata*; Boettger, 1894, and Boulenger, 1920). In China,<sup>1</sup> it is known from Hainan (Boettger 1888 and 1894, Vogt 1913, and Smith 1923); Canton (Boettger, 1888); and Lilong (F. Müller, 1878, as a *Hylarana*). Vogt (1913) and Mell (1922) have recorded it from Kwangtung, but I have before me one of Mell's specimens labeled Canton (A. M. N. H. 24312) that is obviously *Rana taipehensis*, so I doubt if these two Kwangtung records are reliable. Vogt's 1913 material was also a part of Mell's collection. Of course, it is entirely possible that both of these species are included in the series identified as *macrodactyla* by Mell and Vogt.

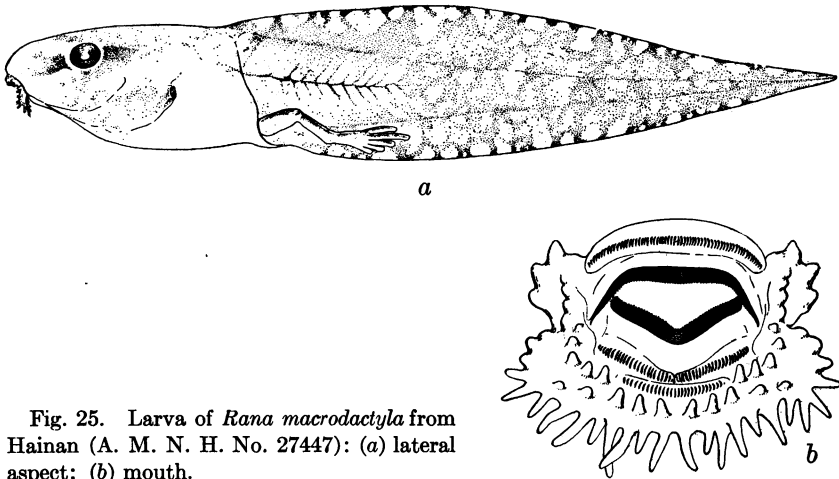


Fig. 25. Larva of *Rana macrodactyla* from Hainan (A. M. N. H. No. 27447): (a) lateral aspect; (b) mouth.

The future discovery of this species in other parts of China is certain because it is known from Bhamo, in Upper Burma (Boulenger, 1887); and the Man-Son Mountains, which are in Tonkin near the Kwangsi frontier (Boulenger, 1920).

The present series is so largely juvenile that little can be done with it. The four largest specimens, all females, measure 41 mm. from snout to vent. These must be fully adult since only one among 14 measured by Boulenger exceeds this length and that by only 3 mm. Sexual dimorphism in size is indicated by Boulenger's figures, the largest male measuring only 32 mm. He states that this sex is devoid of secondary sexual characters.

I have examined 114 tadpoles but found little variation. Two were abnormal in having one half of the inner row of the lower lip continuous

<sup>1</sup>Swinhoe's (1870) Ichang record (as *Hylarana*) requires confirmation.

with the short outer row, and in one the inner row seemed to be entirely lacking. The short outer row of the lower lip varies somewhat in length. The inner row of this lip, even though its two halves generally touch, is really interrupted because each half is mounted upon a fleshy ridge that is deeply notched in the middle. The lower lip is not only fringed with long, slender processes but possesses a distinct row of papillæ between these processes and the outer row of teeth. Judging by Smith's (1917) description, the lower lip of specimens from Siam lacks the fleshy ridges supporting the inner row of teeth and the line of papillæ between the fringe and the outer row. In other respects his description fits my material.

*R. macrodactyla* was abundant in grass along streams and ditches and about the rice-field terraces of the Nodoa region.

***Rana montivaga* Smith**

Plate XVIII; Figure 26

A series of 27 specimens are referred to this species: 24 from Ch'un-gan Hsien (A. M. N. H. 28832, 30140-1, 30404-5, 30412-4, 30417, 30424, 30429, 30437-8, 30445, 30447, 30450, 30452, 30454, 30458-60, 30465, 30472, and 30483) and three from Yenping (A. M. N. H. 28419 and 30820-1). I place here provisionally a barely transformed individual from Ch'un-gan Hsien (A. M. N. H. 30139), large numbers of tadpoles also from Ch'un-gan Hsien (A. M. N. H. 29013, 29023 and 30628-37), and additional ones from Yenping (A. M. N. H. 31084 and 31093), as well as a single larva from Futsing Hsien (A. M. N. H. 32956).

A. M. N. H. 37068, collected some years ago by Caldwell in Fukien, also belongs here.

*R. montivaga* was described in 1921 from Dalat, Langbian Plateau, southern Annam, at an altitude of 1500 m. Smith states that it is allied to *R. varians* of the Celebes and Philippines. It is, then, a *Hylorana* of Boulenger's *Rana erythreæ* group (Boulenger, 1920).

I must plead guilty of having included the entire series of 27 specimens among the paratypes of my new species, *Rana chunganensis*, in the advance description of that form published in 1929. At that time, I considered the present series as female *chunganensis* and became aware of my error only upon a more careful examination of all the material involved.

The specimens before me agree well with the full description of *montivaga*, except in their general lack of dorsal tubercles. The dorso-lateral folds are probably less conspicuous and the tympanic membranes



a little smaller than in the types. I do not consider these differences sufficient to warrant separation, and, moreover, small dorsal tubercles are evident in one individual. Smith found *R. graminea* abundant on the Langbian Plateau, so its distribution largely coincides with that of the present form, a fact of no small significance to the zoögeography of southeastern Asia. As our knowledge increases, the fauna of southern China is seen to be exceedingly complex, involving, as it does, important elements of at least two major faunistic divisions of the world.

My series of 27 specimens is made up of seven juveniles less than 29 mm. in length from snout to vent, five males, and 15 females. The 13

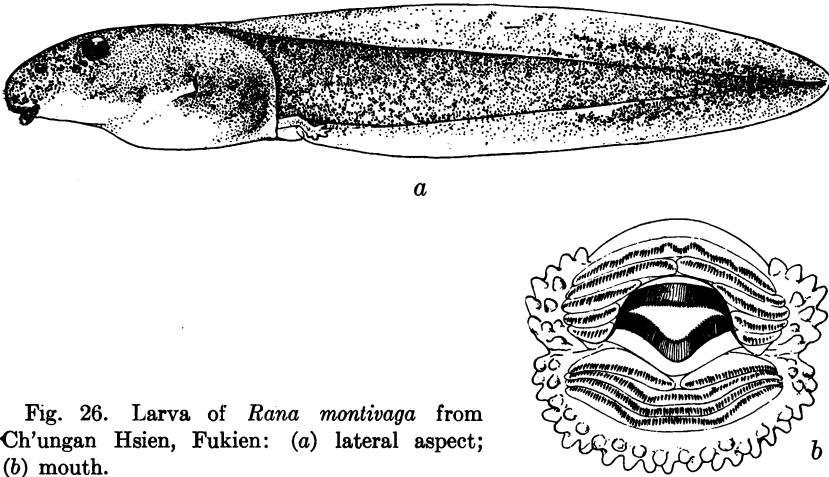


Fig. 26. Larva of *Rana montivaga* from Ch'ungan Hsien, Fukien: (a) lateral aspect; (b) mouth.

largest females range in length from 50 to 62 mm., averaging 55.1 mm., while the males measure 53, 44, 42, 41, and 30 mm. The 50 mm. female contains well-developed ova, so the figures for this sex probably indicate the maximum size obtained by it in Fukien. The data on the males is too incomplete for exact conclusions as to the degree to which sexual dimorphism is developed. One of the males has a moderately well-developed nuptial pad with a minutely granular surface on the inner side of each first finger. It has no external vocal sacs, a condition noticed by Smith in his males.

This frog is an inhabitant of the forest floor about Kuantun and San Chiang where it is not abundant. I saw even very small specimens high on the sides of mountains far from water, and one individual found in the bed of a stream, attempted to hide in some nearby vegetation rather

than among the rocks or in the water. *R. montivaga* seemed to be rare in the mountain forests near Yenping where we secured only three specimens. If I am right, however, in my identification of the numerous tadpoles referred to this species, it is really not rare at Yenping where the larvæ abounded in all the highest streams, and it even occurs in Futsing Hsien, as shown by one tadpole collected there. I saw no sign of it anywhere in open or level country. One night, a green pit-viper, *Trimeresurus gramineus stejneri*, with a distended belly, was taken in a stream bed near Kuatun. This central enlargement proved to be due to a perfectly fresh *montivaga* contained in the stomach.

*R. montivaga* undoubtedly lays its eggs in flowing water because specimens were not infrequently seen in and near streams about Kuatun and San Chiang through August, 1926. A temporarily confined female deposited eggs on August 25, so it is safe to conclude that breeding occurred during that month. These eggs, laid in confinement, were held together in a compact, flattened mass by small, mucous cables too short to be seen without stretching the eggs apart. Each egg measured nearly 3 mm. in diameter and was surrounded by a layer of mucus about 1 mm. thick. All the eggs were uniformly white. A large Yenping female was dissected and found to contain 229 well-developed and entirely unpigmented ova, each about 2 mm. in diameter.

I will not discuss at this point evidence for the time of breeding based upon larval development but reserve it to follow the description of the tadpole. This precaution is taken to guard against future confusion if my identification proves incorrect.

#### Description of Tadpole, Probably that of *Rana montivaga*

Body three-fifths as broad as long; tail slightly more than twice as long as body, four times as long as deep. Nostril nearer to tip of snout than to eye; eyes latero-dorsal, nearer to tip of snout than to spiraculum; distance between eyes a little less than that between nostrils and equal to half width of mouth. Spiraculum sinistral, directed upward and backward, ending in a very short tube, visible from above as well as from below and as far from origin of leg buds as from eye. Vent large, dextral; anal tube rather long, opening by lower border of tail crest. Tail pointed but not acutely so; upper crest scarcely deeper than the lower, which extends to body.

The mouth is ventral and broad. The lower lip is bordered by an unbroken, double row of papillæ; the extremities of the upper by a single one, and extra papillæ are present in the corners of the mouth. There are five rows of teeth above, the outer long and continuous, the next long but narrowly interrupted, while the remaining three are short and broadly interrupted; below there are four long, equal rows only the innermost broken and that but narrowly so. The outermost row below sometimes appears to be shortened because its teeth at either end are poorly developed.

The back, sides, and fleshy part of the tail are light brown. Small, irregular, unpigmented areas are more or less in evidence on the tail but they are never conspicuous. The tail crests are mottled with light brown. The belly skin is transparent and unpigmented, or faintly speckled laterally and anteriorly.

The enormous series before me is in perfect state of preservation and shows remarkably little variation in either form or color. The measurements in millimeters of three specimens from the Kuatun-San Chiang region follow:

BODY	TAIL	LEG BUDS
8.5	18.2	1
9.0	18.5	2
8.5	19.0	5

The only noteworthy variation is seen in the single tadpole from Futsing Hsien, which has a sixth row in the upper lip but is typical in every other respect. I find that 20 Yenping larvæ picked at random from both series collected there have the normal five rows above, while 25 specimens taken by chance from several Ch'ungan Hsien series have either five or four-rows, the latter condition being found in three specimens that were somewhat mashed, and is undoubtedly the result of handling. The Futsing Hsien tadpole may be an abnormal individual but I venture to state that it represents a local race characterized by the acquisition of an additional row of teeth. This explanation is the most likely in view of the numerous cases of slight but distinct differences found between individuals of the same species from Ch'ungan Hsien or Yenping and those from Futsing Hsien. If there really is a difference between the larvæ, is it reflected in the adults? This question cannot be answered until adult *montivaga* from Futsing Hsien are available.

The following data, a summary of the stages of development of these larvæ at various times, arranged to show the probable extent of the breeding season, ought to precede the description of the tadpole, but, as already stated, are placed here in order to avoid possible confusion should my identification of the larvæ prove incorrect. In that case, these data can be transferred to their proper place together with the foregoing larval description and no confusion should result.

DATA FOR CH'UNGAN HSIEN, 1925.—A single series (A. M. N. H. 29023) collected July 16 includes mature larvæ with leg buds 3.5 mm. long, to advanced ones with four legs but tails yet unabsorbed.

DATA FOR CH'UNGAN HSIEN, 1926.—The first series of tadpoles was secured on July 4 (A. M. N. H. 30631) and consists of barely mature individuals with leg buds from 0.25 mm. to 1 mm. in length. Four additional series were collected from July 10 to 18, inclusive (A. M. N. H. 30637, 30632, 30630, and 30629), and contain a few

specimens with leg buds only 0.25 to 1 mm. in length, several with much longer leg buds, and a great many almost completely metamorphosed individuals. Two final series were obtained on August 13 and 14 (A. M. N. H. 30633 and 30639), and include a specimen with leg buds only 1 mm. long, together with a large percentage of well-advanced and almost entirely transformed tadpoles. The last larva collected is dated August 25. It has four legs and a tail scarcely reduced.

DATA FOR YENPING, 1925.—Three tadpoles were taken on June 3 (A. M. N. H. 31084). One has leg buds 4, the other 7 mm. long, while the third possesses four legs with a tail yet unabsorbed. As might be expected, these data indicate earlier breeding at Yenping than in Ch'ungan Hsien.

Although *R. montivaga* lacks external vocal sacs, has a longer snout, smoother skin, and different coloration than *chunganensis*, I find it impossible to determine absolutely the identity of partly transformed individuals undoubtedly belonging to one of the two species. These puzzling specimens are the most advanced larvæ of the series here described as tadpoles of *montivaga*. I have put much time into this problem and believe that my solution is correct but; nevertheless, can present no final proof because the characters that enable one to separate adults of the two species at sight are of little or no value when very small specimens are concerned. After shifting from one point to another, I finally noticed that the frequent occurrence of mottling on the throat in adult *montivaga* is never evident in the other form and find that many of the newly transformed larvæ of the present series have this mottling present to a marked degree. It is possible that this character is not constant during ontogeny so, if such is the case, I admit that my identification is little more than a choice between two possibilities, and it remains for the field worker to say whether the tadpole described above is that of *chunganensis* or *montivaga*.

### *Rana chunganensis* Pope

Plate XVIII; Figure 27

In the original description of this species,<sup>1</sup> I confused it with the series of *R. montivaga*, which I took to be female *chunganensis*, a mistake due to the discovery of cross-mated pairs in the field and the great scarcity of females of the present form. This error resulted in over emphasis of the degree of sexual dimorphism in *chunganensis*. I also must admit to having erroneously stated that the male of this new species possesses a humeral gland. These errors are corrected in the somewhat amplified copy of the original description given below.

TYPE.—A. M. N. H. 30479; adult male; Kuatun Village, northwestern Ch'ungan Hsien, Fukien Province, China; 4500–5000 feet altitude; August, 1926; Clifford H. Pope, collector.

<sup>1</sup>Amer. Mus. Novitates, No. 352, 1929.

DIAGNOSIS.—An *Hylorana* with well-formed digital discs bearing distinct, lateral grooves separating the upper from the lower surfaces. These discs are not twice as broad as the narrowest part of the corresponding penultimate phalanx. The finger discs are slightly wider than those of the toes. There are weakly developed dorso-lateral folds.

DESCRIPTION OF TYPE.—Vomerine teeth in oblique series, their anterior edges on a line with the centers of the choanæ.

Head scarcely longer than broad, depressed; snout rounded, slightly projecting beyond mouth, about as long as eye; canthus rostralis obtuse; loreal region feebly

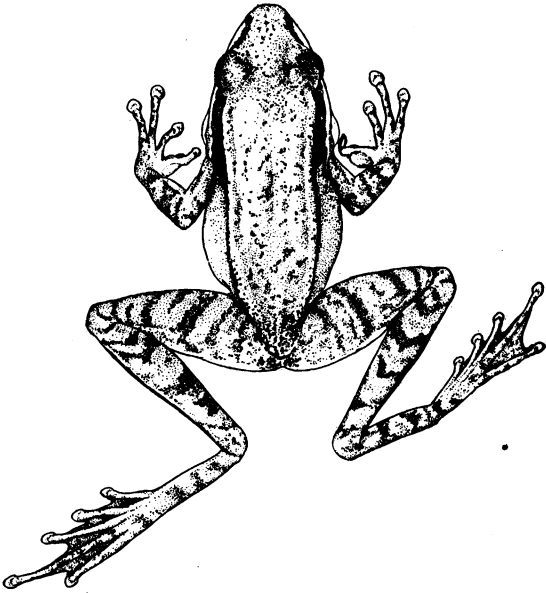


Fig. 27. *Rana chunganensis* A. M. N. H. No. 30479, type: dorsal aspect.

oblique, concave; nostril barely nearer tip of snout than eye; distance between nostrils as great as interorbital width, which equals that of eyelid; tympanum distinct, about three-fifths diameter of eye, separated from it by a distance equal to half the tympanic diameter.

Fingers long and slender, first barely as long as second and with a conspicuous nuptial pad on the inner side. Subarticular tubercles well developed. Toes with pads similar in form and size to those of fingers, webbed to base of pads on all but longest where webbing barely reaches beyond last subarticular tubercle; outer metatarsals separated nearly to base. Inner metatarsal tubercle oval, feebly prominent, no outer tubercle.

Hind limb long and slender, tibiotarsal articulation reaching to end of snout; heels strongly overlapping when placed at right angles to the body; tibia contained 1.7 times in length of head and body; width of tibia 4.6 times in its length.

Dorsolateral fold feeble, especially posteriorly; a glandular fold from below tympanum to shoulder. Skin generally smooth and devoid of tubercles.

The color is reddish brown above but light beneath, the back covered with very small, inconspicuous speckles. A black stripe extends from the tip of the snout to the eye and from behind the eye, where it includes the tympanum, to the base of the thigh. Above, the stripe is bordered by the dorsolateral fold and it rapidly grows narrow behind the line of the shoulder. A light stripe extends from below the nostril to the shoulder, passing just beneath the eye and tympanum. The limbs are boldly barred above. In life, the posterior region of the belly and ventral aspect of the limbs were light yellow. A large, external vocal sac is present on either side just anterior to the insertion of the forelimbs.

The type measures 39 mm. from snout to vent.

NOTES ON PARATYPES.—The 67 paratypes<sup>1</sup> are from the type locality (A. M. N. H. 30395–403, 30406–11, 30415–6, 30418–23, 30425–8, 30430–6, 30439–44, 30446, 30448–9, 30451, 30453, 30455–7, 30461–4, 30466–71, 30473–8, and 30480–2).

*R. chunganensis* seems to resemble more closely *Rana nasica*<sup>2</sup> from northern Tonkin (Boulenger, 1903) than any other species, the chief difference between the two forms lying in the longer snout, larger head, and shorter fingers of *nasica*. In *chunganensis*, the snout is rounded, but in the Tonkin frog it is pointed and very prominent. Boulenger (1920) gives the head length of two male specimens of *nasica* 41 and 42 mm. long, as 15 and 16 mm. respectively, but in four 40 mm. male *chunganensis* the head ranges only from 12.5 to 12.8 mm. in length. Again, Boulenger records the longest finger of his specimens measuring 41, 45, 42, and 41 mm. in length as 7, 7, 7, and 6 mm. long, respectively, while the length of this finger in my four largest males, each 40 mm. long, ranges from 8.5 to 9.0 mm.

*R. nasica* was first found in the Man-Son Mountains and recently re-discovered on Five Finger Mountain, Hainan (Smith, 1923), so its habitat preference may be very similar to that of *chunganensis*. It is impossible to say just how closely related these two species are, but it would not be surprising to find that they are near allies.

The Ch'ungan Hsien series contains only one female and that measures 53.5 mm. from snout to vent. All of the 67 males are adults taken while sexually excited and are remarkably uniform in pattern, structure, and size. Their slight variation in length is shown by the following table:

<sup>1</sup>As explained just above as well as under *R. montivaga*, it is due to an error that the original description lists 95 instead of 67 paratypes. It should be noted, moreover, that this new form is NOT known from Yenping. The three paratypes originally listed from there (Nos. 28419 and 30820–1) have proved to be examples of *montivaga*.

<sup>2</sup>This statement should, of course, replace that made immediately following the original description (1929).

- 8 specimens ranged from 39.0 to 40.0 mm.
- 26 specimens ranged from 37.0 to 38.5 mm.
- 19 specimens ranged from 35.0 to 36.5 mm.
- 13 specimens ranged from 33.0 to 34.5 mm.
- 1 specimen measured only 32.0 mm.

In other words, 43 among 67 males were within 3 mm. of the same length (35.5 to 38.5 mm.). This well illustrates the normal state of affairs found in many species and is a condition that can frequently be of service in identification of material when sufficient data are available. If the measurements of sexually mature *spinosa* be compared with the above table a great difference will be found, so all species do not breed at such a uniform size. In spite of the scarcity of female *chunganensis*, it may safely be concluded that sexual dimorphism in size is marked, because the single female, a gravid individual, is 13.5 mm. longer than the largest male. The well-developed nuptial pad of the male has a minutely granular surface and is found on the inner side of the first finger. The vocal sacs are very prominent, each having its own opening into the throat.

I saw and heard this frog only during its breeding period at Kuatun, even though a single specimen was brought in on July 12, 1926. The excited males called from a few feet above ground where they perched on scrub bamboos growing along the streams.

There were two obvious periods of great sexual activity at Kuatun through the summer of 1926, the first reaching a peak from about August 3-6, the second from approximately August 22-25.<sup>1</sup> During these brief periods, and for a few days previous to each, the males called in great numbers through the day as well as at night, but diligent search for several days revealed only one female and no mated pairs. The first period ended abruptly, for on August 11, I failed to find any sign of *chunganensis* where they had been extremely abundant only five nights before. Temperature and weather conditions will certainly prove to be the chief factors controlling these mating periods.

The eggs of this species are undoubtedly laid in the swift streams and cascades about Kuatun where the males gathered in such numbers, and it would be interesting to know just how and where the clusters are deposited to be safe from current and floods. Ripe ova of the single female collected are unpigmented and about 2.5 mm. in diameter.

The call most frequently given is strongly suggestive of the note of an insect. It consists of twenty or more shrill, trilled whistles, repeated

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<sup>1</sup>My departure from San Chiang on September 4 prevented, of course, observations on this species after that date.

in rapid succession, the first short and weak, the subsequent ones ascending in pitch and volume to a marked climax, which is followed by a high, final whistle, long drawn out and very mournful in tone. Occasionally, two or three sharp notes are uttered alone but another call was also traced to this frog. It, in strong contrast to the principal one, is little more than three short and shrill, ascending whistles given in rapid succession, and separated from a final double whistle, much like the initial ones, by a rather long note that rapidly rises in pitch and volume only to descend in a similar way to an abrupt end.

Under *Rana montivaga*, I have discussed the possibility that the numerous tadpoles now assigned to that species belong here, while, if my provisional identification of that tadpole be correct, there is a rather good chance that the unnamed larva described on page 556 should be placed here instead.

This whole matter is not as complicated as it might seem to be. The long and short of it is that I have two species, *R. chunganensis* and *R. montivaga*, collected in Ch'ungan Hsien, that, in spite of being amply distinct, greatly resemble one another, but differ markedly from all the other forms collected there; and two Ch'ungan Hsien tadpoles likewise similar to each other, but readily distinguished from all other larvæ in the collection: one provisionally referred to *montivaga*, the other described independently on page 556. It is possible to assign a name to one of these larvæ with some degree of certainty because the large series of it include newly transformed individuals, but the other, now represented only by small and mature tadpoles, cannot even be provisionally placed. It is not, therefore, unwise to assume that the tadpole still unassigned to an adult represents the species in turn lacking a tadpole! This assumption is referred to in the preceding paragraph as a "good chance."

### ***Rana andersonii* Boulenger**

Plates XX to XXII

One hundred and ten specimens of this species were secured: 77 from Ch'ungan Hsien (A. M. N. H. 28626-59 and 29751-93), 19 from Yen-ping (A. M. N. H. 28506-7, 28578-89 and 30813-7), and 14 from Futsing Hsien (A. M. N. H. 29168-81).

In addition, Schmidt's 1927 report included two specimens from Tengyueh, Yunnan, and four from Fukien.

*R. andersonii* was described as *Polypedates yunnanensis* (preoccupied by *Rana yunnanensis* Anderson, 1879) from the "Hotha Valley,"



western Yunnan, by Anderson in 1879. It was next collected by La Fea in the Kakhien Hills, near the Yunnan-Burma frontier (Boulenger, 1887). Boulenger reported it from both Hainan and Kuatun in 1899 and his 1920 'Monograph' lists a Foochow specimen. Parker (1925) listed *andersonii* from Ngoi Tio on the Col des Nuages, Tonkin, at an altitude of 4500 to 6500 feet. Vogt (1922) described *Rana melli* from Kwangtung, but I find upon comparing one of his paratypes (A. M. N. H. 24311) with my Fukien *andersonii* that *melli* is indistinguishable from *andersonii*. In fact, the specimen of *melli* before me is in every particular a typical example of *andersonii*. This also explains Mell's apparent failure to secure one of the commonest frogs in southeastern China, for he states that in northern Kwangtung this "new" form (*melli*) is not rare from Lienping (also spelled Lingping) to the sources of the North River. Werner (1924) reports *andersonii* from "between" Yungning, Yungbei (probably Yungpeh) and Likiang in Yunnan but gives the length of the males as 70-75 mm., remarkable figures in view of the fact that among 34 Ch'ungan Hsien males none exceeds 46 mm. in length. Werner, however, has confused *R. andersonii* and *R. grahami*, and these measurements for male *andersonii* in Yunnan require confirmation. Schmidt (1927) has already indicated that Boettger's *schmackeri*, described in 1892 from Ichang, should go into the synonymy of *andersonii*. I find that the size given for the tympanum of the type of *schmackeri* is exactly equal to that of male *andersonii* of the same length. In other words, Boettger described the male of *andersonii* and called it *schmackeri*. The only other difference between the two alleged species as treated by Boulenger (1920) is the position of the vomerine teeth, and the difference there is too slight to be significant. Schmidt (1927) pointed out the greater degree of roughness of the skin in Yunnan *andersonii*. This difference is quite constant and may be found sufficient to warrant separation of an eastern from a western form, in which case the name *melli* would be applicable to the former. Should such a separation be made, the question of sexual dimorphism in size should not be neglected.

In Fukien, *andersonii* is common in the low coastal mountains of Futsing Hsien as well as the higher Yenping and Kuatun ranges. It is probably common in all the swift, mountain streams of the Province.

It may be stated that *andersonii* is now known to occur in Tonkin; Upper Burma; Yunnan; Hupeh; Fukien; Kwangtung; and Hainan.

A study of my series of 77 Ch'ungan Hsien specimens shows that in sexual dimorphism *andersonii* is, with the exception of two indefinite

points, an exact parallel to *graminea*, most of the sexual differences being remarkably similar. The largest male *andersonii* among 34 measures 46 mm. from snout to vent, the largest female among 42 exactly 98 mm. In fact, the adult males are so constant in size that no less than 15 individuals measure just 45 mm., while still an additional 15 measure 42 mm. The only three remaining males of the series of 34 are 39, 39, and 36 mm. long. The female size is not so constant, the second and third largest among the 42 measuring 88 and 85 mm., while after them comes a group of 15 each 88 mm. in length, and then a second group, all the individuals of which are 85 mm. long. The remaining 13 specimens range in length from 83 to 63 mm. As in *graminea*, the male is astonishingly small in bulk. The tympanum of the female 92 mm. long is 4.5 mm. in diameter, that of the male just half this length, 3.8 mm. This male has a rather small tympanum because I find shorter specimens with 4.0 mm. as the tympanic diameter. The sexual difference in size of tympanum is thus seen to equal that in *graminea*. As in *graminea*, this membrane is transparent, but the cavity below is not as large in *andersonii*. I fail to find a difference in color between the sexes of *andersonii*, and the male certainly does not possess such a pronounced external vocal sac as found in *graminea*, even though I do find a poorly developed one, Boulenger's statement notwithstanding. Nuptial pads are present on the first fingers of both forms.

*R. andersonii* is a lover of the larger mountain streams. About San Chiang, it abounded in all the boulder-strewn creeks of the mountain valleys and even ranged into the higher streams of moderate size. "*R. melli*" is found from 500-900 m. altitude in northern Kwangtung (Mell, 1922); but certainly in Futsing Hsien *andersonii* descended to within approximately 150 m. of sea-level, while at Kuantun it probably ascended to 1500 m. Its occurrence on Hainan leads one to expect its discovery below 500 m. in Kwangtung. I frequently saw *andersonii* abroad during the day but it was most abundant at night. Although aquatic, this frog was often seen leaping about in bamboo forests adjacent to a creek. It was, nevertheless, well able to cope with the swiftest currents.

Gravid females were most numerous in July, and six among seven females dissected July 20, 1926, contained ripe ova. Such females were also observed on July 7, 28, and 29, 1926. Five lots of ovarian eggs were counted and found to contain 1150 to 1500 ova. Ripe ova of a preserved female 86 mm. long measure 2 mm. in diameter. The Kuantun Chinese call this "La P'i Ha Ma," the first two words having reference to the poisonous nature of the skin. They have learned by experience that other species of frogs confined with it in a bag soon die.

Under *graminea*, I have discussed the possible advantages of the reduced size of the male in mountain stream and cascade inhabitants and it would be superfluous to repeat here.

The relationship of *graminea* to *andersonii* is an interesting question. Boulenger finds sufficient structural differences to put the former in the *Ranæ chalconotæ* group, the latter in the *Ranæ luctuosæ* group. The great similarity in habits and habitat preference, sexual dimorphism, size and color are arguments for closer relationship. When the breeding habits, habitat preference, and larval forms have been described in full, this question may be taken up to better advantage.

#### ***Rana grahami* Boulenger**

A single specimen of this species has been secured by the American Museum (No. 24313) since Schmidt's 1927 report. It is labeled Yunnan and came from Dr. Werner, identified as *Rana andersonii*.

Schmidt recorded two specimens, one from Yunnanfu, the type locality, and the other from Likiang.

I find no additional records of this species, which seems to be confined to Yunnan. It is considered by Boulenger (1920) as a link between the subgenera *Rana* and *Hylorana*. Schmidt remarked on its striking similarity to *andersonii* and Boulenger believes that a direct genetic relationship exists between the two species. The case is parallel to that of *Rana adenopleura* and *pleuraden*.

The length of six males is given by Boulenger as 80, 74, 74, 74, 70, and 66 mm., and of seven females as 102, 102, 100, 98, 90, 85 and 78 mm. The figures indicate that sexual dimorphism in size, though developed to a moderate degree, is not comparable to that found in *andersonii* from Fukien. The matter is greatly complicated by Werner's measurements of a series of Yunnan *andersonii* in which the female (95 mm.) is not very much longer than the males (70 and 75 mm.), and the fact that the specimen of *grahami*, listed above as received from Werner labeled *andersonii*, is a female just 95 mm. long. At least, as further explained under *andersonii*, one is justified in doubting Werner's figures. The matter is important because it throws light on the relationships of the two species, which in turn occupy crucial positions in their respective subgenera.

#### ***Rana graminea* Boulenger**

Plates XIV, XX, and XXI

Thirty-three specimens of this species were secured: 28 from Ch'ungan Hsien (A. M. N. H. 28604-612 and 29973-91) and five from Yenping (A. M. N. H. 28541-5).

Boulenger described *graminea* in 1899 from two Hainan specimens, and in 1920 recorded a third individual from the Man-Son Mountains, Tonkin. Angel (1928) lists an example from Bac-Kan, Tonkin, while Smith (1921) has given measurements of a series from the Langbian Plateau, southern Annam.

In Fukien, this form seemed to be confined to the higher altitudes for we did not find it in the lower mountains on the coast of Futsing Hsien.

Sexual dimorphism in size is developed to a remarkable degree. Among the 18 males and 15 females comprising the present series, the largest specimen of the former sex measures but 55 mm. from snout to vent, while the largest of the latter sex measures 105 mm. The average length of the ten largest females is 103 mm., that of the ten largest males only 50 mm. These figures give no idea of the vast difference in bulk, for a male placed beside a female appears insignificant! Smith (1921) noticed this difference in size and also that the tympanum in the female is proportionately smaller. The tympanum of a male measuring 48 mm. from snout to vent is 4.5 mm. across, that of a female 103 mm. long, only 5.0 mm. in diameter. The tympanic membrane in the smaller sex is very thin and transparent, allowing one to see clearly into the cavity beneath. It is interesting to know that these males have a very varied voice, their call reminding one of young birds attempting to sing. Smith also states that the dorsal coloration of the males is more uniformly green than that of the females and I can corroborate this to a certain degree. Boulenger (1920) mentions the conspicuous external vocal sacs of the former sex and I find that the first fingers of breeding males bear well-developed nuptial pads.

*R. graminea* was less abundant in Ch'ungan Hsien than *andersonii*. Only one colony of the former came under my observation. This group lived in the Kuantun Creek immediately below Lower Kuantun. It inhabited a mass of huge boulders among and over which the water fell and roared, yet in the midst of this rushing water the frogs were perfectly at home and would not hesitate to dive into the swiftest parts.

On hot, clear nights they called from the tops of boulders, places apparently selected by the males when searching for mates. The loudest part of the call was a very high squeak and often no more could be detected above the roar of the cascades. However, when males were stealthily approached other sounds were heard accompanying the shrill squeaks and it was these weaker notes that reminded me of the singing of young birds not yet sure of themselves. The hearing of this frog

must be good if one can judge by the development of the auditory structures, a point that has already been brought out.

On the night of July 25, 1926, I saw a mated pair reposing on a boulder, but they did not move for so long that I collected them and found that the large female contained 1705 ripe ova. A second female, dissected July 30, held 1689, and a third opened August 14, 1635 ova. The ovarian eggs of a female 105 mm. long were unpigmented and measured 2 mm. in diameter. The difference in size was the more surprising when a mated pair was seen because the vent of the male reached only to the middle of the female's back and it was hard to see just how fertilization could take place in flowing water. On the other hand, it must be an advantage to the female to have a light load while trying to swim about in a current. It might be impossible for two frogs of the same size and weight to hold together under similar circumstances unless the male were in possession of some special structure helping him to cling to the female. The sharp digital and ventral spines and enormously developed forelimbs of *spinosa* may be taken as examples of such structures. A reduction in size of one sex should be considered the equivalent of a development of spines and enlarged forelimbs. Female *spinosa* certainly take severe punishment and, in places where no quieter pools are available, must suffer great injury from the especially vigorous grasp of the males, clinging on in the face of swift water. Another point of importance is that *graminea* is more of an inhabitant of the currents, *spinosa* of the cavities and pools among boulders. It may be that even spines could not suffice to enable large frogs of equal size to remain together in a strong current. The moderately developed nuptial pads and arms of *graminea* prove that the male is relieved of any great effort in clinging to the female, and vice versa, the female has a light load and runs no danger of being lacerated in case of getting into too strong a current.

On July 24, one of my collectors found several hundred eggs attached to the lower side of a stone in the creek between Upper and Lower Kuantun. (See Plate XIV, figs. 1 and 2.) The stone was partly submerged and about one foot in diameter. It lay on the edge of a large pool and was washed by a gentle current during low water but, being immediately in the stream bed, it was exposed to swift water after rains. Each egg was unpigmented and enveloped by a mass of jelly, some 2 or 3 mm. in diameter, but all the eggs of the group clung together in a solid but flattened mass, which was adherent as a whole to the surface of the stone and completely submerged. The structure of this compact cluster was

in strong contrast to that of the type deposited by *spinosa* in which each egg, in addition to being surrounded by an enormous amount of jelly, was separately attached to a rock surface and only loosely joined to its fellows. In the case of *spinosa*, each egg is protected and anchored, but, once deposited, must take care of itself, while in the type described above, the eggs are lost or survive en masse. One cluster may be plucked off at once, the other must be literally scraped off!

Although I carefully watched the newly discovered eggs, they were eaten by fishes before I was able to identify them. Most probably they were the eggs of *graminea*, matching as they did the mature ova of that species, and coming from a section of the stream frequented by it. It is safe to say that they were deposited by either *andersonii* or *graminea* because no other cascade frog found at Kuatun would be capable of laying so many eggs. The egg clusters of these closely allied species may be expected to conform to a single type and, after all, the type of cluster is the important and interesting question with which we are concerned at the present stage of Chinese herpetology.

### **Rana** (species?)

#### Figure 28

Numerous tadpoles secured in Ch'ungan Hsien (A. M. N. H. 30675-7) and Futsing Hsien (A. M. N. H. 29419) represent a species of this genus, but I am unable to determine with any degree of certainty which one it is. Under *Rana montivaga* and *chunganensis*, I have discussed the possibility that they are the larvæ of one of these two species, probably the latter.

DESCRIPTION OF TADPOLE.—Body two-thirds as broad as long, tail twice as long as body, about three and a half times as long as deep. Nostril nearer to tip of snout than to eye; eyes laterodorsal, much nearer to tip of snout than to spiraculum; distance between eyes a little less than that between nostrils and equal to half width of mouth. Spiraculum sinistral, directed upward and backward, ending in a very short tube, visible from above as well as from below and as far from origin of leg buds as from eye. Vent large, dextral; anal tube rather long, opening by lower border of tail crest. Tail rounded at end, but not broadly so; upper crest slightly deeper than lower, which extends to body.

The mouth is ventral and broad. The lower lip is bordered by an unbroken double row of papillæ, the extremities of the upper by a single one, and extra papillæ may be present in the corners of the mouth. There are four or five rows of teeth above, the outer long and continuous, the next long but narrowly interrupted, while the remaining two or three are short and broadly interrupted. In the lower lip, there are four rows, the first narrowly interrupted but as long as the next two, while the outermost row is a little shorter than the rest.

The back, sides, and fleshy part of the tail are light brown. Small, irregular, unpigmented areas can scarcely be made out on the tail. The tail crests are mottled with light brown. Exclusive of the belly, the entire tadpole is very sparsely spotted with small, irregular areas of dark pigment that are moderately conspicuous when the animal is seen with the naked eye. The belly is generally devoid of color but sometimes faintly speckled laterally and anteriorly. Its skin is transparent. A pair of longitudinal, subcutaneous muscles inserted at the base of the tail are more or less

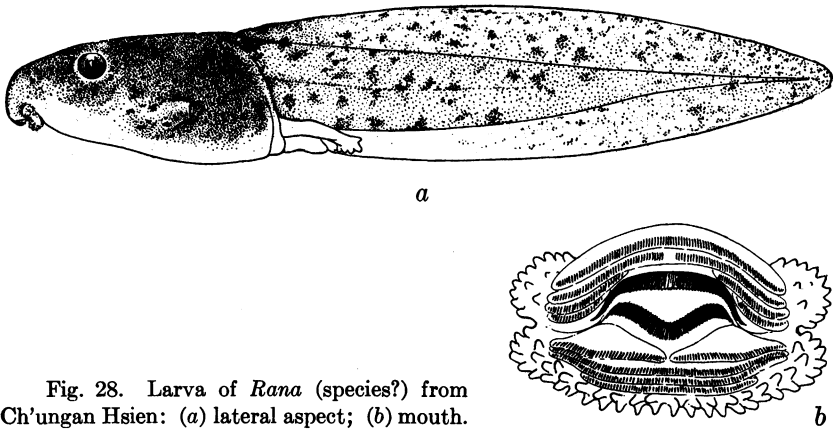


Fig. 28. Larva of *Rana* (species?) from Ch'ungan Hsien: (a) lateral aspect; (b) mouth.

easily seen through the skin of the ventrum. Such muscles are frequently well developed in tadpoles inhabiting mountain streams and are doubtless correlated with current resisting ability.

This description is based upon 11 specimens from Ch'ungan Hsien, leg buds present in all of them. The measurements in millimeters of 2 specimens follow:

BODY	TAIL	LEG BUDS
13	25	4
12	25	10.5

There are four rows of teeth in the upper lip of seven of the 11 tadpoles, but five rows in the remaining four.

This tadpole strongly resembles the one referred to *R. montivaga*, for both of them have four rows of teeth in the lower lip and frequently an equal number in the upper. Their general structure and color are, moreover, much the same. I find, however, two differences that never fail to distinguish them, i.e., pattern and size. In regard to these it should be noted that small, irregular areas of dark pigment are sparsely scattered over the unidentified tadpole but never present in the other, which is little more than half as big as the unnamed form. A comparison

of the respective descriptions will show in addition minor differences and I see no reason why one should have difficulty in recognizing the two larvæ after studying the data set forth here. This question, in view of the uncertainty it involves, is worthy of special attention and hence my pains in presenting it.

This tadpole was not secured at Yenping, although its presence in Ch'ungan Hsien as well as Futsing Hsien makes its occurrence there almost certain.

The following data correlate its development with the season.

CH'UNGAN HSIEN, 1926.—On the ninth of May, four tadpoles with leg buds measuring from 1.5 to 5.5 mm. in length were collected, while on the first and fifth of June, seven more specimens with leg buds ranging in length from 3 to 10 mm. were secured.

FUTSING HSIEN, 1925.—Fifteen immature tadpoles measuring only 6–7 mm. from snout to vent, and a 10 mm. specimen with leg buds 0.5 mm. long, were preserved on September 20, while two additional series, dated October 2 and 4, practically duplicate the first.

#### STAUROIS

The larva of this genus is at once distinguished by its very conspicuous, ventral sucking disc.

#### *Stauois ricketti* (Boulenger)

Plates XIX to XXII; Figure 29

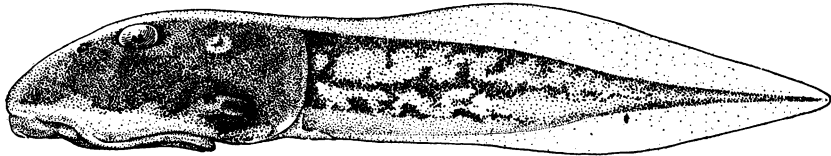
A large series of 232 specimens represents this species: 199 from Ch'ungan Hsien (A. M. N. H. 28660–706, and 29794–945), 31 from Yenping (A. M. N. H. 28370–4, 28418, 28590–602, and 30825–36), and two from Futsing Hsien (A. M. N. H. 29201–2). Numerous tadpoles were secured in Ch'ungan Hsien (A. M. N. H. 29011, and 30650–66), while only one individual was collected near Yenping (A. M. N. H. 31072).

Schmidt's 1927 report included 20 additional Fukien specimens, while A. M. N. H. 37109 from Fukien has not been recorded before.

Boulenger described this form as *Rana ricketti* in 1899 from material collected at Kuatun by La Touche. Vogt reported a single example from Kwangtung in 1914, and Mell (1922) recorded it as the common forest frog of the Kwangtung mountains from 300 to 1000 meters. Boulenger's 1920 'Monograph' gives measurements of three individuals from the Man-Son Mountains of Tonkin, and the American Museum has an example secured through exchange from the Senckenberg Museum, also from Tonkin (A. M. N. H. 23729). It came incorrectly identified as *R. boulengeri*. Stejneger (1925) reports a single Yenping specimen. *S. ricketti* is known, then, from Tonkin, Kwangtung, and Fukien.



In northern Fukien, it is the common frog of the forest cascades, from those of Futsing Hsien, only a few hundred feet above sea-level, to the highest cascades of Ch'ungan Hsien.



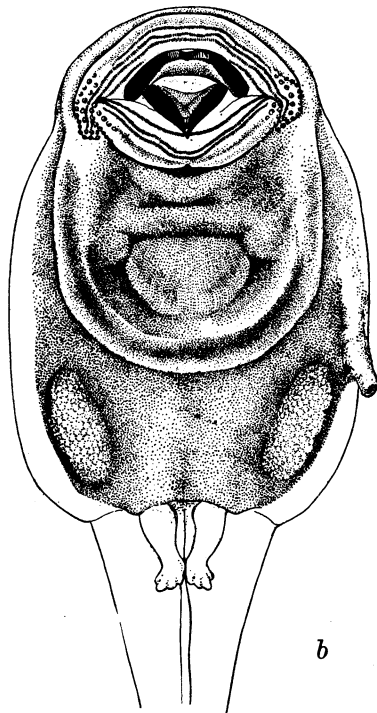
a

Boulenger's description of *ricketti* is ample as I find my series constant in form and color.

Noble (1927, 1929) considers that the ranid forms of eastern Asia, whose larvæ have a ventral sucker, comprise a natural and distinct group, and I have followed him in removing *ricketti* from the genus *Rana* and placing it in *Staurois*.

Boulenger (1920) has already described the unpigmented, distinctly spinous nuptial pads on the first fingers of males but he did not notice the considerably thickened forelimbs of that sex. I have shown, by examination of 94 Ch'ungan Hsien specimens, that the females attain a slightly larger size than the males. The ten largest females among 49 measure from snout to vent 63, 61, 61, 61, 60, 60, 58, 58, 58, and 58 mm., and average 59.6 mm., while the ten largest of the 45 males measure 57, 57, 56, 55, 53, 53, 52, 52, 52, 52, mm., averaging only 53.9 mm.

The tadpole of *ricketti* was figured by me in 1927 and described as well as again figured by Noble in 1929. A general description will be given below, but for a detailed account of the structure of the ventral sucker, Noble's paper and figure should be consulted.



b

Fig. 29. Larva of *Staurois ricketti* from Ch'ungan Hsien, Fukien: (a) lateral aspect; (b) ventral aspect of body showing sucking disc and mouth.

DESCRIPTION OF TADPOLE.—Width of body projected forward from insertion of leg buds reaches to lower mandible; tail slightly more than one and a half times length of head and body, three to four times as long as deep. Nostril twice as far from tip of snout as from eye; eyes laterodorsal, slightly nearer to opening of spiraculum than to tip of snout; distance between nostrils five-sixths of that between eyes; spiraculum sinistral, ending in a short tube, visible from above and below, slightly nearer to insertion of leg buds than to eye; vent median, not involved in ventral tail crest. Tail tapering in immature, less so in mature tadpoles; bluntly pointed or rounded at end; crests only moderately wide, the lower very low anteriorly, barely or not reaching vent. Belly flat, provided with a well-developed sucker continuous anteriorly with the lower lip and surrounded laterally and posteriorly by a free border of skin. The sucker is as wide as, or slightly wider than the mouth and reaches posteriorly a point removed from the insertion of the leg buds by a space equal to one-fourth the distance between the tip of the snout and the insertion of the leg buds. A conspicuous poison gland lies on either side of the belly just behind the sucker. (Noble states that this sucker bears along the posterior edge of its central depression an area of tuberculated skin which functions as a friction surface. He adds that the chief difference between the sucker and the ventral body-wall of *Rana* tadpoles lies in the free fold of integument forming the lip of the sucker's central depression and in the attachment of the ventral musculature of the integument within this rim.)

The mouth is ventral and about two-thirds as wide as the body is broad. With the exception of a few small ones in the corners, the lips are devoid of papillæ. The lower lip, even though continuous with the sucker, has a free edge behind and bears three long, equal rows of teeth, the innermost narrowly interrupted in the middle. The upper lip has four rows of teeth, only the innermost of which is interrupted, while the outer borders the lip and is shortened. The two middle rows are long and, together with the interrupted innermost row, seem to overlap the rows of the lower lip in the corners of the mouth, an appearance produced by a distinct forward fold in the lips where they meet. The teeth of all the rows but the one bordering the upper lip, are fine and set so closely together that they are not readily seen as distinct units even under the high power of a binocular microscope.

In life, this tadpole is jet black above, finely mottled with inconspicuous, bright yellow markings that shine like gold. As the larva matures, both the black and yellow lose their intensity. The ventrum is unpigmented.

The foregoing description is based largely upon a mature tadpole measuring 13 mm. from tip of snout to the insertion of the leg buds, which are just 3.5 mm. long.

One could scarcely imagine a tadpole more perfectly adapted to life in swift water than this one of *ricketti*. The depressed, evenly rounded dorsum, the flat ventrum equipped with an efficient sucker and continuous in profile with the well-developed tail, compose a perfect whole. The large mouth, so well equipped with strong mandibles and close-set teeth arrayed in long rows, is doubtless correlated with the habit of feeding on the surface of boulders while resisting the pressure of swiftly flowing water.

About San Chiang and Kuatun, this was the only tadpole among the many forms living in the swift streams that deliberately chose to spend much of its time in strong currents and it thus avoided competition with all the pool-inhabiting species. On the other hand, it did seem to compete with *Hemimyzon zebroidus*, a specialized loach also provided with a means of holding itself to the surface of boulders submerged in strong currents. In June, the young of this fish and immature *ricketti* tadpoles were of nearly equal size and both could be seen slowly progressing over the boulders as they fed on the rock surface. It was not easy to distinguish fish from amphibian! *S. ricketti* tadpoles can swim through open water but they are reluctant to do so and seem to require a flat or convex surface to rest upon, because, when put in glass vessels whose walls do not fill these requirements, they make endless efforts to fit their concavity to the vessels' convexity. One afternoon, near San Chiang, I observed a large *Pachytrion brevipes* moving over the surface of a submerged boulder casually devouring tadpole after tadpole of *ricketti*. The victims seemed to be unaware of the approach of an enemy and proved easy prey.

*Staurois ricketti* is the most successful cascade form of northern Fukien because it occurs in large as well as small streams and has little or no altitude preference. It may be found in all the swift, shaded water courses about San Chiang and Kuatun where it is the most abundant frog. Its small size allows it to find concealment under almost any cover, while its greatly depressed body, large digital discs, powerful legs, webbed feet and tough skin enable it to cope with the swiftest water or most slippery of rock surfaces and secrete itself in the narrowest of cracks. In addition, its color and flattened body render it very inconspicuous. It is largely nocturnal but I have often seen it abroad through the day, especially under an overcast sky and in deeply shaded cascades. It is most numerous and active on still, clear nights, however. While hunting this frog, I was constantly astonished at its agility on rock surfaces so slippery that progress would seem impossible. Its ability to leap great distances, dive into falling water and slip into cracks and crevices that scarcely appear to exist is astounding. When pursued, it either remains motionless until actually picked up or makes a series of great leaps that take it far from danger. Thus, it sometimes appears to depend upon its protective pattern for safety. I observed almost daily for some weeks two or three of these frogs that apparently spent a large part of each day reposing in a shallow, protected pocket worn out of the side of a huge boulder lying over and across a waterfall in the main Kuatun creek. If

approached too closely, they would disappear in the foaming torrent below but they were slow to take alarm. I once found a *ricketti* in the stomach of a green pit-viper, *Trimeresurus gramineus stejnegeri*, and doubtless great numbers go the same way because at Kuatun this snake haunted the streams.

I am in doubt about the extent of the breeding season at San Chiang and Kuatun because, from the sudden appearance of countless tadpoles early in June, 1926, one would conclude that eggs had been deposited late in April and through the first weeks of May, but such a conclusion is not substantiated by the discovery of numerous females containing large ova throughout August, while those dissected during July did not show such signs of imminent ovulation. Do these frogs breed twice a year at San Chiang and Kuatun? This question cannot be settled until more data are at hand. A summary of the evidence secured in 1926 from two lines of investigation is given below. The tails are not included in the measurements.

Forty-three tadpoles taken June 4-7 were quite immature and measured only 6 to 9 mm.

Ten tadpoles taken July 10 ranged in size from 11 to 14 mm., while four specimens dated July 15 measured 11 to 13 mm., the largest with leg buds 3 mm. long, the others with leg buds only half this length.

Five tadpoles taken August 11 include one with absorbed tail 18 mm. long, exclusive of its legs, another still retaining a stump of its tail, and 3 measuring 15 mm. with tails partly absorbed. Twenty additional metamorphosing specimens were collected on this same date.

On August 23 the streams seemed to be deserted by these tadpoles.

Six *ricketti* were dissected on August 19 and four of the lot found to contain ripe ova. Additional females with ripe ova were seen on July 29, August 1, 9, 22, and 27.

Eleven lots of well-developed ova were counted and found to contain 717, 681, 664, 657, 638, 631, 614, 573, 550, 491, and 483 ova, respectively, or an average of 609 per lot. These ovarian eggs measured 1.5 mm. in diameter and were unpigmented.

### **Polypedatidæ**

#### **POLYPEDATES**

The larvæ of these frogs are included in the key preceding the genus *Rana*, page 484.

#### **Polypedates dennysi** (Blanford)

Plate XV and Figure 30

Forty-nine specimens represent this species: 21 from Ch'ungan Hsien (A. M. N. H. 28899-900 and 30513-31), 27 from Yenping (A. M.

N. H. 28110-36), and one from Futsing Hsien (A. M. N. H. 29200). Tadpoles and recently metamorphosed individuals were secured from Ch'ungan Hsien (A. M. N. H. 30693-9 and 30701) and Yenping (A. M. N. H. 31073, 31075 and 31077), while a single larva was collected at Hok'ou (A. M. N. H. 30770).

Schmidt's 1927 report listed three additional specimens: one from Yuchi or Yuki, a locality about 35 miles south of Yenping, one from Yenping, and one without a more specific designation than Fukien. I place here, in addition, two specimens: one from Pinghsiang (A. M. N. H. 670); the other from foothills opposite Changsha, across the Siang River (A. M. N. H. 13192). Schmidt identified these as Boettger's *P. exiguus* described in 1894 from Chinhai, near Ningpo, probably because of the lack of a good series of *dennysi* for comparison. The two specimens match my series of this species perfectly and, in fact, the Pinghsiang individual was originally labeled *dennysi*. It is a male, and Schmidt was misled by the smaller webbing. The "row of well-defined white spots along the sides" also misled him, but the abridged description below shows that *dennysi* almost invariably possesses such a row.

A. M. N. H. 5792, collected by Andrews and Heller at Yenping, has not been previously reported.

This frog was described as *Rhacophorus dennysi* in 1881 from a specimen of doubtful origin. Boulenger later secured a second individual from Foochow and three more from Kuatun. His 1899 description was based upon all of these specimens, the only ones known at that time. Since then, it has been reported from Pinghsiang (Wolterstorff, 1906); near Yenping (Stejneger, 1925); "within 20<sup>1</sup> miles of Foochow" (Stejneger, 1925); and Kwangtung (Vogt, 1914). Mell (1922) gave three additional Kwangtung records: east of Shiuchow; "Fung wan"; and the Hunan border region; while Vogt (1930) lists three examples from Kwangsi.

L. S. Chen (1929) described *P. feyi* from Yaoshan, Kwangsi, but in his full description I can find only one significant point that distinguishes his species from *dennysi*. He states that in *feyi* a strong, dermal fold extends along each side of the body, a most extraordinary character for the genus. In spite of this difference, I believe that *feyi* is identical with *dennysi*.

This is such a distinctive species that an elaborate description is not needed, those already extant being quite sufficient. There are, however, a few minor points to be cleared up. I find that among my series of 49

<sup>1</sup>Not "200 miles," as stated by Stejneger. Mr. Kellogg, the collector, has personally pointed out this error to me.

<sup>2</sup>Described as a market town about 36 km. east of Shiuchow.

specimens the lateral white spots are totally absent in but one individual and evident only as a mere trace in three others. They may, very rarely, form an almost continuous line. The brown, light-edged, dorsal spots exhibit a great range of variation in form and size, are frequently lacking, and never tend to be symmetrically arranged. Such markings are scarcely to be considered normal. Among 21 Ch'ungan Hsien specimens, they are absent in ten, quite evident in six, and very small in five, but among 27 from Yenping they are lacking in only three, quite evident in 17, and so profuse that they tend to run together in seven. There are

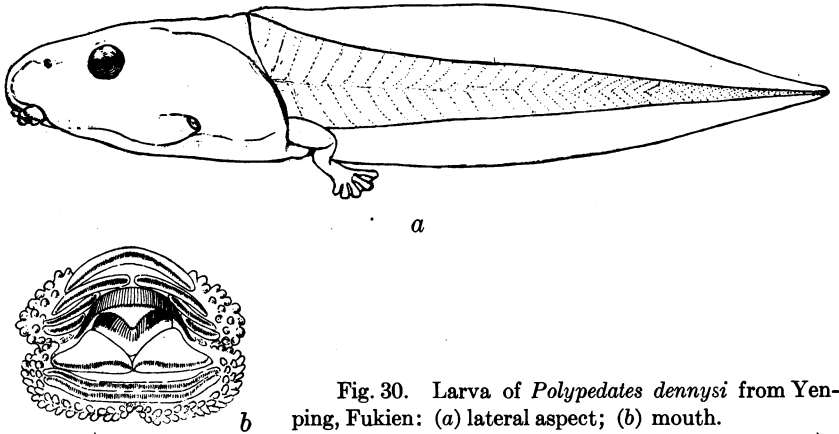


Fig. 30. Larva of *Polypedates dennysi* from Yenping, Fukien: (a) lateral aspect; (b) mouth.

no such spots on the single Futsing Hsien frog. The only generalization one can make is that they tend to be present anteriorly rather than posteriorly. The violet of the lower jaw, though always variable in amount, is entirely lacking in a young specimen only 40 mm. in length from snout to vent. In this example, even the upper jaw is light-edged. This violet is lacking in only one adult among 49, so I am convinced it develops with age. The half-grown Changsha specimen measures 67 mm. from snout to vent and lacks all trace of this violet.

Sexual dimorphism in size is marked. The new series of 49 specimens from Fukien is made up of one juvenile, 29 males, and 19 females. The 11 largest males range in length from 90 to 99 mm., and average 91.9 mm., while 16 of the 29 measure from 86 to 91 mm. The smallest of the series is 79 mm. in length. The 12 largest females range from 108 to 115 mm., averaging 110.8 mm., while the smallest of the 19 is 98 mm. long. Breeding males have a smooth, inconspicuous pad on the

inner side of each first finger, while, curiously enough, the metacarpal tubercle of the female is better developed than that of the male.

The Fukien locality records for *P. dennysi* prove that it is universally distributed throughout the Min River Valley from the highest Ch'ungan mountains to the low altitudes of Futsing Hsien. I was unable, on account of its secretiveness, to ascertain just what the limits of its habitat preference are. One is not surprised that such a large frog is shy. Obviously, *dennysi* is a mountain dweller but just how widely distributed it is through the flat country I cannot say. The Futsing Hsien specimen was probably taken on a mountain slope. In fact, I learned little of the non-breeding behavior of this frog, for only once did I detect its presence away from a breeding site. Bamboo forests at all altitudes on the mountain slopes of Fukien and neighboring provinces may be taken as its most typical habitat. This by no means implies that it is not found in other than bamboo forests.

We spent part of April, 1925, in a temple high up on the side of a wild, forested gorge in the mountains above Yenping. There was a shallow spring under a bush some ten feet high, just in front of the temple. Low, thick clouds and a heavy rain, on the afternoon of April 25, shut out most of our light and made the middle of the afternoon resemble dusk. Several *P. dennysi*, confined in a bucket near the spring, began to call, and soon their calling was answered from the drenched bamboo groves surrounding the temple. The answers grew more and more numerous and one could make out large forms leaping about the temple yard. By five o'clock, the frogs were present in great numbers and very obviously trying to pair off, but the dim light and their extreme agility prevented my following their movements closely. Soon I saw a mated couple near the brush which was growing over the spring.

The downpour continued, but by eight o'clock a mated pair had ascended the bush and begun to lay on the leaves of a limb which was overhanging the spring. During the process, other males moved restlessly about over the embracing frogs, and indeed, on the same bush at another time, I saw a mass of at least six frogs clinging together about what appeared to be a single female.

The laying pair were not greatly disturbed by intermittent light and I was able to observe some of the details of the process. The grasp of the male was axillary, while the female clung to the leaves of the bush with her forelimbs. The male held his feet together with their dorsal surfaces pressed against the posterior end of the female's body, but at regular intervals he slid them dorsally, bringing their upper surfaces

against the end of his own body for a very brief instant, after which they were returned to their original position against the female. The female on her part was now resting, now moving her feet around and around in a paddling motion over the surface of the leaf just behind the pair. The two sets of motions seemed to be correlated thus: the beating was begun by the female, the shuttle-like motion of the male following the first few beats. All the movements were quite mechanical and deliberate. The female's center of beating was shifted to some extent but the male did not take part in it. Intervals of rest followed 12 to 15 strokes as a rule, but there was much variation in this respect. Unfortunately, the great size of the male's feet prevented any observations on the actual process of egg and mucus expulsion but the steady increase in size of the froth-mass on the leaf below proved that expulsion was taking place. The whole process lasted about four hours.

Females of *P. reinwardtii* (Siedlecki, 1909) and *P. leucomystax* (see *P. l. leucomystax*, p. 574) will go through the whole laying and beating process when no male is present, so we may conclude that stimulus by the male is not always indispensable and that the female, in some species, takes an almost independent part in the process. If the same is true in *dennysi*, I think it is reasonable to interpret the interrelation of the movements described above as follows: the female is stimulated to begin her beating movements by the outward passage of the eggs and mucus, the arrival of which upon the feet of the male causes it to make the shuttle-like movement and eject its spermatic fluid on to the eggs and mucus adhering to its feet. The return of its feet to their original position carries the mucus and eggs back to within reach of the stroke of the female's feet.

Comparing this method to that of *P. schlegelii* described by Ikeda (1897), I find them strikingly similar, in spite of the fact that he has not interpreted the motion of the male just as I have. Okada (1927) seems to disagree with Ikeda, for the former, in writing about *P. schlegelii* states that, "Both [the sexes] move the hindlimbs similarly at the same time. . . ." Siedlecki (1909), in describing the process as observed in *P. reinwardtii*, records that the male and female beat the froth up together. Different species might well be expected to vary somewhat in method of foam-nest production, but here we have disagreement of a human as well as an amphibian nature!

As might be expected from the gregarious breeding habits described above, the nests of *P. dennysi* are often found hanging in great numbers from a single tree or bush, but there seems to be no hard and fast rule in



this regard (see Plate XV, figs. 1 and 2). I have seen several dozen nests but have no record of one that was not hanging directly over water, nor have I found one placed in grass. The highest nest observed was adhering to the leaves of a tall tree at a point some twenty-five feet above the pool below. Siedlecki (1909) found any number of *P. reinwardtii* nests carelessly placed so that they were not above water, but Okada (1927) is of the opinion that *arborea*, the tree-inhabiting form of *P. schlegelii*, is anything but careless in depositing its eggs, thus resembling *dennysi* rather than *reinwardtii*. Okada adds that the eggs of *arborea* are placed from one to four meters above the water. One point should not be overlooked, i.e., the bad results of irregular placing of nests would be expected to vary with climate for, where the rainfall and humidity are great, the larvæ stand better chances of being washed into permanent pools of water. It is not surprising, then, to find precision of egg placement well developed in the northern forms. It would be interesting to determine by experiment and prolonged observation just how one of these frogs can tell when it is directly over a small pool of water, let us say, twenty-five feet below!

The nest of *dennysi* is not placed between or wrapped about by leaves like that of *reinwardtii* (Siedlecki, 1909), nor do the tadpoles gather in a central chamber as, according to Siedlecki, do those of *reinwardtii*.

In regard to the enclosure of the nest by leaves, Okada's observations on *P. s. arborea* also brought only negative results, while he describes its nest, after hatching has occurred, as "semi-fluid for about one-third of the inner part," a phrase well applicable to the advanced nest of *dennysi*. Such a semi-fluid condition is in strong contrast to a well-defined chamber holding a neat little pool of liquid as shown by Siedlecki's figure.

Okada (1927) gives the measurements of the nest of typical *schlegelii* as 50×78 mm. minimum, and 73×110 mm. maximum, and the number of eggs contained from 350-660. His corresponding figures for the variety *P. s. arborea* are 70×55 mm., and 152×243 mm., and 300-800. The eggs of the typical form are only 3, those of *arborea* 3.5-4.0 mm. in diameter. *P. reinwardtii* lays but 60-90 eggs, each with a diameter of about 3 mm., in a nest measuring 50-70 mm. across (Siedlecki, 1909). Three nests of *P. dennysi* counted by me contained 2415, 2544, and 2844 eggs, each egg approximately 2 mm. in diameter. I found the nests so variable in size that I did not record their dimensions, but the largest measured some 250×150 mm. It is doubtful if these measurements of a

few nests are of value, but data based upon both weight and size of a large number would be of interest for comparative purposes.

I do not see that any generalizations can be deduced from the above figures unless we wish to consider the breeding habits of *reinwardtii* to be more highly specialized in the direction of foam-nest production, a view substantiated by the greater efficiency of the nest as a protection for the eggs and larvæ. This is shown by (1) the more careful construction (enclosure by leaves) and greater durability of the nest (retention of liquid within) and (2) the greater dependence of the early larvæ of *reinwardtii* upon the nest, as proved by Siedlecki's statement that newly hatched larvæ of that species cannot survive when placed in water. In the case of *dennysi*, I found that even unhatched larvæ, entirely lacking gills and unable to move, would survive if taken from the foam and placed in water.

The following data indicate the extent of the breeding season of *dennysi* in northern Fukien. On April 14, 1925, I first saw its foam-nests on a bush near the temple in which we lived while working in the Yenping mountains. Breeding took place at this same site as late as May 4. Although we remained there until early in June, the frogs did not return to breed after the first week in May. I saw nests in the San Chiang region April 25 and May 13 and 15, 1926 (Plate XV).

At Yenping, on May 29, 1925, immature tadpoles, with bodies but 8 mm. long, and barely mature ones with leg buds measuring only 1 mm., were collected, while the Yenping specimen described in detail below possessed 8 mm. leg buds when it was killed on June 1, 1925. The single Hok'ou tadpole was collected between June 28 and July 12, 1926, when its leg buds were 11 mm. long.

Two small wild pig wallows in a bamboo grove on the very top of the high range opposite Kuatun Mountain contained a large company of *dennysi* tadpoles as well as numerous hynobiid larvæ. I was able to follow the development of the frog tadpoles from May 29, 1926, when they entirely lacked leg buds and measured 12-15 mm. from snout to vent, to August 30. At this latter date, they had metamorphosed en masse, the pool being quite devoid of them. The newly-transformed froglets, with only a black spot where the tail had been, measured 14 mm. from snout to vent.

The foregoing data indicate that mating took place near Yenping from the last of March well into May, 1925, while, in the higher Ch'ungan Hsien mountains, it began and ended perhaps two weeks later. The rather specific data show that, in the latter locality, metamorphosis occurred late in August.

Kreyenberg (1907) wrote that the call of *dennysi* has a metallic tone like that of a xylophone. I would describe it as a clear, liquid sound suggestive of a flute. The note is repeated in rapid succession and the result is remarkably pleasing. It is little wonder that a Chinese took one of these frogs, the type specimen as a matter of fact, to Singapore, or that a ritual for the worship of this unique amphibian has developed in Kiangsi and Fukien where, at certain times, it is even carried about the streets on the shoulders of men.

Kreyenberg (1907) first reported the froth-nest and larva of *dennysi* but he recorded no details.

DESCRIPTION OF TADPOLE.—Width of body three-fifths its length; tail twice as long as body, three and a half times as long as deep. Nostrils as far from tip of snout as from eye or slightly nearer to latter; eyes dorsolateral, as far from spiraculum as from end of snout; distance between nostrils four-fifths of that between eyes. Spiraculum sinistral, without tube, scarcely visible from above, plainly visible from below, its opening as far from insertion of leg buds as from eye or a point midway between eye and nostril. Vent dextral, about in the middle between muscular portion and lower border of tail. Tail acutely pointed, upper crest slightly deeper than lower, not extending on to back.

Lower lip, sides of mouth and extremities of upper lip, bordered with a double row of papillæ, except for a narrow notch at the middle of the lower lip. Teeth of upper lip in five rows, the outer continuous, the second narrowly interrupted and the three inner broadly so; those of the lower in three long rows, only the inner of which is barely interrupted.

In life, the body is greenish brown laterally and dorsally, and lighter below. The tail is dull green, richly mottled with dark brown. The green element of the coloration is noticeable under close scrutiny only.

This description is based upon the well-preserved Yenping series.

One specimen (A. M. N. H. 31073), the subject of a water-color, has leg buds 7 mm. long and measures 41 mm. from tip to tip. Its tail alone is 27 mm. in length.

DEVELOPMENT OF TADPOLE.—A developmental series (A. M. N. H. 31103) was taken from the froth-nest made by the pair of frogs whose behavior while depositing their eggs is described on pages 565-6. Beginning twelve hours after deposition of the nest, several embryos were placed in a fixing solution every successive 12 hours for 228 hours, or more than nine days. In addition, immature tadpoles from the same lot were preserved at 11-, 15- and 25-day periods. It is not within the scope of this paper to go into details of the first embryonic stages, but a brief outline of the landmarks of early development of the tadpole certainly is not out of place and should be of great use to field workers. It should be remembered that this series shows growth under natural conditions

because the eggs were allowed to develop undisturbed on the original bush.

The embryos, at approximately 156 hours after fertilization of the eggs, were still coiled about the yolk and quite pigmentless but gill buds were evident. Twelve hours later, some pigment was visible, while adhesive discs and large gill buds were very distinct. The larvæ were then no longer confined to the egg capsules. In the field, several tadpoles at this stage were accidentally dropped into water along with some enveloping froth from which they immediately wriggled free. The following morning, ninety per cent of them were alive. Previous to gill formation, same unhatched tadpoles of another lot were placed in water and 11 of 12 survived and lived until absorption of the gills had taken place several days later. Normally, the tadpoles probably remain in the froth until hatched, when they drop into the water below. The hatching process most likely releases enough liquid to cause the froth to begin to break down and flow (Siedlecki, 1909), and in the absence of formation of an inner reservoir or chamber, as in *P. reinwardtii* (Siedlecki, 1909), the larvæ must wriggle free almost at once and fall downward. In case of their being washed free by heavy rains before hatching, chances of survival would still be good. At 180 hours, the gills were much larger and more pigment was evident in the eyes and on body and tail, while at 192 hours the colorless gills had reached their maximum development. Each gill was made up of two large, lower stalks and an upper, small one. About eight long rami branched out from the large stalks and four short ones from the small one. The long rami averaged 1 mm. in length and spread out fanwise, while the rami of the small, upper stalk were only half this length. The body and head together measured 3.5 mm. At 204 hours, the tadpoles were well pigmented with gills persistently large and adhesive discs still very distinct, but it is about this time that the gills were reduced because, 12 hours later, they were noticeably shorter. At this stage (216 hours), the lower lips were partly formed and, 12 hours afterward, the whole mouth had taken shape and dark edges could be seen on the developing mandibles. The adhesive discs were barely separated from the sides of the rather large, toothless lower lips while, as a whole, the final body form had been assumed. The average body length, taken together with the head, was 4.5 mm., that of the tail 8.5 mm. In spite of the larvæ having acquired their final shape and almost absorbed their gills at the 228 hour or nine and a half day stage, they were still far from being completely developed. My next series was fixed 36 hours later at the end of the eleventh day

by which time the following changes had taken place: (1) the gills were entirely gone and no openings were to be seen where the right ones had been, while on the left, the spiraculum had, in every case, assumed its final form; (2) most of the teeth and papillæ were present in the almost normal mouths; (3) the average length of body and head had increased to 5.5 mm., that of tail to 9 mm. Growth in size soon reached its maximum rate, for, by the fifteenth day, the average body and head length was 8, the tail 11 mm., but during the subsequent ten days, the average body and head length increased but 1, the tail 2 mm.

The only changes that took place after the eleventh day, other than normal growth, were the addition of teeth and assumption of final shape by the labial papillæ. Some interesting details, shown in these final stages, are described below. At 11 days, only the outer row of teeth of the upper lip was well formed, but it was the two INNER rows of the lower that were correspondingly distinct. The inner row of the lower lip was plainly interrupted in the middle, as was the row of adjacent papillæ. At 15 days, the lower lip possessed all its rows of teeth but, in the upper, only the three outer rows were well formed, the fourth barely evident in only three among seven larvæ and totally lacking in the remaining four. The interval in the innermost row of the lower lip, as well as that in the adjacent papillæ, had become much less evident. At 25 days, even though the leg buds had appeared as two protuberances each 0.2 mm. in length, the upper lip still lacked the shortest or fifth row of teeth! We see, then, that in *dennysi*, the innermost rows of teeth of the upper lip are developed last, while apparently the reverse is true in the lower lip. These data are not detailed enough to prove what the entire dental developmental succession is, but one would judge that it is uniformly toward the mandibles in the upper, away from them in the lower lip. The narrowing of the gap in the innermost row of teeth and the bordering papillæ of the lower lip are interesting and significant minor developments.

It is impossible to say just how much importance can be placed upon data of this kind until they have been followed up in various species, but I do not see why such evidence cannot be taken into consideration when relationships are in question. If species of a single genus have varied larval dental formulæ, these different combinations must have evolved along with the several species, and, why may we not work our genetic relationships based upon this as well as upon any other kind of evidence? The larval dental pattern of any related group, though differing much from species to species, undoubtedly is constructed upon a

fundamental, primitive plan from which all the specific formulæ have been derived, and this pattern might be determined through a study of the order in which the various rows and teeth appear in the very young tadpoles.

The mature *dennysi* tadpole shows no signs of adaptation to life in running water, nor did I ever find it in such, even though one Ch'ungan Hsien froth-nest was directly over a pool of quiet water caught in a cavity of the bed rock of a swift mountain-stream. It is hard to believe that the breeding adults can tell exactly what the nature of the water beneath is, so one would expect to find nests over the quieter stretches of mountain streams if not over the cascades. But what chance would a newly hatched tadpole have in water flowing over rocks at even a moderate rate? This is an interesting question to be followed up in the field.

The *dennysi* larvæ inhabiting the pig wallows described above suffered from the attacks of the *Hynobius* larvæ living in the same pools. After the latter had attained a good size, all of the *dennysi* tadpoles possessed badly mutilated tails.

#### **Polypedates leucomystax leucomystax** (Gravenhorst)

##### Figure 31

A series of 80 specimens from Nodoa represents this form (A. M. N. H. 25891-970). In addition, there are numerous tadpoles from the same locality (A. M. N. H. 27433).

In these Hainan frogs, the skin of the top of the head is not free as in the Fukien series, so I am following Stejneger (1925) in calling the mainland form *P. l. megacephalus* and considering that typical *leucomystax* only reaches Hainan. I must admit, however, that a careful examination has failed to reveal any other constant difference between mainland and insular specimens and, in the case of young individuals, it is impossible to separate the forms because, in the Hainan frogs, the skin becomes ossified with the skull only after a certain age has been reached. The posterior aspect of the femur may be very vividly marked in some Fukien individuals but such is also the case in the Hainan series and there is really no appreciable difference in this respect. The single diagnostic character, insignificant though it may be, is extremely constant and, in my opinion, sufficient to warrant separation into subspecies. It should not be forgotten that most of the forms found on Hainan are closely allied to those from Indo-China rather than to typical Chinese ones and the present case only adds another to the long list of cases already recognized.

*P. l. leucomystax* is a widely distributed Malayan form that even reaches the Philippines. I will not attempt to outline its range because various authors (Annandale, 1912, etc.) have suggested its division into numerous forms whose ranges do not interest us here. It was first reported from Hainan by Boettger in 1888 as *Rhacophorus maculatus*. Additional Hainan records are by Boulenger (1899), Boettger (1894), Barbour (1912), and Smith (1923).

Sexual dimorphism in size is marked. The series of 80 specimens is made up of 33 male, 45 female and two juvenile examples. The 12 largest males range in length from 50 to 55.5 mm., averaging 51.5 mm., while 15 of the 33 are from 48 to 50 mm. long. The 11 largest females

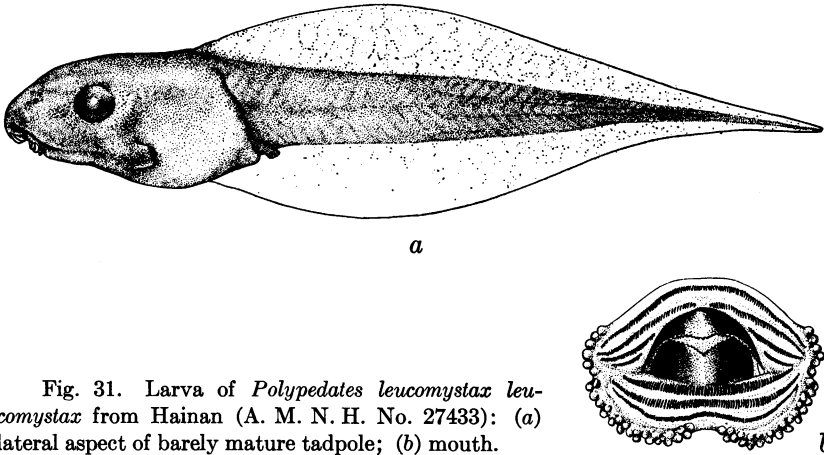


Fig. 31. Larva of *Polypedates leucomystax leucomystax* from Hainan (A. M. N. H. No. 27433): (a) lateral aspect of barely mature tadpole; (b) mouth.

range from 69 to 75 mm. and average 71.1 mm. in length. The females are not so uniform in size as the males, for 20 of the 45 specimens measure from 64 to 69 mm. in length. A smooth but moderately well-developed nuptial pad is present on the inner side of each first finger and a much smaller one on the second finger in breeding males.

An extensive mating season is indicated by a tadpole with its tail more than half absorbed, dated May 8, 1922, and records of froth-nests seen on May 8 and June 9 of the same year. These data, meagre though they be, show that mating took place about Nododa in 1922, at least from the last of February through the first part of June, and it is safe to assume that these dates mark anything but extremes. Flower (1899) gives details for this species as follows: "I have noticed tadpoles in the following months: January, February, March, April (Singapore); May

(Kedah); June and July (Bangkok); November (Penang); December (Singapore); and newly transformed young were just leaving the water in September, 1898 in Singapore."

One froth-nest contained 455 eggs, each unpigmented and 1.5 mm. in diameter.

A female held alone in a glass vessel deposited eggs, beating the surrounding mucus into a froth-mass of normal appearance. The significance of this behavior is discussed under *P. dennysi*.

### **Polypedates leucomystax megacephalus** Hallowell

#### Plate XV

This form is represented by 107 specimens: 83 from Ch'ungan Hsien (A. M. N. H. 28855-70 and 30056-122) and 24 from Yenping (A. M. N. H. 28352-69 and 28546-51). Tadpoles were secured from Ch'ungan Hsien (A. M. N. H. 29014, 30612 and 30704-6) and Yenping (A. M. N. H. 31081).

A. M. N. H. 37102 was collected in Fukien by Caldwell but has not previously been reported.

As stated under *P. leucomystax leucomystax*, I am following Stejneger (1925) in applying the name *megacephalus* to specimens of *leucomystax* from the Chinese mainland only. The following records of this species from China, and Hongkong, the type locality of *megacephalus*, probably belong here: Lilong and Fumun, Kwangtung (Müller, 1878, as *maculatus*); Canton (Boettger, 1888, as *Rhacophorus maculatus*; and Vogt, 1924, as *Rhacophorus leucomystax*); Swatow (Boettger, 1885, as *R. maculatus*); Kwangtung (Vogt, 1914, and Mell, 1922, as *R. leucomystax*); Kwangsi (Vogt, 1930, as *R. leucomystax*); Foochow (Stejneger, 1925); Kuatun (Boulenger, 1899, as *R. leucomystax*); Mohkanshan, Chekiang (Wilder, 1921, as *R. leucomystax*) and Soochow (Gee, 1919, as *R. leucomystax*); Hongkong (Guenther, 1858, as *maculatus*; Boulenger, 1882, and Boettger, 1888, as *R. maculatus*; Boettger, 1894, as *R. leucomystax*; and Hallowell, 1860 as a new species, *megacephalus*); Kowloon Mountain, near Hongkong (Wolterstorff, 1906, as *R. leucomystax*). Stejneger (1907), Van Denburgh (1912), etc., give Formosan records. This is the common tree frog of Fukien where it ranges from the lowest levels to the larger valleys of the Ch'ungan Hsien mountains. We found it abundant about Yenping and at San Chiang. Our failure to secure specimens in Futsing Hsien is readily explained by our presence there in the late summer and fall, probably after the end of the breeding season. Mell (1922) reported it as abundant on the plains of southern Kwangtung but rare at 500-600 m.



altitude in the mountains of the northern part of that province. These observations do not entirely agree with my own, for we found *mega-cephalus* abundant in northern Fukien at altitudes much greater than 600 m., and Wilder (1921) saw larvæ "perhaps 600-800 feet below the top" of Mohkanshan.

As in Hainan *leucomystax*, sexual dimorphism in size is marked. The series of 83 Ch'ungan Hsien specimens is made up of 53 males, 29 females and one juvenile. The 11 largest males range in length from 47.5 to 52 mm., averaging 49.0 mm., while the corresponding figures for the 29 females are 65 to 71 and 67.1 mm. The frogs of this series are slightly smaller than those of *leucomystax* from Hainan but the difference is not great. Breeding males from Ch'ungan Hsien possess a nuptial pad on the inner side of the first and second fingers just as those from Nododa do.

At San Chiang and near Yenping, *megacephalus* lived and bred in rock-work terrace-facing supporting the irrigated rice fields. The frogs inhabited cavities between the rocks and deposited their froth-nests in the grass growing over the face of the terraces. Those familiar with oriental rice culture on steep mountains will understand why I do not regard this habitat preference as essentially different from that selected by typical *leucomystax* of the lowlands. The arboreal instincts of any amphibian would, I believe, be satisfied by the climbing concomitant to life in the vertical rock-work supporting, as it invariably does, terraces ascending the mountain sides like so many steps. Moreover, I observed on Hainan what Butler (1903) has already reported, i.e., that typical *leucomystax* often descends to the ground to deposit its nests; so it is obvious that there is no inherent aversion to terrestrialism in the species. It should not be forgotten that the frequent flooding of the fields at the base of the terrace-facing in question transforms that retreat into an ideal breeding site. Thus, the frogs find in their artificial environment satisfaction for their sexual as well as their arboreal instinct.

At San Chiang, where *megacephalus* was very abundant, its froth-nests were seen May 11 and 13, 1926. Small tadpoles were first observed there on May 25, but on June 1 they were abundant. By June 16, the leg buds were 2 mm. long in numerous individuals, while on July 5, large numbers had pushed their forelimbs and were preparing to leave the water. A careful search on September 3 failed to reveal signs of tadpoles at any stage of development. A froth-nest was seen at Yenping May 21, 1925, and five days later larvæ with leg buds 1 mm. long were collected there. These data, meagre though they be, indicate a much

more extensive breeding season for Yenping than for the Ch'ungan Hsien mountains, an indication not surprising in view of the greater altitude of these mountains. This apparently long Yenping season becomes insignificant, however, when compared to the really extensive one of typical *leucomystax* on Hainan and in regions farther south.

The eggs of two froth-nests collected near Yenping numbered 301 and 330, or somewhat less than the 455 found in a *Nodoa* nest of typical *leucomystax*. In view of the smaller size of *megacephalus*, this difference is only what would be expected.

The call of *megacephalus* suggests a setting hen, for it is simply a low cluck repeated about six times in rapid succession, the initial syllable being the loudest.

Siedlecki (1909) concluded that the froth-masses of *P. reinwardtii* are not attacked by insects but I found a large percentage of *megacephalus* nests inhabited by maggot-like larvæ. Okada (1927), in writing about *P. schlegelii*, stated that "a natural enemy of the egg-masses is a kind of Isopoda, which swarm about and eat them"; while Ferguson (1904) writes that, "Sometimes before the outside of the nest has hardened, a species of blow-fly lays its eggs in it and the maggots feed on the frogs' eggs and pass their pupa stage in the nest." His observations were made on *P. malabaricus* in Travancore.

I can find no difference between the tadpoles of *megacephalus* from Fukien and those of Hainan *leucomystax*.

### ***Polypedates oxycephalus* (Boulenger)**

#### Figure 32

A series of 87 specimens from *Nodoa* represents this species (A. M. N. H. 26860-945 and 32958). Numerous tadpoles were collected at *Nodoa* (A. M. N. H. 27432).

Boulenger described *oxycephalus* under *Rhacophorus* in 1899 from Hainan, while Smith, (1923) secured additional material there.

My specimens agree well with the original description except that, as also noticed by Smith in his series, the largest finger web is more than a "distinct rudiment." I do not detect any sexual difference in the extent of finger webbing as does Smith. The coloration of this species is remarkably constant.

In spite of the lack of data on adult females, the following figures indicate that the males are little more than half as long as the females. The new series of 87 specimens includes 54 males and 12 females more than 24 mm. in length from snout to vent. The four largest males

measure 37, 33, 33 and 33 mm., while numerous other individuals are scarcely shorter. The two largest females are only 47 and 33 mm. long, but Smith's longest female among three measured 59 mm., so it may be concluded that my females are almost entirely immature and, in fact, only the largest of them contains ripe ova. Each of the 54 males exceeding 24 mm. in length from snout to vent possesses a large and conspicuous pad with a minutely granular surface on the inner side of the first finger as well as a very poorly developed one on the second.

*P. oxycephalus* was found in great abundance in the cascades of the small river that flows near Nodoa. These cascades are about three and

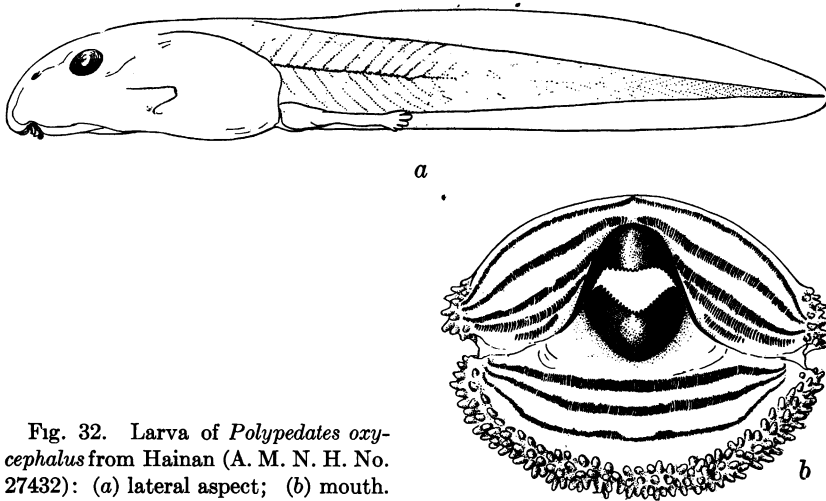


Fig. 32. Larva of *Polypedates oxycephalus* from Hainan (A. M. N. H. No. 27432): (a) lateral aspect; (b) mouth.

a half miles to the southwest of the town. There the water flows down a wide bed of deeply worn, solid rock. The frogs are to be found abroad at night on the rock and in the waterfalls and pools of the stream. Their agility at swimming straight through rushing water is remarkable but it is quite as astonishing to see how they can cling to the wet and slippery face of the smooth bed-rock which they perfectly match in color. In their possession of large digital discs, a compressed light body, slender but powerful legs, large nuptial pads and dark pattern, they are perfectly adapted structurally to life in falling torrents. When taken away from a stream they make huge leaps in any direction until they are exhausted and their bodies covered with dust and dirt which soon kills them by absorption of their natural moisture.

This *Nodoa* cascade is at an altitude of only a few hundred feet but some of Smith's specimens were taken at 800 m., so *oxycephalus* no doubt thrives in all the swift streams of Hainan, regardless of altitude. This indicates great vigor because there is considerable difference between the sun-baked, open cascade of the *Nodoa* River and the heavily shaded, cooler ones on the slopes of Five Finger Mountain where Smith secured his specimens.

I found the tadpoles of this species abundant in the innumerable depressions in the bed-rock of the cascade near *Nodoa*. These depressions are generally but a few square feet in extent and contain shallow water several inches deep, at the bottom of which is found a little fluffy mud. Those examined by me were not connected with the main flow of water and were often separated from the vegetation of the river bank by 20 to 30 yards of bare, rough rock well heated by the sun in clear weather. The behavior of the tadpoles is very distinctive. They live on the bottom of these small pools of quiet water but nevertheless are exceptionally active. When put in a wooden bucket of water they either remain on the bottom or swim to the surface and attempt to crawl up the perpendicular face of the wood. Even the immature ones can do this with some success, while the more advanced ones are extremely adept at it. The slight concavity of their bellies helps in this crawling process but the mouth is also used. Metamorphosing individuals in possession of their legs are agile like the adults and hard to catch. The dark pattern of the tadpoles matches the color of the bed-rock of the stream. It might be said that these larvæ normally live in the stream proper and are found in these depressions only occasionally but the egg-laying habits of the adults in my opinion render this assumption unreasonable. It is not at all improbable, however, that in small streams the tadpoles are found free in the current, because in such places floods would frequently wash out all adjacent pools. In fact, there is no reason why these larvæ should not survive in currents, thanks to their slender bodies, flat bellies, and great agility. The slight concavity of their bellies, together with their large lips, even suggest suction ability and this suggestion is backed up by the fact that I observed them to have such to a limited but definite extent. It might also be argued that quiet pools of water are either absent or too frequently washed out along many streams to permit the development of a species dependent upon them, but this point can be answered, first, by the facts of the *Nodoa* cascade and, secondly, by the admission that this species simply would not survive in such streams. In other words, even "cascade" is too general a term

because, from the point of view of frog life, it may include several niches or sections of swift-water environment. These niches are not easily defined and probably intergrade imperceptibly, but the whole question might be expressed thus: tadpoles with suctorial discs are equipped to compete directly with swift water, while those without such discs have to be satisfied with life in protected parts of the current, or pools, either directly in the main stream or along its side. Several ranid tadpoles are known to have discs and we will call them current dwellers, while innumerable kinds live in swift-stream pools and may be styled cascade-pool dwellers. *P. oxycephalus* possibly represents a third type that is primarily based on the apparent inability of the adults to deposit their eggs directly in a current as the adults of the other two types are able to do. We may call this last the side-pool dweller. One might be inclined to consider the side-pool tadpoles "inferior" to the others but, on the other hand, they could survive in a type of mountain stream with a current too swift for either of the other types,—they have dodged the issue and avoided the necessity of life in swift water.

The breeding season of *oxycephalus* at Nodoa is extensive. This is shown by the fact that metamorphosing as well as small, immature tadpoles were abundant in the same pools on April 16 as well as June 30, and that eggs were discovered August 6. How much greater the extent might be I cannot say, because I did not find the tadpoles until the middle of April and left Nodoa before the middle of August. In spite of Smith's failure to secure larvæ in March, the metamorphosing tadpoles taken in April indicate that breeding goes on at least as early as February, and it very probably continues into September or October.

Pigmented eggs slightly more than half black were found in a side pool of the Nodoa cascade on August 6, 1923. They floated on the surface in small, loosely adherent bunches and were enveloped in transparent jelly. Although I am not in possession of a series of these eggs as absolute evidence, I am sure that they were deposited by *oxycephalus* for six reasons: (1) repeated search of the same pools failed to reveal other species of tadpoles; (2) *oxycephalus* tadpoles of various stages had been and were present in these pools; (3) it is unlikely that a terrestrial frog would have crossed such an expanse of open rock to deposit eggs; (4) constant night visits by a collector had not resulted in the capture of another species in these cascades, so *oxycephalus* probably inhabits them alone; (5) the eggs discovered were pigmented as are the ovarian eggs of *oxycephalus*. The sixth and final reason requires a brief introduction. The question of whether or not *oxycephalus* laid the eggs

described above is of special significance because, so far as known, all but two species of the genus make froth-nests which they deposit on vegetation near water (Noble, 1927). These two exceptions, *reticulatus* and *everettii*, produce large eggs in the capsules of which the tadpoles undergo much of their development. Since the ovarian eggs of *oxycephalus* are small (1.2 mm.), very obviously it cannot be placed in the large-yolk class with *reticulatus* and *everetti*, and seems to represent an entirely new type for the group. Now to go back to the sixth reason: (6) arguing conversely, the discovery of very small *oxycephalus* tadpoles in tiny, isolated pools separated from the nearest vegetation by twenty yards or more of dry rock may be taken as evidence that the eggs of this species are not deposited in masses of typical froth attached to vegetation near water. This is only negative evidence but it is very pertinent here because the real issue is not the habits of *oxycephalus* but the habits of *Polypedates* as a whole, and once we are convinced that *oxycephalus* does not conform it is easy to believe that it has this, that, or any other reasonable breeding habits. The whole question, however, must remain open because of the lack of egg clusters and early larval stages as absolute proof that *oxycephalus* has departed from the usual *Polypedates* breeding habits. It is hoped that some field worker will in the near future take up the problem and work out the life history of this interesting frog in sufficient detail to prove whether or not it has introduced a third type of breeding behavior into its genus.

DESCRIPTION OF TADPOLE.—Body twice as long as wide, two and a half times as long as deep; tail twice as long as body, a little more than four times as long as deep. Nostrils slightly nearer to eye than to end of snout; eyes dorsolateral, nearer to spiraculum than to end of snout; distance between nostrils three-fourths of that between eyes. Spiraculum sinistral, without tube, plainly visible from below, scarcely if at all visible from above, its opening much nearer to insertion of legs than to tip of snout, a little nearer to eye than to insertion of leg buds. Vent dextral. Tail gradually tapering but with rounded tip; upper crest low and even, a little deeper than the lower. The body is distinctly flattened, the dorsum generally rounded and much depressed anteriorly. The ventrum is flat, the line of the lower tail-crest continuous with that of the belly which is slightly concave centrally. A pair of well-developed, longitudinal muscles immediately under the skin partly hide the intestinal coil and are inserted posteriorly at the base of the tail.

Mouth large, with very conspicuous teeth. Lower lip bordered with three or four rows of closely set papillæ. These papillæ are interrupted at each corner of the mouth by a deep notch beyond which they extend for a short distance along the border of the upper lip, where they are in not more than two rows. Teeth of upper lip in one long, continuous, one long, narrowly interrupted, and three broadly interrupted, shortened rows; those of lower in three, long uninterrupted rows of equal length.

In life, the tadpole is finely mottled with black and brown but at a short distance it appears to be uniformly dark. A row of inconspicuous, dark spots extends down the dorsal side of the muscular part of the tail, while its crests are transparent with small, dark spots on the upper one. Ventrally, the tadpole is lighter except over the intestinal coil where it is black.

This description is based upon a specimen 9.5 mm. long to the insertion of the leg buds, which are themselves 5 mm. in length. The tail alone measures just 19 mm. A water-color was made from it in life. The tadpole is still in excellent condition.

**Polypedates** species?

Figure 33

I secured five tadpoles at Nodoa that cannot be definitely identified. Three of them remain in the larval stage (A. M. N. H. 27444) but two

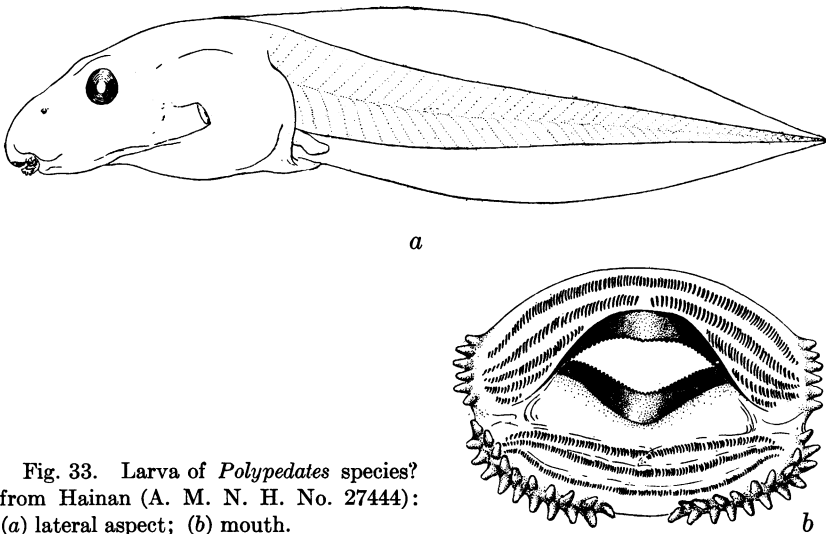


Fig. 33. Larva of *Polypedates* species? from Hainan (A. M. N. H. No. 27444): (a) lateral aspect; (b) mouth.

were allowed to metamorphose (A. M. N. H. 26999 and 27000) and the largest now measures 10 mm. from snout to vent.

The following brief description is based upon these two recently transformed specimens.

No vomerine teeth can be made out. Snout feebly projecting, short and blunt; nostril much nearer to end of snout than to eye. Interorbital space broad, eyes large. Discs of fingers moderate, about equal in size to those of toes. Fingers long, devoid of webs; toes about two-thirds webbed.

Skin generally smooth, entirely lacking pigment, even the limbs being uniformly light yellow.

In life, the color of these minute specimens resembled that frequently assumed by tree frogs of the genus *Polypedates* when their pattern has been lost through exposure to bright light.

During the few days that I was able to observe them, they did not vary in color. The tadpoles are very characteristic, so, obviously, the meagre material represents a distinct species, probably undescribed, and certainly never before collected on Hainan. It will doubtlessly be found in future collections from there, and its tadpole should be recognized after comparison with the following description based upon the single specimen still in full possession of its larval teeth.

**DESCRIPTION OF TADPOLE.**—Length of body one and three-fourth times its width; tail 1.7 times as long as body, three times as long as deep. Nostril about equidistant from eye and tip of snout; eyes lateral, slightly nearer to spiraculum than to tip of snout, the distance between them equal to the width of the mouth. Spiraculum sinistral, not ending in a tube, midway between eye and origin of leg bud. Vent dextral. Tail pointed, upper crest distinctly deeper than lower, barely extending on to back.

The lower lip is bordered with a double row of papillæ broadly interrupted in the middle; the extremities of the upper by a single row. There are five rows of teeth in the upper lip, the outer long and continuous, the next long and narrowly interrupted, the three remaining ones broadly interrupted and successively shortened. The lower lip has three rows of about equal length, the inner very narrowly interrupted or possibly broken through handling. The darkened borders of the beaks have serrated edges.

In life, this tadpole was quite unpigmented and so translucent that the blood gave a reddish hue to the body. The tail crests were perfectly clear. Exclusive of the tail crests, which are still entirely devoid of color, the specimen is now pale yellow.

The body is 7, the tail 12 mm. in length, while the leg buds measure just 1 mm.

These tadpoles were taken in quiet water near Nodoa. The described specimen was killed on June 4, 1923, after a water-color had been made of it. Another individual, the forelimbs on the verge of appearing, was preserved on June 20, and still another on the twenty-seventh after its forelimbs had emerged but before absorption of the tail.

#### PHILAUTUS

The larvæ of these arboreal frogs are included in the key preceding the genus *Rana*, page 484.

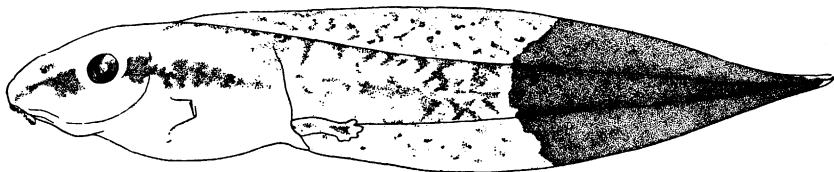
#### *Philautus doriæ* (Boulenger)

Figure 34

Twenty-six specimens from Nodoa represent this species (A. M. N. H. 26756-78 and 32941-3). A large series of tadpoles was also secured at Nodoa (A. M. N. H. 27443).



This form was described in 1893 from the Karin Hills, Burma, as *Chirixalus doriæ*. Annandale (1912) reported a specimen from an altitude of 400 feet at Kobo, in the Himalayan foothills just north of Assam. As recently as 1915, he described another species, *C. simus*, from a locality near the base of these same foothills. M. A. Smith (1924) gave a second record for *C. doriæ* by reporting it from Nong Khor and Ban Khen, two localities in Siam, but Cochran (1927) named *Philautus nongkhorensis* from specimens secured at Nong Khor by Dr. H. M. Smith and considers that Smith's *doriæ* from that locality represents her new species. She treats *Chirixalus* as a synonym of *Philautus* and I have followed her.



a

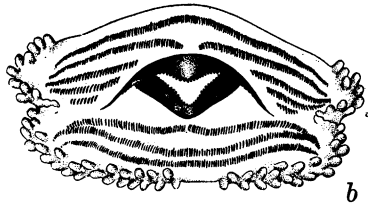


Fig. 34. Larva of *Philautus doriæ* from Hainan (A. M. N. H. No. 27443): (a) lateral aspect; (b) mouth.

The species *doriæ*, *simus*, and *nongkhorensis* are closely allied, but my series fits the description of *doriæ* very well. Its range is extended into China by this first Hainan record.

Annandale's Kobo specimen was taken at a low altitude, so one is not surprised to know that this form was found on the Hainan plain only a few hundred feet above sea-level. It was very secretive but the abundance of its tadpoles testified to its presence in some numbers.

Sexual dimorphism in size is marked. The 11 largest females among 15 measure 30, 28, 28, 28, 28, 27.5, 27, 27, 26, 26, and 26 mm. from snout to vent, while the smallest is 23 mm. long. The ten males are 23.5, 23.5, 23.5, 22.5, 22.5, 22.5, 22, 20, 19, and 19 mm. in length. A single very small specimen was not sexed. I fail to detect any trace of nuptial asperities or enlargement of forelimbs in the series of males. In some of them, the skin of the throat is quite loose.

DESCRIPTION OF TADPOLE.—Length of body one and two-thirds its width; tail a little less than twice as long as body, about three times as long as deep. Nostrils equidistant from tip of snout and eyes; eyes lateral, as far from spiraculum as from tip of snout; distance between nostrils three-fifths of that between eyes. Spiraculum sinistral, plainly visible from below, without tube, as far from insertion of leg buds as from eye. Vent dextral. Tail acutely pointed, upper crest equal to or slightly deeper than lower, and extending a short distance along back.

The lower lip is bordered by a double row of papillæ briefly interrupted in the middle. The papillæ extend but a short distance along either end of the upper lip where they are in a single row. There are five rows of teeth on the upper lip, the first uninterrupted, the second only narrowly so, while the last three are short and broadly interrupted; of the three long, equal rows on the lower lip, the innermost is sometimes very narrowly interrupted. This apparent interruption may be only a break.

This tadpole is at once distinguished from all others that I found on Hainan by the jet-black color of the last half of its tail. This black includes both crests and, apparently, is never lacking. The rest of the tadpole is greenish brown. There is a weak tendency for the darker pigment to form three longitudinal stripes, a mid-dorsal and two lateral ones, the latter extending forward through and beyond the eyes.

The above description is based upon a large series of well-preserved material. I am able to detect little or no variation. A typical specimen with leg buds 2 mm. long measures 26 mm. from tip to tip, the tail alone occupying 17 mm.

#### ***Philautus vittatus* (Boulenger)**

##### Figure 35

This species is represented by a large series of specimens from Nodoa (A. M. N. H. 26496–518, 26520–715, and 32937–40). Numerous tadpoles were secured at Nodoa (A. M. N. H. 27442).

Boulenger described this frog as *Ixalus vittatus* from Bhamo, Upper Burma, in 1887. It is now known from Siam and Cochin China as well (Smith 1924), but it has never before been recorded from Chinese territory.

The Hainan specimens agree with the original description and are strikingly similar to two individuals from Siam secured through exchange (A. M. N. H. 24938–9).

In life, *vittatus* varies in dorsal coloration from dark green to pale yellow, the single light stripe of either side being in evidence only when the dark green pigment predominates.

Breeding males have well-developed, white nuptial pads on the inner side of each first finger. These pads are smooth in texture and about half as long as the finger itself. The skin of the throat in breeding males is not noticeably loose, even though an opening leading into the vocal sac is present on either side of the lower jaw within the mouth.

Sexual dimorphism in size is marked. A series of 104 specimens is made up of 47 males and 57 females of remarkable uniformity in size. The ten largest males range in length from 20.5 to 22 mm., while 34 individuals among the 47 measure either 19.5 or 20 mm. The three remaining males are 19 mm. long. The ten largest females range in length from 24.5 to 25 mm., while no less than 40 females measure 23, 23.5, or 24 mm. The smallest specimen of this sex is 20.5 mm. long.

The large series secured testifies to the abundance of this species at Nodoa. Its egg masses were first observed on June 6, 1923. On July 23, I found numbers of these frogs on the leaves of a rush-like plant growing in a shallow, water-filled depression just outside of a Nodoa

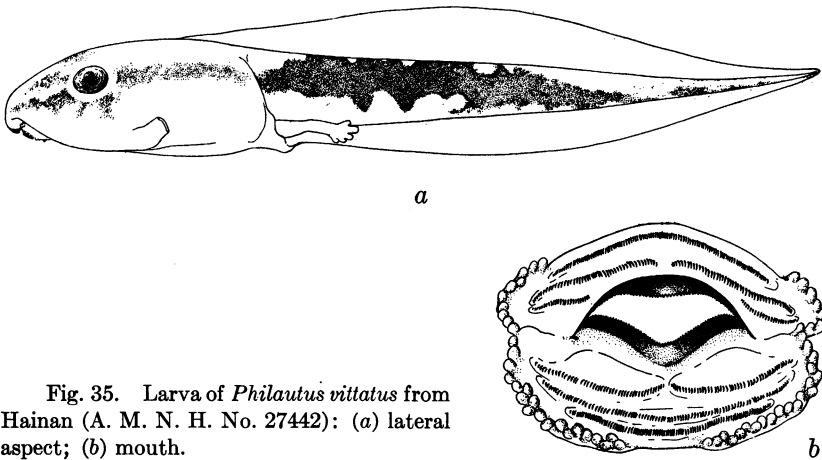


Fig. 35. Larva of *Philautus vittatus* from Hainan (A. M. N. H. No. 27442): (a) lateral aspect; (b) mouth.

gate. The water was only a foot or two deep and the depression some twenty-five feet in diameter, while the surrounding country was rolling grassland, well cropped by cattle. Numerous egg masses, only a few inches above the water, were found adhering to the long leaves of the plants, while the frogs sat about evidently interrupted in their breeding by the coming of day. The egg masses were uniform in shape, which might be described as globular, the lower end bluntly rounded, the upper much the smaller. One mass examined contained 235 white eggs evenly distributed through a whitish, translucent mucus globule measuring seven-eighths by three-fourths of an inch. I have seen these egg masses on different kinds of leaves and one of my collectors found them eight to ten feet above water. Undoubtedly, they are deposited in a great variety of localities as indicated by the general abundance of the tadpoles.

Smith (1924) describes this egg cluster as a "frothy nest" and Noble (1927) considers this froth-making habit of systematic importance.

The apparently ripe ova found in two preserved females number 175 and 195, but allowance should be made for several that were broken through handling, the ova being very fragile in this species. These ova are entirely unpigmented and about 1.3 mm. in diameter.

I have compared my large series of tadpoles with Smith's 1924 description and figure of Siamese specimens but find several points of disagreement, a surprising fact in view of the similarity of the adults. These differences are summarized below:

- 1.—The distance between the nostrils is fully four-fifths of the interorbital space, not only one-half as in Smith's specimens.
- 2.—Only nine among 38 specimens have a fourth row of teeth in the upper lip and at best, this extra row is very small. Smith's Siamese specimens have four or five upper rows.
- 3.—The second row of the upper lip is distinctly interrupted in all of my series of 38 but in the Siamese specimens this is continuous.
- 4.—The color in the Hainan tadpoles is quite invariable, the black stripe along the muscular part of the tail uniformly present and always possessing a zigzag upper border. Smith's series is much less constant in coloration.

The Siamese specimens are figured with a continuous row of papillæ bordering the lower lip but described in the text as having an interrupted row. In my series, this row is always distinctly interrupted. The nostril might be described as equidistant from the eye and tip of snout or nearer the latter, as stated by Smith. Its relative location varies with the angle from which it is viewed.

A typical *Nodoa* tadpole measures 25 mm. from tip to tip, the tail occupying 16 mm. In this specimen, the leg buds are 3 mm. long.

### Brevicipitidæ

#### KALOPHYRNUS

#### *Kalophrynus pleurostigma* (S. Müller)

Twelve specimens from *Nodoa* represent this species (A. M. N. H. 27001-12).

Van Kampen (1923) gives the range of *pleurostigma* as southern China, Burma, Siam, Malay Peninsula and Archipelago. In eastern China, it was reported from Hongkong in 1867 by Peters as *K. p. sinensis* and recently from the general region of Canton, in Kwangtung (Mell, 1922). It is said by Mell to be fairly common in grassy and bushy hills to 300 m. La Fea collected it in Upper Burma at Teinzo, in the Kakhien Hills; and at Bhamo (Boulenger, 1887).

In view of these records, the discovery of *pleurostigma* on Hainan is not surprising and merely adds another southern species to the already long list of such known to occur on Hainan.

Ten of the series of 12 specimens are males. The nine largest among these are almost equal in size, ranging in length only from 35 to 38 mm. and averaging 36.2 mm. The smallest is 31 mm. long. The females measure 44 and 40.5 mm. and are mature, both containing well-developed ova. These measurements indicate marked differences in size between the sexes but I find no nuptial pads or enlargement of the forearms in the males. The ova of the larger female are partly pigmented, 1 mm. in diameter and about 4000 in number. This figure was arrived at through actual count of an approximate fourth of the entire lot of ova.

In captivity, this frog is deliberate in its movements, preferring to walk on all fours rather than hop. Its legs are weak, for it makes short, four-inch hops. The specimens were caught during spells of protracted rain when the males were heard calling. At other times, the frogs were not in evidence.

#### KALOULA

##### *Kaloula borealis* (Barbour)

##### Figure 36

Fifty-six specimens represent this species: 53 from the Western Hills, near Peking (A. M. N. H. 27761-813) and three from Tsinan (A. M. N. H. 28103-5). In addition, there is a large series of recently metamorphosed individuals (A. M. N. H. 27814) and one of tadpoles (A. M. N. H. 27815), both from the Western Hills.

Schmidt's 1927 report included 111 specimens from Kichowpeh,<sup>1</sup> a walled city some 60 miles east and a little north of Peking. The locality given by Schmidt, "26 miles S. of Hsing Lung Shan," is inaccurate, designating, as it does, a camp site removed from Kichowpeh by only a few miles, but at a considerably higher altitude. The specimens were actually taken within the walls of Kichowpeh.

This species was reported from Tsingtao as *verrucosa* by Wolterstorff in 1906, but *verrucosa* is now known to be distinct from *borealis* and confined to Yunnan and the southwest. The three Tsinan specimens listed above corroborate the occurrence of *borealis* in Shantung. In 1908, Barbour described *Cacopoides borealis* from Antung, Manchuria, and Slevin (1925) has recorded specimens from Chicksan, Korea. As Schmidt remarks, doubtless Vogt's (1913) *Callula tornieri*, also from

<sup>1</sup>Also spelled Kichow and Chichow.

Korea, is only another locality record for the often confused *borealis*. As recently as October, 1929, this frog has been reported from Peking by Shaw who gives a description, figures, and habitat notes.

In 1925, Stejneger described *Kaloula wolterstorffi* from Nanking, stating that, "quite probably the species here described is the same which Dr. Wolterstorff has recorded from Tsingtao, Shantung, under the name *Callula verrucosa*. The deviations noted by him from Boulenger's description of that species tally very well with the Nanking specimen. Such an identification would also make for a more consistent geographical distribution of the two species." I have followed Schmidt in considering Wolterstorff's Tsingtao *verrucosa* as certainly identical with *borealis* and not with Stejneger's Nanking form. My reason for doing this is twofold: (a) The Tsinan specimens at hand are obviously to be referred to *borealis*; (b) I agree with Schmidt who shows that the forms distributed around the Gulf of Chihli and Korea Bay are often closely related, so one would expect the Tsingtao toads to be allied to those from Peking, Antung, etc., rather than to the species occurring at Nanking.

Schmidt is inclined to doubt the validity of *wolterstorffi*, finding only a "slight difference in the amount of web," upon a comparison of it with *borealis*, and suggests that the type might have been carried to Nanking from the north. This suggestion is invalidated by Shaw's 1929 report of a second specimen received at Peking from Nanking. I have recently examined the type of *wolterstorffi* and am convinced that it represents a form distinct from *borealis*. The type resembles *verrucosa* in its smooth skin, smaller and distinctly separated metatarsal tubercles, and slenderness of limbs. Conversely, it differs from *borealis* in these characters. In its comparatively great interorbital width and small amount of webbing between the toes, it strongly suggests *borealis*, differing markedly from *verrucosa*. These facts are less surprising in the light of other recent discoveries, such as Stejneger's *Kaloula rugifera* from Kiating, Szechwan. In short, Chinese herpetology is still in its infancy and more new forms of certain supposedly rare groups will be brought to light, closing many wide and puzzling gaps.

Examination of a series of 128 specimens from the Western Hills and Kichowpeh reveals only one constant difference between the sexes. The skin of the throat in the males is developed into a large vocal sac, the integument of which is dark. The dorsum in the females is often lighter than in the males, but I find both dark and light specimens of either sex and do not believe this to be an absolutely constant difference. It is difficult to measure because of the great amount of variation shown.

Even the extremes of color are not marked and the difference may be one that develops during the breeding season. Shaw also notices that the females are lighter in coloration and states that the males are smaller in

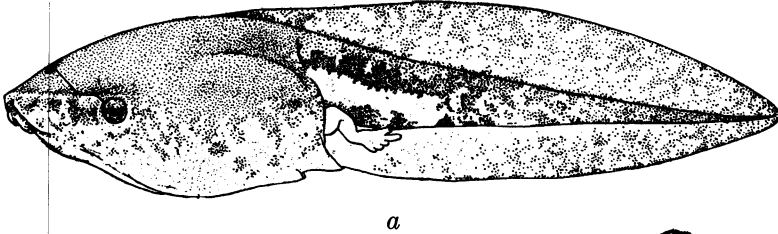
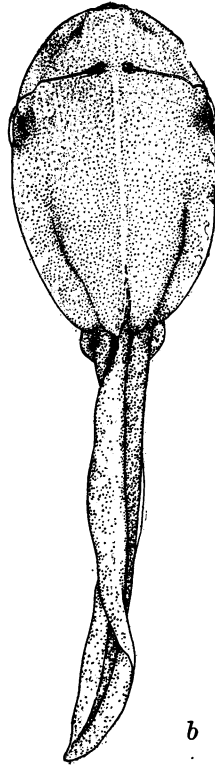


Fig. 36. Larva of *Kaloula borealis* from the Western Hills, near Peking (A. M. N. H. No. 27815): (a) lateral aspect; (b) dorsal aspect.

bulk. My measurements of a series of 96 males and 32 females, taken for the most part while breeding, fail to show any appreciable difference in length and, indeed, Shaw says that the sexes are of equal length. The ten largest males range from 49 to 53 mm. in length, averaging 51.2 mm., while the corresponding figures for the females are 46 to 51 and 48.8 mm. This small difference may be due entirely to the great discrepancy in numbers, the males being three times as numerous. About half of the males measure from 46 to 48 mm., so such figures should be taken as indicative of the normal length. I fail to detect any sign of nuptial excrescences on the fingers of breeding males. Moreover, their arms appear to be the same size as those of the females.

If the skin of one of these frogs is cut through around the body, it will be seen that a continuous glandular layer lies within the integument of the back and this accounts for the ability of *borealis* to secrete a viscous fluid when annoyed. This is doubtless an efficient protective measure, a phenomenon extremely common in amphibians.

The Kichowpeh toads were breeding in the quiet water of a ditch



when collected August 15, 1922. They were croaking loudly well within the limits of this ancient city and were present in great numbers. I heard these toads calling in water holes along the roads of this same region three weeks before this date, so its breeding season extends at least through the last week in July and the first half of August. Shaw records finding breeding pairs at Peking July 18 and 19, 1929, dates that agree very well with mine. An explanation of this mid-summer breeding is found in the fact that the maximum precipitation at Peking occurs in July, a datum for which I am indebted to Shaw. He states that the eggs floated and were contained in jelly masses 3 mm. in diameter. The eggs themselves were 1.3 mm. in diameter. Ovarian eggs of my series are partly pigmented.

DESCRIPTION OF TADPOLE.—Length of body about one and a half times its width; tail one and a fourth times length of body, two and a half times as long as deep. Nostrils nearer to line joining anterior corners of eyes than to tip of snout. Eyes lateral, the distance between them about six times that between nostrils. Spiraculum median, large, opening under a transparent sheath below posterior end of body. Anus median, opening just below edge of subcaudal crest. Tail pointed; crests convex, about equal in depth.

Mouth terminal, lacking horny beak and teeth, its width not more than a third the interocular space.

Uniform dark above, white beneath, the belly skin translucent. Sides and tail crests mottled.

The above description is based upon a large series of well-preserved tadpoles from the Western Hills. The body of a typical specimen with leg buds 3 mm. long measures 13, the tail 18 mm. Completely transformed individuals with bare caudal remnants are 15–17 mm. in length. The extreme softness of the tadpoles renders the taking of measurements difficult, so all of the proportions should be checked on living or fresh material.

#### *Kaloula verrucosa* (Boulenger)

Schmidt's 1927 report included 15 specimens of *verrucosa* from Yunnanfu. An additional specimen, labeled Yunnan, has recently been acquired (A. M. N. H. 24310).

This species, described from Yunnanfu in 1904 as *Callula verrucosa* has since been recorded from Talifu (Mell, 1922) and "Yunnschan," near Wukang in southwestern Hunan (Werner, 1924). Werner also records eight specimens from Yunnan.

The series of 11 Yunnanfu specimens available for study is made up of four males measuring 45, 44, 43, and 43 mm. from snout to vent, and seven females measuring 52, 52, 44, 43, 42, 38, and 36 mm. The females



appear to reach the larger size but the difference is not great and doubtless would be lessened were more males available. The sexes were found to be of equal size in *borealis*, so it is reasonable to expect the same relation in *verrucosa*. The females are a shade lighter than the males, while only the latter have pigment on the lower jaw. These two differences in color are also recorded for *borealis*. In *verrucosa*, the males have distinctly fuller webbing than the females, a point that should be carefully noted when comparing it with allied species.

#### KALLUELLA

##### *Kalluella yunnanensis* Boulenger

The new material does not contain this rare form described in 1919 but the Museum's general collection includes two specimens (Nos. 5450 and 6527) from Yunnanfu, the only place this frog is thus far known to occur. These examples were secured through John Graham who also collected Boulenger's types.

The largest specimen, a female, measures 33.5 mm. from snout to vent, while the smaller, a male, is but 25 mm. long.

#### MICROHYLA

It is hard to find definite and conspicuous characters by which to distinguish some of the tadpoles of this genus. I would like to remind field workers, however, of the rapid larval development characteristic of many species and their ability to thrive in even a small amount of quiet water. It might sometimes be easier to await metamorphosis than attempt to distinguish between, let us say, *ornata* and *pulchra*.

In his recent revision of the genus, Parker uses the following characters to separate the larval forms known from China:

I.—Lower lip produced into a funnel, which almost surrounds the mouth.

*M. heymonsi*.

II.—No funnel-like projection of the lower lip

1.—Spiraculum opening under a flap which extends posteriorly almost to the anterior edge of the anal opening; latter large, slit-like and with its edges pigmented.....*M. butleri*.

2.—Spiraculum opening about the center of the gut, well separated from the anus which is small, circular and without pigmented lips

a.—Tail less than twice as long as head and body....*M. ornata*.

b.—Tail twice or more than twice as long as head and body.

*M. pulchra*.

A careful comparison of the material at hand shows that Parker's first character in this key distinguishing *butleri* from *ornata* and *pulchra*,

though possibly of some value, does not hold good consistently because the difference cited is so slight. The flap covering the spiraculum often comes as near the vent in *ornata* and *pulchra* as in *butleri* and the position of the spiraculum in the latter is very slightly forward of its position in *ornata* and *pulchra*. In addition to those brought out in this key, there are numerous characters that might serve to distinguish *butleri* from either *ornata* or *pulchra*, as for example, in the former the mouth is distinctly terminal, the dorsum heavily pigmented and the body broad anteriorly, while in the latter the mouth is dorso-terminal, the pigment of the dorsum concentrated along its midline and the body narrow anteriorly. In life, the tails of *Nodoa butleri* larvæ are conspicuously marked with scarlet, a condition never evident in the tadpoles of *ornata* and *pulchra*. I am unable to find any but a slight difference in size between *ornata* and *pulchra* larvæ and do not believe that, as stated by Parker, relative tail length will serve to distinguish them.

#### ***Microhyla butleri* Boulenger**

##### Figure 37

Fifteen specimens of this species were collected at Yenping between July 28 and August 6, 1925 (A. M. N. H. 28559-62, 28564-73 and 28575).

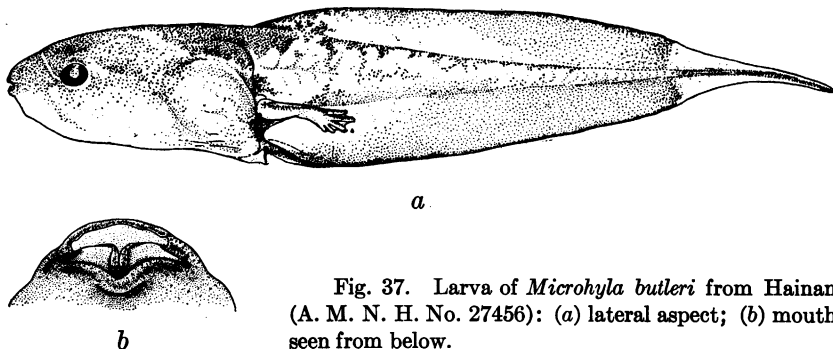


Fig. 37. Larva of *Microhyla butleri* from Hainan (A. M. N. H. No. 27456): (a) lateral aspect; (b) mouth seen from below.

A series of tadpoles was secured near Yenping (A. M. N. H. 29414) and another but larger one at Nodda (A. M. N. H. 27456). A lot of barely metamorphosed individuals (A. M. N. H. 27449) was also collected at Nodda.

Parker (1928) considers that *butleri* ranges as far into China as Szechwan, for he puts Stejneger's *M. grahami*, described from Suifu in 1924, in the synonymy of *butleri*. *M. sowerbyi* (Stejneger, 1924) is provi-

sionally placed in the same synonymy, so it is a pleasure to settle this last point by reporting *butleri* abundant at Yenping, the type locality of *sowerbyi*, the type of which I have examined and found to be identical with my Yenping series of *butleri*. This, then, constitutes the first definite Fukien record of *butleri*. It is not known from Formosa. Vogt's *M. bouleengeri* from Hainan, described in 1913, is probably *butleri* (Parker, 1928), and Mell (1922) has found what he calls *bouleengeri* in Kwangtung, so we may possibly have additional records for *butleri* in southern China. Smith (1923) reports it from Hainan, and my large series of larvæ confirms the Hainan reports. Exclusive of China, the range of *butleri* is given by Parker as Tonkin, Siam, Cochin China, and the Malay Peninsula. Its type locality is Larut Hills, Perak, whence it was described in 1900.

The 15 specimens from Yenping, all of which are adult males, range in length from 21 to 23 mm., nine individuals measuring 21 to 22 mm. I can detect no sign of dermal modification on the inner side of the fingers in any of these males.

The tadpoles of *M. butleri* were taken about Nodoa only in more permanent pools at the bottom of excavations, NOT in any and every small, temporary pool and mud hole inhabited by the larvæ of *pulchra* and *ornata*. Smith found such to be the case in Siam where he observed *butleri* and *ornata*. My observations further confirm his in that the Nodoa *butleri* tadpoles had a great deal of scarlet on their tails in life. The so-called flagellum is longer and seems to be more active than in any of the three other species recorded in this paper. In fact, its very existence is apparently the result of its activity, for I believe it to be little more than that part of the extremity of the tail remaining after friction against the water has worn the rest away.

The series of tadpoles from Yenping was collected May 22, 1925, and gives some indication of the breeding season there. The individuals of this series are varied in size, the smallest only a few millimeters long, the largest with leg buds 1 mm. in length.

#### ***Microhyla heymonsi* Vogt**

##### Figure 38

A series of 68 specimens of this species was secured: 38 from Ch'ung-an Hsien (A. M. N. H. 28833-42, 29548-74 and 32953) and 30 from Yenping (A. M. N. H. 28375-403 and 28563). Numerous tadpoles were collected in Futsing Hsien (A. M. N. H. 29412), near Yenping (A. M. N. H. 31080) and in Ch'ungan Hsien (A. M. N. H. 29021).

*M. heymonsi* was described from Formosa in 1911. This species, according to Parker (1928), is the *achatina* of most authors. He confines *achatina* to Java, giving the range of *heymonsi* as Formosa, southern China, Tonkin, Hainan, Siam, Cochin China, the Malay Peninsula, Nias, and Sumatra. Stejneger (1925) records an example collected at Yenping, while Smith (1923) reports its discovery on Hainan. I strongly suspect that Mell's Kwangtung collection contains specimens distinguished under another name because *heymonsi* should be present in northern Kwangtung. It apparently is the common mountain form of northern Fukien, for I found it abundant in the mountains near Yenping

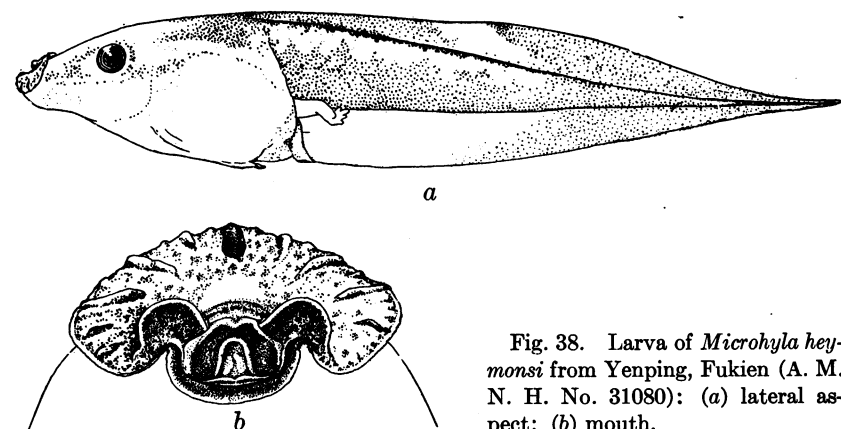


Fig. 38. Larva of *Microhyla heymonsi* from Yenping, Fukien (A. M. N. H. No. 31080): (a) lateral aspect; (b) mouth.

and in the still higher ones of Ch'ungan Hsien. The numerous larvæ collected in Futsing Hsien prove its occurrence there.

Breeding males have a conspicuous subgular vocal sac but I fail to find any trace of dermal modification on the inner side of their first fingers, neither do their forelimbs appear to be enlarged. There is no sexual difference in color. The females attain a greater length than the males. After six juvenile specimens less than 11 mm. in length had been removed, the adult series from Yenping and Ch'ungan Hsien was made up of 43 males and 19 females. The 13 largest of these females range from 21 to 25 mm. in length, averaging 22.8 mm., while the corresponding figures for the 13 largest males are 20 to 21.5 and 20.2 mm. The males are remarkably uniform in size, the extreme measurements for the 43 being 16 and 21.5 mm. No less than 31 of these males range only from 18 to 20 mm. in length.

It is interesting to note, at this point, that the Yenping specimens are larger than those from Ch'ungan Hsien, five of the seven largest females and six of the seven largest males coming from the former locality. This adds another datum to the many noted elsewhere, proving the relative distinctness of the fauna found in the northwestern highland of Fukien from that inhabiting the middle and lower valley of the Min.

*M. heymonsi* was abundant in the thick grass covering the rice-field terraces at San Chiang. During the height of the breeding season it sang in a loud chorus every night. The cricket-like note is little more than a series of sharp clicks, repeated at a moderately rapid rate and slightly increasing in volume at first but decreasing towards the end.

As early as May 16, 1926, *heymonsi* was singing in full chorus at San Chiang but tadpoles were not found until June 5. On June 10, numerous eggs were seen and the breeding season was evidently in full swing. Eggs were still abundant from June 24 to 28, and on July 5 the first larvæ with well-developed leg buds were discovered. Five days later, advanced tadpoles were numerous but a last search on September 3 failed to reveal the least sign of eggs or larvæ in any stage of development, so it is safe to conclude that the breeding season had ended some weeks previous to that date. As might be expected, the egg-laying period at San Chiang is brief and retarded, compared even to that of the mountains near Yenping where tadpoles with well-developed leg buds were abundant as early as May 27, 1925. Larvæ in all stages of development were collected in Futsing Hsien the last week of August and the first in September, 1925, indicating a still more extensive season there. At Bangkok, *heymonsi* tadpoles have been reported from May to October (Smith, 1916).

At San Chiang, I found the eggs floating on the surface of the quiet water of the rice fields. They were distributed in small groups but always near the face of a terrace. Several of these groups appeared to make up a cluster because the groups themselves seemed to form more or less connected series, just as if a pair of toads had swum along near the base of the terrace, stopping at intervals to deposit several eggs. A series of nine of these small groups, apparently forming a single cluster, was counted and each one found to contain from two to 24, or an average of 11 eggs apiece. Two more supposed clusters were examined on June 24 and each shown to consist of about eight small groups spread along some 20 feet of terrace facing. The perfectly transparent egg capsules forming a group are loosely joined to one another, while the entire group is often more or less attached to a grass stem or any other object.

The foregoing data indicate that a single pair of toads would deposit at least 100 eggs at one mating. I have counted the ripe ova of two females and found that one contained about 160, the other 170 ovarian eggs and such figures tally well with the estimated 100 based upon field data. It is not very probable that every group making up one cluster would be found, for one must remember that a single egg measures only 1.1 mm. in diameter. Searching for such specks under the overhanging vegetation of a terrace, while wading in a foot or more of water and soft mud, is not an easy task. Unless one proceeds after the manner of a cat creeping upon its prey, the ripples caused by one's movements will dislodge any group of *heymonsi* eggs long before they have come in sight.

The following data were secured through a study of embryos that had been allowed to develop under natural conditions. They show that the early stages proceed very rapidly. The egg cluster from which they developed was almost certainly deposited early in the morning of July 7. The embryos were spherical at 10 A.M. but decidedly elongate by 3 P.M., while at seven that evening the tail buds had appeared. At 9 A.M. of the ninth, they had developed into free-swimming larvæ with eyes quite evident and, by noon of the twelfth, these larvæ had assumed their final form and were in possession of tails twice as long as their bodies. Four days later, they had attained a total length of 10 mm., or about half that of mature tadpoles. I was unable to determine how much more time was required for metamorphosis but since *rubra* has been observed to metamorphose in 20 days when confined (Rao, 1915), it is safe to conclude that three weeks would suffice for *heymonsi*.

The remarkable tadpole of *heymonsi* is figured by Smith (1916), Annandale (1917) and Noble (1927). The function of the produced lower lip has been discussed, but I have not seen the following point brought out. Among the four species treated here, *heymonsi* stands alone in my experience as a true mountain form. Even though it is one of the only tropical species that ranges as high into the Ch'ungan Hsien mountains as San Chiang, it is extremely abundant there, while other species, *ornata* and *bulleri*, so common at Yenping and in the Hainan lowlands, are either rare or absent at San Chiang. If *heymonsi* is really a mountain form, am I not justified in considering its enlarged lip an adaptation to surface feeding in the clearer mountain water that certainly contains less microscopic life than stagnant pools and ponds of the lowlands? Elsewhere in this paper, I have suggested that *Megophrys boettgeri* may be a parallel case. Incidental to this point, the greater activity of *heymonsi* is worthy of mention because such can reasonably

be considered as advantageous to a tadpole undoubtedly sometimes forced to cope with moving water. I have tried to learn the exact habitats of other species for comparison but study of the literature has not proved very helpful because accurate and detailed field data are rarely given. Altitude records alone may be quite misleading. One often finds true cascades within a few hundred feet of sea-level; typical swamps thousands of feet higher. It is a description of the exact spot whence the specimen came that is always needed but so rarely found.

Although I have never detected *heymonsi* tadpoles gathered into shoals, I repeatedly saw them moving about in small groups that I assumed to be derived from the original groups of eggs deposited together. The larvæ in general remind one of those of related species but are decidedly less transparent in life. Viewed from above, the tadpole appears black, with a metallic silvery spot on the back and another non-metallic, light one at the base of the tail. The second is simply the upper end of a light, diagonal band that crosses the tail. Both of these spots render the contour of the body less conspicuous from without the water, while no doubt the lateral band does the same from within.

### ***Microhyla ornata* (Duméril and Bibron)**

#### Plate XXII

A series of 375 specimens represent this species: 153 from Nodoa (A. M. N. H. 27025–27176 and 32954), 96 from Futsing Hsien (A. M. N. H. 29310–405), 29 from Yenping (A. M. N. H. 28404–16, 28491–505 and 28574), 16 from Kianning (A. M. N. H. 30785–800), 43 from Ch'ungan City (A. M. N. H. 29504–46), nine from Ch'ungan Hsien (A. M. N. H. 28843–50 and 29547), 14 from Hok'ou (A. M. N. H. 30756–69), and 15 from Yuankiang (30956–70). In addition, there is a series of juveniles from Futsing Hsien (A. M. N. H. 29428). Several lots of tadpoles were secured from Nodoa (A. M. N. H. 27453, etc).

Schmidt (1927) reported two specimens from Pinghsiang; one from Changsha; one from Huping College, near Yochow, Hunan; and a large series from Ningkwo, all of which he called *M. eremita*.

Parker (1928) gives the range of this species, exclusive of China, as Formosa, Tonkin, Burma, Assam, Siam, Annam, Malay Peninsula, India, and Ceylon. He includes *M. fissipes*, described from Formosa by Boulenger in 1884, and *M. eremita*, described by Barbour (1920) from Nanking, in the synonymy of *ornata*.

I have found the following records for *ornata* in China: Hainan (Vogt, 1913, and Smith, 1923); Canton (Vogt, 1914 as *fissipes*; and

Boettger, 1888); Kwangtung (Mell, 1922, as *fissipes* and *ornata*); Foochow (Wolterstorff, 1906); Futsing and Yenping (Stejneger, 1925, as *fissipes*); Ningpo and region (Boulenger, 1882, and Boettger, 1894); Nimrod Sound, east of Ningpo (Wolterstorff, 1906); Shanghai (Stejneger, 1925, as *eremita*; and Wolterstorff, 1906); Kiangyin, in Kiangsu (Stejneger, 1925, as *eremita*); Nanking (Barbour, 1920, type locality of *eremita*; and Wolterstorff, 1906); Kiukiang and region (Wolterstorff, 1906); Pinghsiang (Wolterstorff, 1906); and Szechwan (Boulenger, 1882). *M. ornata* is also known from Hongkong (Boettger, 1894), while Formosan records of *fissipes* are numerous (see Parker's synonymy).

In Fukien, *ornata* was common in Futsing Hsien, the Yenping region, and on the Ch'ungan Hsien plateau. I did not determine at what altitude it ceased to be found but its presence at San Chiang, where, however, *heymonsi* was far more abundant, demonstrated its ability to ascend to some 3500 feet. Mell (1922) corroborates this point by stating that in Kwangtung it is found as high as 800 m., a relatively great altitude for that province.

Breeding males may be told by their subgular vocal sacs but I fail to find nuptial pads on the first fingers or enlargement of forelimbs in this sex. Measurements of 80 Ningkwo specimens, 39 females and 41 males, show that females attain a greater size. The 16 largest females range from 20 to 24 mm. in length, averaging 21.15 mm., while the 18 largest males range from 19 to 22.5 mm. and average 19.86 mm. The three largest specimens among the series of 152 from Nodda are 25, 23, and 22 mm. long, all being females. Among 28 Yenping examples, the largest, a female, is just 23 mm. in length, so it may be concluded that *ornata* from eastern China is remarkably uniform in size. It is interesting to note that Flower (1899) gives 23 and 22 mm. for the maximum size of female and male, respectively, from Siam, and 24 mm. as that for the largest Penang specimen (sex not recorded).

*M. ornata* tadpoles were constantly seen about Nodda in small, temporary rainwater pools that could not possibly remain for more than a limited number of days. Rao (1915) observed *M. rubra* larvæ complete their development in 20 days, so the presence of *ornata* larvæ in temporary pools can be understood. This rapid growth is, as suggested by Rao, a most important factor in the distribution of *Microhyla* species and would not only permit them to exist in areas of limited and irregular rainfall but allow the growth of an enormous population in well-watered regions. About Nodda, *ornata* tadpoles were unbelievably numerous in the more permanent pools and mud holes from which they could be scooped, literally, by the hundreds. Due to their small size, the adults required



remarkably little protection and seemed to find no difficulty in concealing themselves by day, in short grass, under stray leaves, or any other small object. Immediately upon the descent of dusk, they became evident in every direction.

Both Annandale (1917) and Smith (1917) have commented upon the gregarious habits of *butleri* and other *Microhyla* tadpoles. About *Nodoa*, *ornata*, *pulchra*, and *butleri* displayed such habits, the resulting shoals being remarkably inconspicuous, due to the transparency of the larvæ. One day I noticed that several groups of mixed *ornata* and *pulchra* tadpoles had assumed peculiar forms and I was puzzled until closer observation convinced me that the contour of each group corresponded with the outline of a shadow thrown upon the water by overhanging leaves. The tadpoles were carefully avoiding direct rays of a hot sun. When alarmed, every individual of a group moved rapidly outward, causing a sudden and even expansion of the group. If no further annoyance occurred, the former outline was very slowly resumed. Annandale recorded similar behavior of *butleri* in 1917. Such concerted action is certainly less conspicuous than general, wide scattering and darting about because the eye of a chance enemy would have to be directed upon the group just at the instant of shifting, or it would not catch sight of the prey. I have seen a number of *ornata* tadpoles confined in a vessel of murky water disappear as if by magic and found, upon looking in through the side of the vessel, that they had simply dropped as one tadpole, a centimeter or so below the surface. In a muddy pool, they can thus conceal themselves instantly.

On one occasion, I placed approximately 200 larvæ of either *ornata* or *pulchra* in a vessel holding some 33 cubic inches of clear water, or about six larvæ to a cubic inch, and allowed them to remain for two days undisturbed. At the end of this time, not one was dead nor was there any sign of discomfort or crowding, the individuals being as uniformly distributed through the water as before. This gives some conception of the vast numbers that could develop in even a small pool of clear rain-water. It is doubtful if bottom-loving tadpoles could survive under similar conditions because they would crowd together below, leaving most of the available space vacant.

#### ***Microhyla pulchra* (Hallowell)**

##### Figure 39

A series of 126 specimens from *Nodoa* represents this species (A. M. N. H. 27182-307). Several lots of tadpoles were secured from the same locality (A. M. N. H. 27450, etc.).

*M. pulchra*, as such, was first reported from Hainan by Vogt in 1913, but Barbour's *hainanensis*, described in 1908, has since been placed in the synonymy of *pulchra* (Smith, 1923, and Parker, 1928) and really constitutes the first record of this species from Hainan. Smith secured additional material in 1923. It is known from Hongkong (Hallowell, 1860, type material described as *Engystoma pulchrum*; Boulenger, 1882; Boettger, 1894; and Wolterstorff, 1906), and various Kwangtung localities as follows: Canton (Boettger, 1888, and Mell, 1922); Lilong (Müller, 1878); Waichow, southern Kwangtung; and Lofaoshan (Mell, 1922).<sup>1</sup>

In his revision of the genus, Parker (1928) gives the range of *pulchra* as South China, Tonkin, Hainan, Siam, and Cochin China. Mell states that the altitudinal distribution in Kwangtung is 50 to 450 m., and

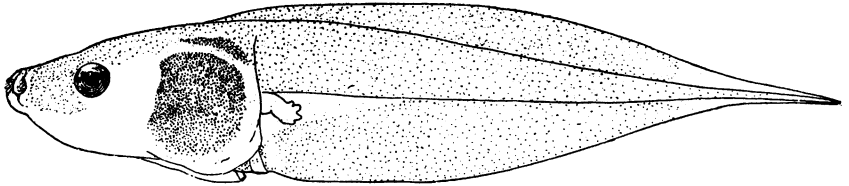


Fig. 39. Larva of *Microhyla pulchra* from Hainan (A. M. N. H. No. 27434): lateral aspect.

Hallowell (1860) reported it as common in the brackish-water swamps between Hongkong and Whampoa.

The males may sometimes be told by a fold of skin across the breast just anterior to the limb insertions, delimiting, no doubt, the posterior extension of the subgular vocal sac. The skin covering this sac is often slightly roughened. I cannot detect any sign of dermal modification on the inner side of the first finger in the males and, in fact, the sexes are remarkably hard to distinguish.

The females attain a greater size than the males. Sixty-five specimens among the series of 125 were discarded because they measured 22 mm. or less, while one medium-sized individual was left out of consideration as a result of an unsuccessful effort to determine its sex. The remaining series of 60 was made up of 31 males and 29 females. The 11 largest of the latter sex ranged from 27 to 34, averaging 30.5 mm. in length, while the 11 largest males ranged from 24 to 27 and averaged 25.3 mm. Eighteen of the males were from 21 to 23 mm. long.

These toads inhabit patches of jungle about Nodoa in great numbers, hiding under leaves and grass by day but coming out at night. I found

<sup>1</sup>Swinhoe's (1870) Ichang record (as *Diptopelma*) requires confirmation.

that one was able to jump a distance of six feet, four inches, or 75 times its length. If *Rana spinosa* had a proportionate amount of strength, it would leap 30 feet! In spite of this great strength, *pulchra* is a shy species and does not venture forth as freely into open grassland as *ornata* does.

It is interesting to find that a large female held no fewer than 2400 ova, each about 1 mm. in diameter. Comparing this count with those for *ornata* (500 and 575) and *heymonsi* (145 and 150), it becomes evident that *pulchra* develops by far the largest number of eggs. Its eggs are, moreover, scarcely reduced in size. This means that if *pulchra* gains advantage in rate of productivity, it loses in its necessarily greater bulk because a large body is less readily concealed and protected than a smaller one. Here we may have an explanation of *pulchra's* comparatively secretive habits and only a casual glance is necessary to convince one of the great difference in bulk more than in actual length between *pulchra* and *ornata*. These two species, although living apparently side by side, have adopted separate niches in a rather similar environment and each has gained its own peculiar advantages as a result of the selection of a particular niche. *M. heymonsi*, on the other hand, has avoided much direct competition in becoming adapted to mountain life. Its special modifications are found in the larval form, for its tadpoles differ from those of lowland *ornata*, *pulchra*, and *butleri* in several respects. In the first place, the buccal apparatus has become specialized and is probably a more efficient food-securing mechanism. May it not be that the procuring of food in the purer water of mountain pools is much more difficult than in the more or less stagnant pools of the lowlands? Secondly, the larvæ of *heymonsi* are more active and not so given to gathering in shoals. Greater activity is certainly advantageous in less sluggish water and the shoaling habit would become increasingly difficult in the comparatively harder mountain existence of the larvæ.

I found the tadpoles of *M. pulchra* very abundant about Nodoa in April. They were seen as a rule in small, clear pools of rainwater as well as in numerous mud holes where they were unbelievably numerous. They differ very little from *ornata* tadpoles in habits and form but are slightly larger and, according to Parker, have proportionately longer tails.

#### BIBLIOGRAPHY

- AHL, E. 1930. 'Beiträge zur Lurch-und Kriechtierfauna Kuangsi's.' Sitzber. Ges. Naturf. Freunde Berlin, pp. 315-319.
- ANDERSON, JOHN. 1871. 'Description of a New Genus of Newts from Western Yunnan.' Proc. Zool. Soc. London, pp. 423-425.

1879. 'Anatomical and Zoological Researches: Comprising an Account of the Zoological Results of the Two Expeditions to Western Yunnan in 1868 and 1875; and a Monograph of the Two Cetacean Genera, *Platanista* and *Orcella*,' I and II. London.
- ANDREWS, ROY CHAPMAN. 1920. 'Camps and Trails in China.' New York.
- ANGEL, M. F. 1922. 'Sur deux espèces nouvelles de Grenouilles, d'Afrique et de Chine, appartenant au genre *Rana*.' Bull. Mus. Nat. Hist. Paris, XXVIII, pp. 399-403.
1923. 'Étude complémentaire sur *Rana Courtoisi* Angel.' Bull. Mus. Nat. Hist. Paris, XXIX, pp. 289-290.
1928. 'Reptiles et Batraciens recueillis en Indo-Chine par la Mission de MM. Delacour et Lowe.' Bull. Mus. Nat. Hist. Paris, XXXIV, pp. 445-447.
- ANNANDALE, N. 1911. 'Contributions to the Fauna of Yunnan Based on Collections Made by J. Coggin Brown, B.Sc., 1909-1910. Part VI.—Batrachia and Reptiles.' Rec. Ind. Mus., VI, pp. 215-218.
1912. 'Zoölogical Results of the Abor Expedition, 1911-1912. Batrachia.' Rec. Ind. Mus., VIII, pp. 7-36.
1915. 'Herpetological Notes and Descriptions.' Rec. Ind. Mus., XI, pp. 341-347.
1917. 'Zoological Results of a Tour in the Far East. Batrachia.' Mem. As. Soc. Bengal, VI, pp. 121-155.
- ANNANDALE, N., AND RAO, C. R. N. 1918. 'The Tadpoles of the Families Ranidæ and Bufonidæ Found in the Plains of India.' Rec. Ind. Mus., XV, pp. 25-40.
- BARBOUR, THOMAS. 1908. 'Some New Reptiles and Amphibians.' Bull. Mus. Comp. Zoöl., LI, pp. 315-325.
1909. 'On the True Status of the Genus *Cacopoides*.' Proc. Acad. Nat. Sci. Phila., 1909, pp. 401-405.
- 1909a. 'Notes on Amphibia and Reptilia from Eastern Asia.' Proc. New England Zoöl. Club, IV, pp. 53-78.
1912. 'Some Chinese Vertebrates. Amphibia and Reptilia.' Mem. Mus. Comp. Zoöl., XL, pp. 125-136.
- 1912a. 'A Contribution to the Zoögeography of the East Indian Islands.' Mem. Mus. Comp. Zoöl., XLIV, pp. 1-203.
1920. 'An undescribed *Microhyla*.' Occ. Pap. Mus. Zoöl., Univ. Mich. No. 76, pp. 1-4.
- BEDRIAGA, J. v. 1898. 'Wiss. Res. Przewalski Cent.-Asien Reisen.' Zool., III, Sect. 1, part 1, pp. 1-69. St. Petersburg.
- BLACKWELDER, ELIOT. 1907. 'Research in China.' I, part 2, 'Report on Zoology,' pp. 481-507.
- BOETTGER, OSKAR. 1885. 'Materialien zur Herpetologischen Fauna von China I.' Ber. Offenb. Ver. f. Nat., pp. 115-170.
1888. 'Aufzählung einiger neu erworbener Reptilien und Batrachier aus Ost-Asien.' Ber. Senck. Ges., pp. 187-190.
- 1888a. 'Materialien zur Herpetologischen Fauna von China II.' Ber. Offenb. Ver. f. Nat., pp. 53-191.

1892. 'Katalog der Batrachier-Sammlung im Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt am Main.' Frankfurt.
1894. 'Materialien zur herpetologischen Fauna von China III.' Ber. Senck. Ges., pp. 129-152.
1901. 'Aufzählung einer Liste von Reptilien und Batrachiern aus Annam.' Ber. Senck. Ges., pp. 45-53.
- BOLKAY, STEFAN, 1911. 'On the Systematic Value of *Rana chinensis* Osbeck.' Proc. Biol. Soc. Washington, XIII, pp. 67-84.
- BOULENGER, GEORGE ALBERT. 1878. 'Description de deux Genres nouveaux de la Famille des Salamandrides.' Bull. Soc. Zool. France, III, pp. 71-72.
1880. 'On the Palaearctic and Æthiopian Species of *Bufo*.' Proc. Zool. Soc. London, pp. 545-574.
1882. 'Catalogue of the Batrachia Gradientia s. Caudata and Batrachia Apoda in the Collection of the British Museum.' London.
- 1882a. 'Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum.' London.
1885. 'Description of a New Frog of the Genus *Megalophrys*.' Proc. Zool. Soc. London, p. 850.
1887. 'An Account of the Batrachians obtained in Burma by M. L. Fea, of the Genoa Civic Museum.' Ann. Mus. Genova, (2) V, pp. 418-424.
- 1887a. 'Description of a new Frog of the Genus *Megalophrys*.' Ann. Mus. Genova, (2) IV, pp. 512-513.
1889. 'Description of a New Batrachian of the Genus *Leptobrachium*, Obtained by M. L. Fea in the Karens Mountains, Burma.' Ann. Mus. Genova, (2) VII, pp. 748-750.
1890. 'A List of the Reptiles and Batrachians of Amoorland.' Ann. Mag. Nat. Hist., (6) V, pp. 137-144.
- 1890a. 'The Fauna of British India, Including Ceylon and Burma. Reptilia and Batrachia.' London.
1893. 'Concluding Report on the Reptiles and Batrachians Obtained in Burma by Signor L. Fea, Dealing with the Collection made in Pegu and the Karin Hills in 1887-88.' Ann. Mus. Genova, (2) XIII, pp. 304-307.
1898. 'The Tailless Batrachians of Europe.' London.
1899. 'On a Collection of Reptiles and Batrachians made by Mr. J. D. La Touche in N. W. Fokien, China.' Proc. Zool. Soc. London, pp. 159-172.
- 1899a. 'On the Reptiles, Batrachians, and Fishes Collected by the Late Mr. John Whitehead in the Interior of Hainan.' Proc. Zool. Soc., London, pp. 956-962.
1904. 'Descriptions of New Frogs and Snakes from Yunnan.' Ann. Mag. Nat. Hist., (7) XIII, pp. 130-134.
1905. 'Description of a New Batrachian of the Genus *Bombinator* from Yunnan.' Ann. Mag. Nat. Hist., (7) XV, pp. 188-189.

- 1905a. 'Description of a New Newt from Yunnan.' Proc. Zool. Soc. London, pp. 277-278.
1908. 'A Revision of the Oriental Pelobatid Batrachians (Genus *Megalophrys*).' Proc. Zool. Soc. London, pp. 407-430.
1909. 'Descriptions of Four New Frogs and a New Snake Discovered by Mr. H. Sauter in Formosa.' Ann. Mag. Nat. Hist., (8) IV, pp. 492-495.
1912. 'A Vertebrate Fauna of the Malay Peninsula from the Isthmus of Kra to Singapore Including the Adjacent Islands. Reptiles and Batrachia.' London.
1917. 'Descriptions of New Frogs of the Genus *Rana*.' Ann. Mag. Nat. Hist., (8) XX, pp. 413-418.
1919. 'Description of a New Dyscophid Frog from Yunnan.' Ann. Mag. Nat. Hist., (9) III, p. 548.
1920. 'A Monograph of the South Asian, Papuan, Melanesian and Australian Frogs of the Genus *Rana*.' Rec. Ind. Mus., XX, pp. 1-223.
- BOULENGER, G. A., AND ANNANDALE, N. 1918. 'Further Observations on *Rana tigrina*.' Rec. Ind. Mus., XV, pp. 51-67.
- BROWN, J. COGGIN. 1910. 'Contributions to the Fauna of Yunnan Based on Collections Made by J. Coggin Brown, B.Sc., 1909-1910. Introduction.' Rec. Ind. Mus., V, pp. 193-196.
- BUTLER, A. L. 1903-4. 'A List of the Batrachians Known to Inhabit the Malay Peninsula, with Some Remarks on Their Habits, Distribution, etc.' Journ. Bombay Nat. Hist. Soc., XV, pp. 193-205, 387-402.
- CHEN, L. S. 1929. 'Description of a New Species of the Genus *Polypedates*.' China Journ., X, pp. 198-199.
- COCHRAN, DORIS M. 1927. 'New Reptiles and Batrachians Collected by Dr. Hugh M. Smith in Siam.' Proc. Biol. Soc. Wash., XL, pp. 179-192.
- COPE, E. D. 1894. 'On a Collection of Batrachia and Reptilia from the Island of Hainan.' Proc. Acad. Nat. Sci. Phila., pp. 423-428.
- DAVID, ARMAND. 1871. 'Rapport adressé à MM. les Professeurs—Administrateurs du Muséum d'Histoire Naturelle.' Nouv. Arch. Mus. Hist. Nat. Paris, VII, Bull., pp. 75-100.
1872. 'Journal d'un Voyage dans le Centre de la Chine et dans le Thibet Oriental.' Nouv. Arch. Hist. Nat. Paris, VIII, Bull., pp. 3-137.
1875. 'Journ. de mon Troisième Voyage d'Exploration dans l'Empire Chinois.' I and II. Paris.
- DU BOIS-REYMOND, C. 1910. 'Ueber Kaulquappen der Gattung: *Megalophrys* aus China.' Sitzber. Ges. Naturf. Freunde Berlin, pp. 285-287.
- DUNN, EMMET REID. 1918. 'The Collection of Amphibia Caudata of the Museum of Comparative Zoölogy.' Bull. Mus. Comp. Zoöl., LXII, pp. 445-471.
1923. 'The Salamanders of the Family Hynobiidæ.' Proc. Amer. Acad. Arts and Sci., LVIII, pp. 445-523.
- FANG, P. W., AND CHANG, T. H. 1926. 'A Frog from Wenchow.' Trans. Sci. Soc. China, IV, pp. 52-55.

- FERGUSON, H. S. 1904. 'A List of Travancore Batrachians.' Journ. Bombay Nat. Hist. Soc., XV, pp. 499-509.
- FITZINGER, L. J. 1861. 'Die Ausbeute der österreichischen Naturforscher an Säuge-  
thieren, und Reptilien während der Weltumsegelung Sr.  
Majestät Fregatte Novara.' Sitz. Akad. Wiss. Wien, Math.  
Nat. Kl., LXII, pp. 383-416.
- FLOWER, STANLEY S. 1896. 'Notes on a Collection of Reptiles and Batrachians  
Made in the Malay Peninsula in 1895-96; with a List of the  
Species Recorded from that Region.' Proc. Zool. Soc. London,  
pp. 856-914.
1899. 'Notes on a Second Collection of Batrachians Made in the Malay  
Peninsula and Siam, from November 1896 to September 1898,  
with a List of the Species Recorded from Those Countries.'  
Proc. Zool. Soc. London, pp. 885-916.
- GEE, N. GIST. 1919. 'A Beginning of the Study of the Flora and Fauna of Soochow  
and Vicinity.' Journ. N. China Br. Roy. As. Soc., L, pp. 170-  
184.
- GEE, N. GIST, AND BORING, ALICE M. 1929. 'A Check List of Chinese Amphibia  
with Notes on Geographical Distribution.' Bull. Peking Soc.  
Nat. Hist., IV, part 2, pp. 15-51.
- GUENTHER, ALBERT. 1858. 'Catalogue of the Batrachia Salientia in the Collection  
of the British Museum.' London.
1864. 'The Reptiles of British India.' London.
1875. 'Third Report on Collections of Indian Reptiles Obtained by the  
British Museum.' Proc. Zool. Soc. London, pp. 567-577.
1889. 'Third Contribution to Our Knowledge of Reptiles and Fishes from  
the Upper Yangtze-Kiang.' Ann. Mag. Nat. Hist., (6) IV,  
pp. 218-229.
1896. 'Report on the Collections of Reptiles, Batrachians and Fishes  
Made by Messrs. Potanin and Berezowski in the Chinese  
Provinces Kansu and Szechwan.' Ann. Mus. Zool. St. Péters-  
bourg, I, pp. 199-219.
- HALLOWELL, EDWARD. 1860. 'Report Upon the Reptilia of the North Pacific  
Exploring Expedition, Under Command of Capt. John Rogers,  
U. S. N.' Proc. Acad. Nat. Sci. Phila., XII, pp. 480-510.
- HIRTH, FRIEDRICH. 1907. 'Syllabary of Chinese Sounds,' 'Research in China.' I,  
part 2, pp. 511-528.
- HORA, SUNDER LAL. 1922. 'Animal Life in Torrential Streams.' Journ. Bombay  
Nat. Hist. Soc., XXXII, pp. 111-126.
1928. 'Further Observations on the Oral Apparatus of the Tadpoles of the  
Genus *Megalophrys*.' Rec. Ind. Mus., XXX, pp. 139-145.
- IKEDA, S. 1897. 'Notes on the Breeding Habit and Development of *Rhacophorus*  
*schlegelii*, Günther.' Annot. Zool. Jap., I, pp. 113-122.
- JACOT, ARTHUR PAUL. 1923. 'Shantung Herpetology.' China Journ., I, pp. 257-260.
- JERDON, T. C. 1870. 'Notes on Indian Herpetology.' Proc. As. Soc. Bengal,  
pp. 66-85.
- KREYENBERG, MARTIN. 1905. 'Zoologische Ausflüge in Fokien.' Wochenschr.  
Aquarienkunde, Braunschweig, II, pp. 266-269.

1907. 'Briefe aus China VI.' Wochenschr. Aquarienkunde, Braunschweig, IV, pp. 521-522.
- LATASTE, FERNAND. 1880. 'Batraciens et Reptiles recueillis en Chine par M. V. Collin de Plancy Attaché à la Légation de Pékin.' Bull. Soc. Zool. France, V, pp. 62-69.
- MAKI, MOICHIRO. 1927. 'Notes on Salamanders found in Formosa.' Annot. Zool. Jap., XI, pp. 129-133.
- MARTENS, EDUARD VON. 1876. 'Verzeichniss der gesammelten oder beobachteten Wirbelthiere.' Preuss. Exped. Ost-Asien. Zool., I, pp. 362-410.
- MELL, R. 1922. 'Beiträge zur Fauna Sinica. I. Die Vertebraten Südchinas: Feldlisten und Feldnoten der Säuger, Vögel, Reptilien, Batrachier.' Arch. Naturg. Berlin, LXXXVIII, Abt. A, Heft. 10, pp. 1-146.
1929. 'Beiträge zur Fauna Sinica. IV. Grundzüge einer Ökologie der chinesischen Reptilien und einer herpetologischen Tiergeographie Chinas.' Berlin.
- MÖLLENDORFF, O. F. VON. 1877. 'The Vertebrata of the Province of Chihli with Notes on Chinese Zoological Nomenclature.' Journ. N. China Br. Roy. As. Soc., N.S., XI, pp. 41-111.
- MONINGER, M. M. 1919. 'The Isle of Pines; Sketches of Hainan.' Shanghai.
- MÜLLER, F. 1878. 'Katalog der im Museum und Universitätskabinet zu Basel Aufgestellten Amphibien und Reptilien nebst Anmerkungen.' Verh. Naturf. Ges. Basel, VI, pp. 559-709.
- NIKOLSKY, A. M. 1918. 'Faune de la Russie et des Pays Limitrophes Fondée Principalement sur les Collections du Musée Zoologique de l'Académie des Sciences de Russie. Amphibiens.' Petrograd.
- NOBLE, G. K. 1924. 'A New Spadefoot Toad from the Oligocene of Mongolia, with a Summary of the Evolution of the Pelobatidæ.' Amer. Mus. Novitates, No. 132.
1927. 'The Value of Life History Data in the Study of the Evolution of the Amphibia.' Ann. N. Y. Acad. Sci., XXX, pp. 31-128.
1929. 'The Adaptive Modifications of the Arboreal Tadpoles of *Hoplophryne* and the Torrent Tadpoles of *Staurois*.' Bull. Amer. Mus. Nat. Hist., LVIII, pp. 291-334.
- NOBLE, G. K., AND JAECKLE, M. E. 1928. 'The Digital Pads of the Tree Frogs. A Study of the Phylogenesis of an Adaptive Structure.' Journ. Morph. and Physiol., XLV, pp. 259-292.
- NOBLE, G. K., AND NOBLE, R. C. 1923. 'The Anderson Tree Frog (*Hyla andersoni*). Observations on its Habits and Life History.' Zoologica, II, pp. 416-455.
- OKADA, YAICHIRO. 1925. 'Notes on some Tadpoles from Japan.' Annot. Zool. Jap., X, pp. 337-348.
- OKADA, Y. 1926. 'A Study of the Distribution of Tailless Batrachians of Japan.' Annot. Zool. Jap., XI, pp. 97-103.
1927. 'Strange Habits of Japanese Green Frogs.' Japan Magazine, XVII, No. 7, pp. 1-5.
- PARKER, H. W. 1925. 'On a Collection of Reptiles and Batrachians from Tonkin.' Ann. Mag. Nat. Hist., (9) XV, pp. 300-306.

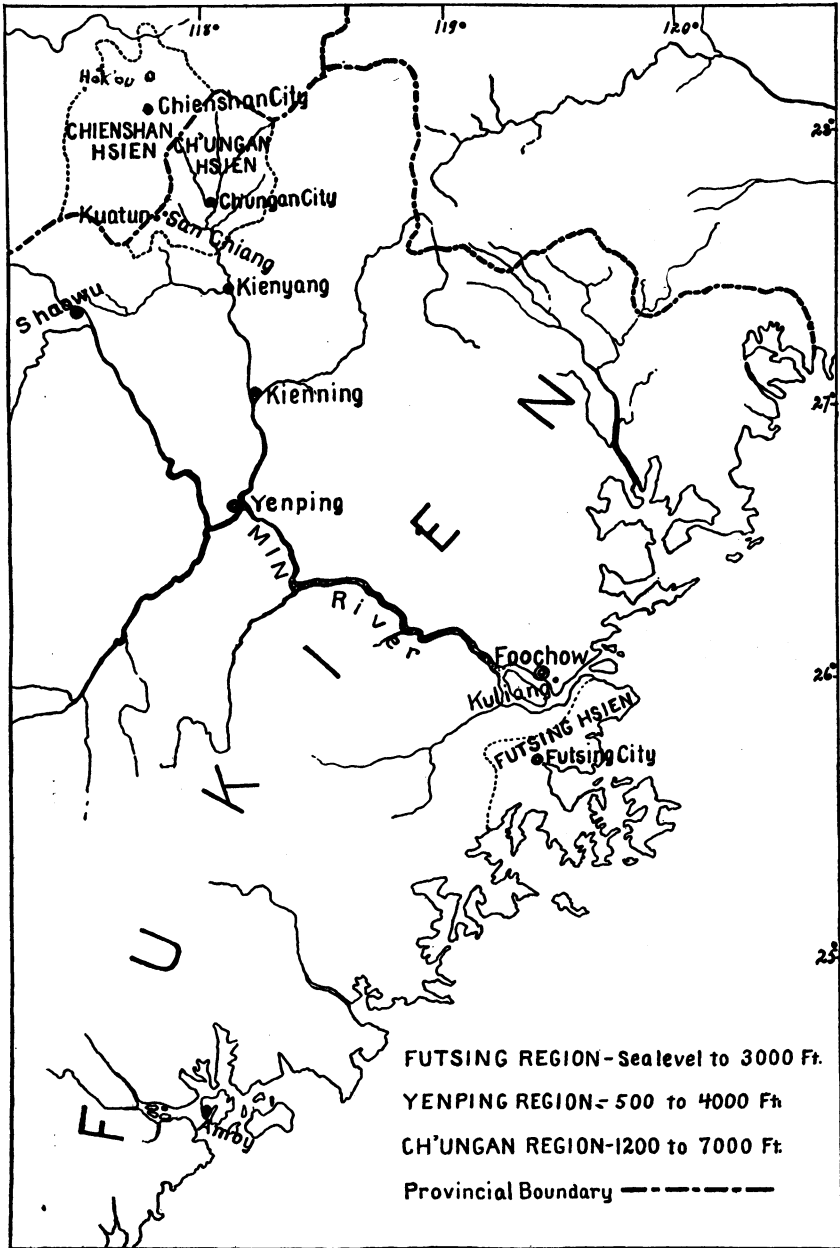


1928. 'The Brevicipitid Frogs of the Genus *Microhyala*.' Ann. Mag. Nat. Hist., (18) II, pp. 473-499.
- PAVLOFF, P. A. 1926. 'The Manchurian Reptilia and Amphibia Based upon Collections Stored in the M. R. S. Museum.' Misc. Pap. Man. Res. Soc., (A) Fasc. 13, pp. 1-22.
- PETERS, W. 1867. 'Herpetologische Notizen.' Montsber. Kön. Preuss. Akad. Wiss. Berlin, pp. 13-37.
- POPE, CLIFFORD H. 1924. 'Hainan, an Island of Forbidding Reputation that proved an Excellent Collecting Ground.' Natural History XXIV, pp. 215-223.
1927. 'Frog Hunting in Fukien, China.' Natural History, XXVII, pp. 462-473.
- 1927a. 'A Snake-Buyer in China.' Asia, XXVII, pp. 636-641, 680-682.
1928. 'A Modern "Medicine Man" in China.' Natural History, XXVIII, pp. 253-263.
1929. 'Notes on Reptiles from Fukien and Other Chinese Provinces.' Bull. Amer. Mus. Nat. Hist., LVIII, pp. 335-487.
- 1929a. 'Four New Frogs from Fukien Province, China.' Amer. Mus. Novitates, No. 352.
- 1929b. 'Frogs Habitats in China.' Bull. Peking Soc. Nat. Hist., IV, part 2, pp. 11-14.
- RAO, C. R. N. 1915. 'Notes on some South Indian Batrachia.' Rec. Ind. Mus., XI, pp. 31-38.
- SAUVAGE, H. E. 1877. 'Sur quelques Batraciens de Chine.' Bull. Soc. Philom. Paris, (7) I, pp. 115-118.
- SCHMIDT, KARL P. 1925. 'New Reptiles and a New Salamander from China.' Amer. Mus. Novitates, No. 157.
1926. 'Some Questions About the Common Toads of Central China.' China Journ., IV, pp. 75-76.
1927. 'Notes on Chinese Amphibians.' Bull. Amer. Mus. Nat. Hist., LIV, pp. 553-575.
- 1927a. 'The Reptiles of Hainan.' Bull. Amer. Mus. Nat. Hist., LIV, pp. 395-465.
- SHAW, TSEN-HWANG. 1929. 'The Amphibians of Peiping.' Bull. Fan. Mem. Inst. of Biol., I, pp. 77-97.
- SIEDLECKI, M. 1909. 'Zur Kenntniss des javanischen Flugfrosches.' Biol. Centrallblatt, XXIX, pp. 704-737.
- SLEVIN, JOSEPH R. 1925. 'Contributions to Oriental Herpetology II. Korea or Chosen.' Proc. Calif. Acad. Sci., (4) XIV, pp. 89-100.
- SMITH, M. A. 1916. 'Descriptions of Five Tadpoles from Siam.' Journ. Nat. Hist. Soc. Siam, II, pp. 37-43.
- 1916a. 'On a Collection of Reptiles and Batrachians from Peninsula Siam.' Journ. Nat. Hist. Soc. Siam, II, pp. 148-171.
- 1916b. 'On the Frogs of the Genus *Oxyglossus*.' Journ. Nat. Hist. Soc. Siam, II, pp. 172-175.
1917. 'A List of the Batrachians at Present Known to Inhabit Siam.' Journ. Nat. Hist. Soc. Siam, II, pp. 226-231.
- 1917a. 'On Tadpoles from Siam.' Journ. Nat. Hist. Soc. Siam, II, pp. 261-275.

1921. 'New or Little-known Reptiles and Batrachians from Southern Annam (Indo-China).' Proc. Zool. Soc. London, pp. 423-440.
1923. 'Narrative of a Journey to the Interior of Hainan.' Journ. Nat. Hist. Soc. Siam, VI, pp. 185-194.
- 1923a. 'On a Collection of Reptiles and Batrachians from the Island of Hainan.' Journ. Nat. Hist. Soc. Siam, VI, pp. 195-212.
1924. 'New Tree-Frogs from Indo-China and the Malay Peninsula.' Proc. Zool. Soc. London, pp. 225-234.
- 1924a. 'Descriptions of Indian and Indo-Chinese Tadpoles.' Rec. Ind. Mus., XXVI, pp. 137-143.
- 1924b. 'The Tadpole of *Tylotriton verrucosus*.' Rec. Ind. Mus., XXVI, pp. 309-310.
1927. 'Contributions to the Herpetology of the Indo-Australian Region.' Proc. Zool. Soc. London, pp. 199-255.
1930. 'The Reptilia and Amphibia of the Malay Peninsula.' Bull. Raffles Mus., Singapore, No. 3, pp. 1-140.
- SOWERBY, ARTHUR DE CARLE. 1925. 'A Naturalist's Note-Book in China.' Shanghai.
- SOWERBY, ARTHUR DE C., AND CLARK, ROBERT S. 1912. 'Through Shen Kan.' London.
- STEINDACHNER, FRANZ. 1869. 'Reise der Osterreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859.' Zoologischer Theil. Amphibien. Wien.
- STEJNEGER, LEONHARD. 1907. 'Herpetology of Japan and Adjacent Territory.' Bull. U. S. Nat. Mus., LVIII, pp. 1-577.
1910. 'The Batrachians and Reptiles of Formosa.' Proc. U. S. Nat. Mus., XXXVIII, pp. 91-114.
1924. 'Herpetological Novelties from China.' Occ. Pap. Boston Soc. Nat. Hist., V, pp. 119-121.
- 1924a. 'The Woodfrogs of Japan.' Proc. Biol. Soc. Washington, XXXVII, pp. 73-78.
1925. 'Chinese Amphibians and Reptiles in the United States National Museum.' Proc. U. S. Nat. Mus., LXVI, pp. 1-115.
1926. 'Two New Tailless Amphibians from Western China.' Proc. Biol. Soc. Washington, XXXIX, pp. 53-54.
- STONE, WITMER. 1899. 'A small Collection of Reptiles and Batrachians from Eastern Mongolia.' Proc. Acad. Nat. Sci., Phila., pp. 183-184.
- SWINHOE, ROBERT. 1870. 'List of Reptiles and Batrachians Collected on the Island of Hainan (China), with Notes.' Proc. Zool. Soc. London, pp. 239-241.
- UNTERSTEIN, W. 1930. 'Beiträge zur Lurche- und Kriechtierfauna Kwangsi's.' Sitzber. Ges. Naturf. Freunde Berlin, pp. 313-315.
- VAN DENBURGH, JOHN. 1909. 'New and Previously Unrecorded Species of Reptiles and Amphibians from the Island of Formosa.' Proc. Calif. Acad. Sci., (4) III, pp. 49-56.
1912. 'Concerning Certain Species of Reptiles and Amphibians from China, Japan, the Loo Choo Islands and Formosa.' Proc. Calif. Acad. Sci., (4) III, pp. 187-258.

- VAN KAMPEN, P. N. 1907. 'Amphibien des Indischen Archipels.' Weber's Zool. Ergebn., Leiden, IV, pp. 383-418.
1910. 'Beitrag zur Kenntniss der Amphibienlarven des Indischen Archipels.' Natuurk. Tijdschr. voor Ned.-Indië, LXIX, pp. 25-48.
1923. 'The Amphibia of the Indo-Australian Archipelago.' Leiden.
- VOGT, THEODOR. 1911. 'Beitrag zur Amphibienfauna der Insel Formosa.' Sitzber. Ges. Naturf. Freunde Berlin, pp. 179-184.
1913. 'Zur Reptilien- und Amphibienfauna Koreas und Japans.' Sitzber. Ges. Naturf. Freunde Berlin, pp. 219-221.
- 1913a. 'Über die Reptilien- und Amphibienfauna der Insel Hainan.' Sitzber. Ges. Naturf. Freunde Berlin, pp. 222-229.
1914. 'Sudschinesische Reptilien und Amphibien.' Sitzber. Ges. Naturf. Freunde Berlin, pp. 96-102.
1921. 'Über einen neuen Frosch aus China mit stark entwickelten Brunstorganen.' Sitzber. Ges. Naturf. Freunde Berlin, pp. 75-77.
1922. 'Zur Reptilien- und Amphibienfauna Südchinas.' Arch. Naturg. Berlin, LXXXVIII, Abt. A, Heft 10, pp. 135-146.
1924. 'Reptilien und Amphibien aus Szetschwan, Osttibet und Tschili.' Zool. Anz., LX, pp. 337-344.
1927. 'Beitrag zur Reptilien- und Amphibienfauna Südchinas.' Zool. Anz., LXIX, pp. 281-288.
- WERNER, F. 1903. 'Ueber Reptilien und Batrachier aus Guatemala und China in der zoologischen Staats-Sammlung in München nebst einem Anhang über seltene Formen aus anderen Gegenden.' Abh. Bayer Akad. Wiss., 2 Kl., XXII, pp. 343-384.
1924. 'Ergebnisse der Expedition Dr. Handel-Mazzetti's nach China 1914 bis 1918 aus Kosten der Akademie der Wissenschaften in Wien. Über Reptilien und Amphibien aus Südchina.' Denkschr. Akad. Wiss. Wien (math.-natur.), XCIX, pp. 39-58.
- WIEGMANN, A. F. A. 1835. 'Beiträge zur Zoologie, gesammelt auf einer Reise um die Erde, von Dr. F. J. F. Meyer.' Siebente Abhandlung: Amphibien. Nova Acta Acad. Leop. Carol., XVII, pp. 185-268.
- WILDER, H. H. 1921. 'Notes on Larval Amphibia Collected in China in 1920.' Copeia, No. 98, pp. 59-62.
- WOLTERSTORFF, W. 1905. 'Bemerkungen zu dem Aufsätze "Zoologische Ausflüge in Fokien."' Wochenschr. Aquarienkunde, Braunschweig, II, p. 511.
1906. 'Über *Callula verrucosa* Boulenger von Tsingtau,' Zool. Anz., XXX, pp. 554-558.
- 1906a. 'Über die von Herrn Dr. Kreyenberg in Ostasien gesammelten Frosch- und Schwanzlurche.' Abh. Mus. Magdeburg, I, pp. 123-164.
- 1906b. 'Über *Triton pyrrhogaster* subsp. *orientalis* Dav.' Zool. Anz. XXX, pp. 558-563.
1925. 'Katalog der Amphibien-Sammlung im Museum für Natur- und Heimatkunde.' Abh. Mus. Natk. Magdeburg, IV, pp. 231-310.

1926. 'Ostasiatische Tritonen.' *Blätter Aquarienkunde*, Stuttgart XXXVII, pp. 372-375.
- WOOD-MASON, ——. 1877. 'A Specimen of a Newt.' *Proc. As. Soc. Bengal*, pp. 53-54.
- WU, HSIEN WEN. 1929. '*Osteosternum amoyense*, a New Frog from Amoy.' *Cont. Biol. Lab. Sci. Soc. China*, V, No. 2, pp. 1-9.



Map 1.—Eastern Fukien showing the region in which intensive collecting was carried on by the Central Asiatic Expedition during 1925 and 1926.

PLATE XIII

Fig. 1. Eggs of *Rana spinosa*, Kuatun, May 30, 1926.

The eggs shown here, adhering to the lower surface of an upturned rock, were originally submerged in the pool beneath. Note the size of the individual capsaules, each of which invariably holds a single egg. The rock is about three feet long.

Fig. 2. Eggs of *Rana spinosa*.

These eggs are the same as those seen in Fig. 1 above. In the lower, left corner of this photograph a little of the cascade near which the eggs were deposited may be seen. This picture conveys some idea of the dense foliage meeting over the swift stream but fails to give any conception of the great steepness of the mountain side on which the photograph was taken.



1



2

PLATE XIV

Fig. 1. Frog eggs deposited in a swift stream at Kuantun.

This cluster of eggs, although of doubtful identity, was probably laid by *Rana graminea*. The photograph was made July 24, 1926. As explained in the text, the compact cluster shown here is in strong contrast to the one represented in figures 1 and 2, of plate XIII.

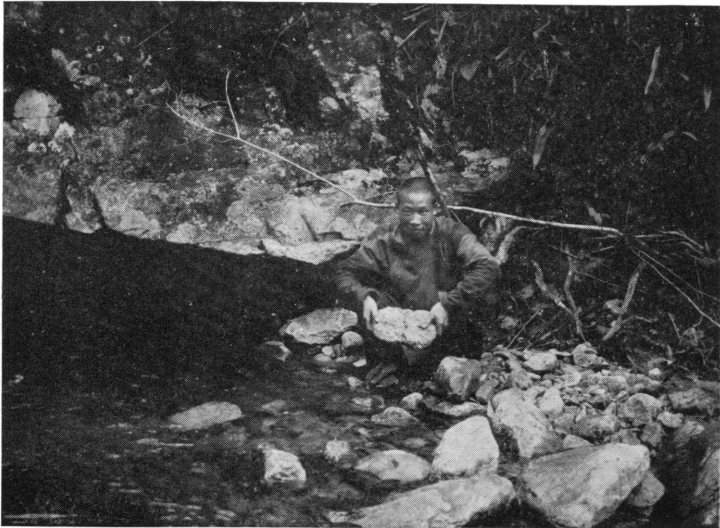
Fig. 2. Pool in which the egg-cluster shown above was found.

Collector Yu Fa is seen holding the rock to which the cluster adheres at the site of discovery.





1



2

PLATE XV

Fig. 1. Froth-nests of *Polypedates dennysi*, San Chiang, May 15, 1926.

These nests, only one of which still contained eggs when the photograph was made, were deposited directly over a flooded field on bushes growing at the edge of a thicket. The small sun hat lying on the bank indicates relative size.

Fig. 2. Froth-nest of *Polypedates dennysi*, San Chiang, May 13, 1926.

The flooded fields below this froth-nest were also a well-frequented breeding site of *Hyla sanchiangensis*, *Rana latouchii*, *R. adenopleura*, *R. limnocharis*, and *Polypedates leucomystax megacephalus*.



1



2

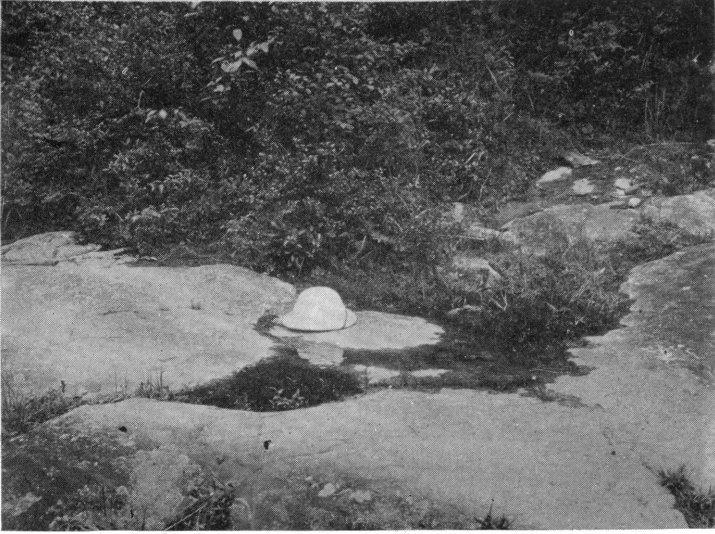
PLATE XVI

Fig. 1. Breeding site of *Rana kuhlii*, San Chiang, 1926.

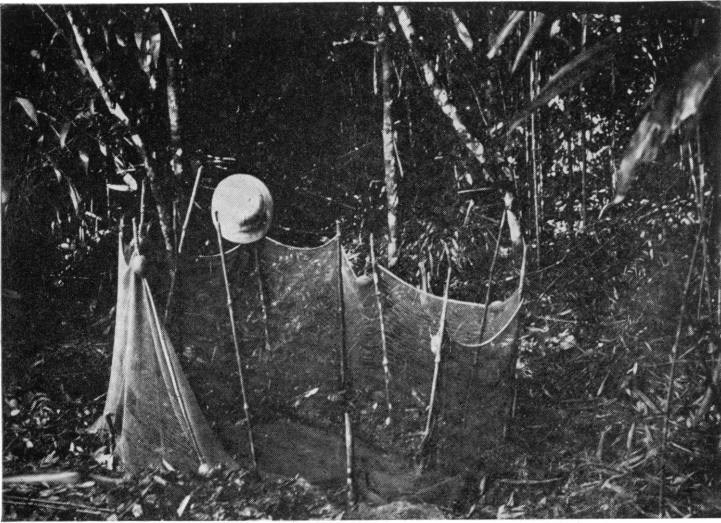
This shallow trail-side pool in the open San Chiang Valley, near the upper end of the village, is typical of the type of place selected by the adults of this species for living as well as for breeding.

Fig. 2. Breeding site of *Hynobius chinensis*, near the top of the high range opposite Kuantun, 1926.

*Hynobius chinensis* bred in the wild pig wallow here shown surrounded by a net. Relative size is indicated by the small sun hat seen in the background.



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2

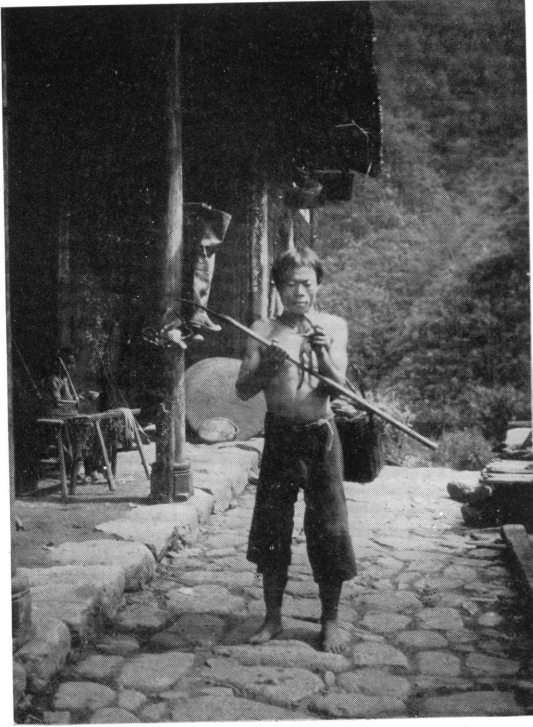
PLATE XVII

**Fig. 1. San Chiang villager equipped for night frog hunting.**

In his right hand he holds the handle of an iron fire basket, while a load of pine kindling is carried on his back. A large *Rana spinosa* can be seen in his left hand.

**Fig. 2. Ploughing a San Chiang rice field.**

A good conception of the exact conditions under which the San Chiang field frogs live can be formed from this picture showing the universal method of preparation for the setting out of rice plants.



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2

PLATE XVIII

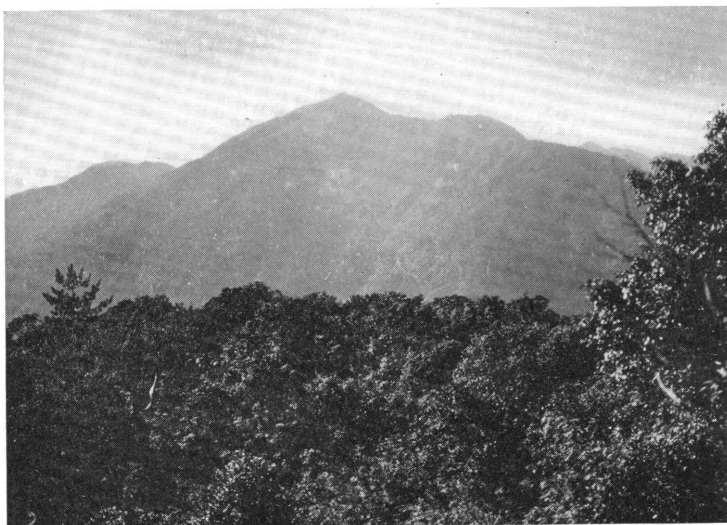
Fig. 1. Kuatun Mountain, northwestern Fukien.

This mountain, famous as the type locality of some three score vertebrate forms, is here seen from the range across the valley in which Ch'lich'iao is located.

Fig. 2. Looking down Upper Kuatun Valley.

The vegetation of this wide but elevated valley is kept in control by the few people living there. Fields and bamboo forests abound. *Bufo bankorensis*, *Rana montivaga* and *R. chunganensis* are the chief amphibian inhabitants of the forests.





1



2

## PLATE XIX

### Fig. 1. Looking across Upper Kuatun Valley.

The main branch of the Kuatun stream flows just in front of the house in the foreground. *Pachytriton brevipes*, *Megophrys boettgeri*, *M. hasseltii*, *Rana spinosa* and *Staurois ricketti* are generally abundant at this point in the stream, while *Megophrys kuatunensis* also occurs in it, but only at higher levels.

### Fig. 2. The high range of mountains opposite Kuatun Mountain seen from Lower Kuatun.

The photograph of Kuatun Mountain represented in Plate XVIII, fig. 1, was taken from the range seen in the distance, while the breeding site of *Hynobius chinensis* shown in Plate XVI, fig. 1, is located near the top of this same range. A bark roof is evident in the foreground.

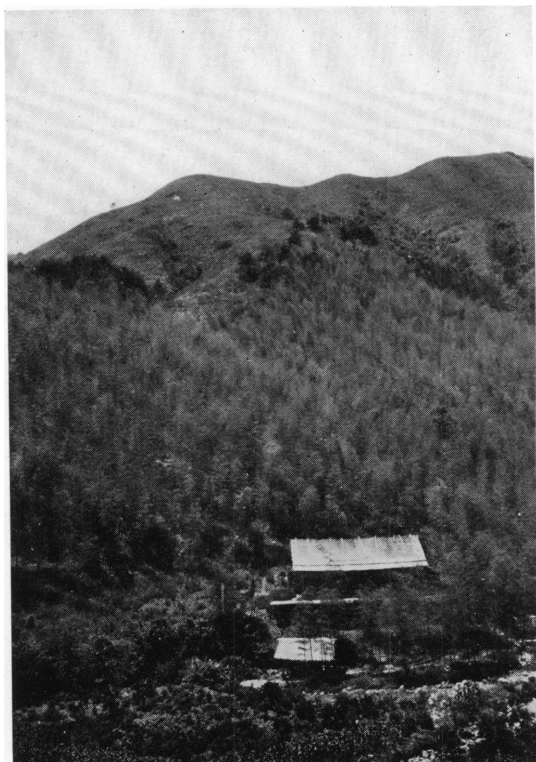


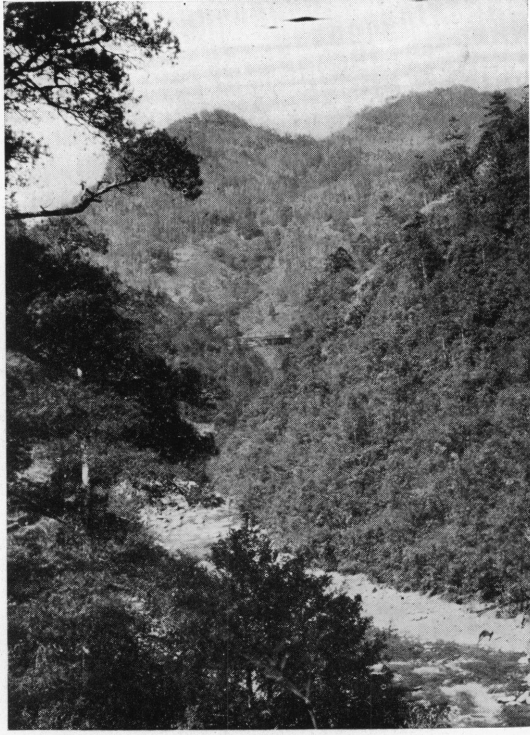
PLATE XX

Fig. 1. A scene at San Chiang.

The stream shown here is the eastern branch of the three that unite at San Chiang to form the larger one of Plate XXI, fig. 2.

Fig. 2. Stream scene near San Chiang.

This photograph illustrates the type of habitat preferred by *Pachytriton brevipes*, *Megophrys pelodytoides*, *M. hasseltii*, *Rana graminea*, *R. andersonii*, *R. spinosa* and *Staurois ricketti*.



1



2

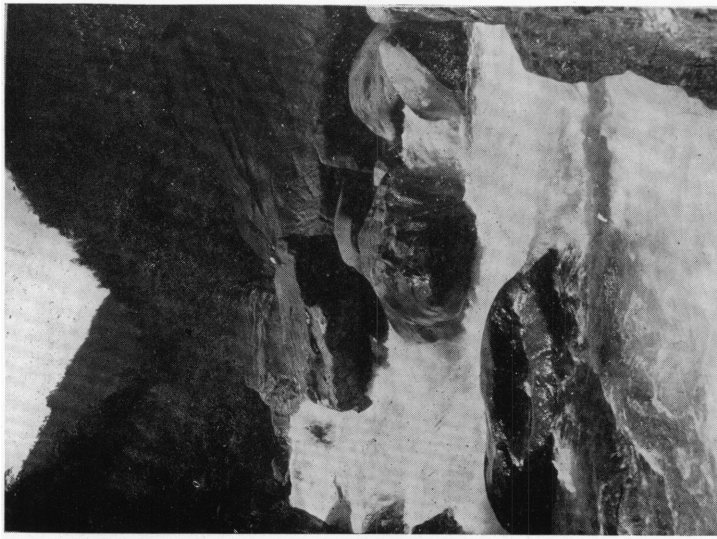
PLATE XXI

Fig. 1. Cascades near San Chiang.

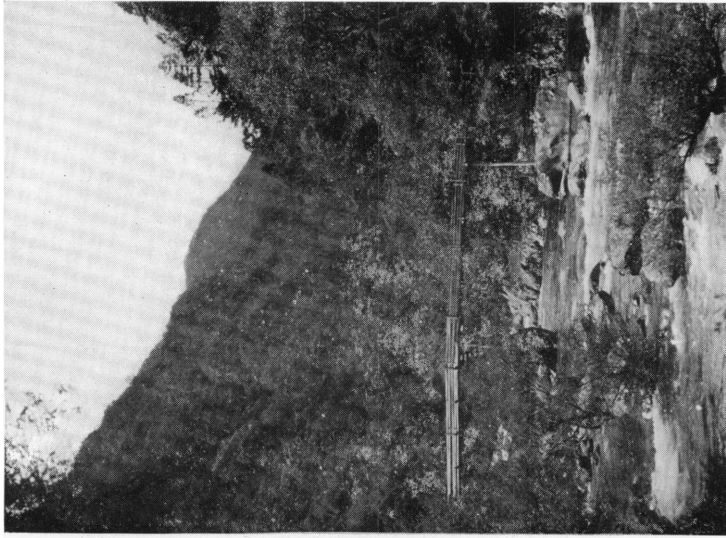
This picture shows the actual habitat of true cascade frogs such as *Rana spinosa*, *R. andersoni*, *R. graminea*, and *Staurois ricketti*.

Fig. 2. Scene immediately below San Chiang.

This larger stream is formed near San Chiang by the union of three smaller ones.



1



2

PLATE XXII

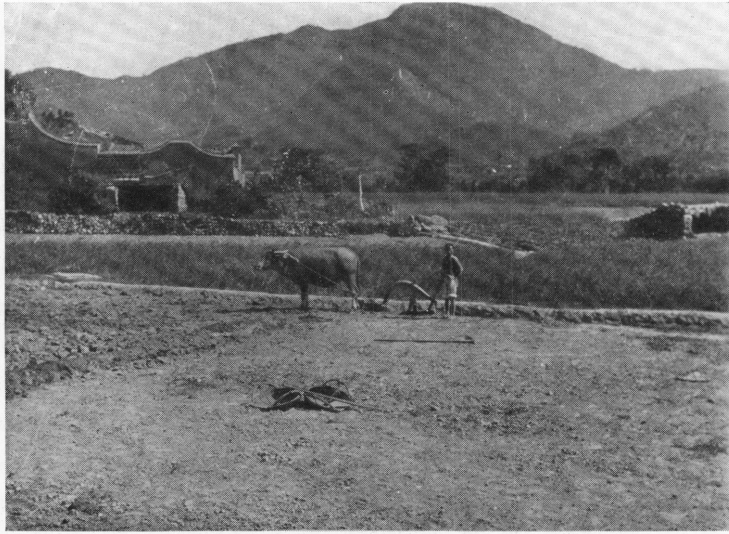
Fig. 1. Looking across a Futsing Hsien plain.

The mountains of Futsing Hsien, like those seen in the background of this photograph, have been denuded of their original forests, while the plains are intensely cultivated. *Bufo melanostictus*, *Hyla chinensis*, *Rana rugulosa*, *R. limnocharis*, *R. fukiensis*, *R. guentheri* and *Microhyla ornata* were found to be abundant on these plains but, as stated in the text, other species are known to occur here as well.

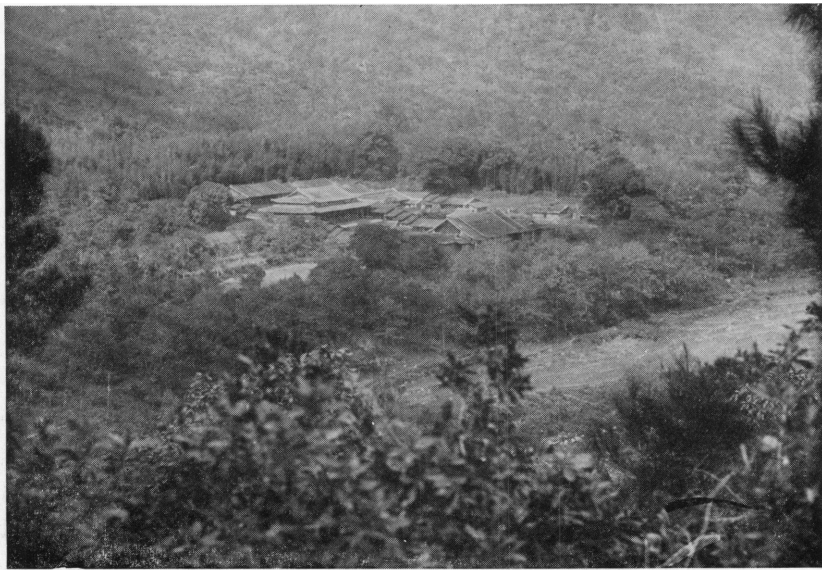
Fig. 2. Ling Shih Monastery, our Futsing Hsien base.

This monastery stands in a forested, mountain-encircled basin whose rim reaches a height of 3000 feet at some points. The shaded cascades of the encircling range are inhabited by true swift water forms, chief among them *Pachytriton brevipes*, *Rana andersonii*, *R. spinosa* and *Staurois ricketti*. *Megophrys boettgeri* and *M. pelodytoides* are also found along the beds of the steep streams.





1



2

