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SECONDARY SEX CHARACTERS
OF CHINESE FROGS AND TOADS

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INTRODUCTION

The extensive and varied nature of sexual dimorphism among the Salientia has, from the beginning of modern biology, directed attention to the secondary sex characters of this group of animals. Aside from their intrinsic interest, they have proved to be of great value in the discrimination of species. Careful studies of breeding behavior and experimental studies of the genetic and hormone control of their development and conservation have served to renew and broaden interest in these structures. The best available summary of the extensive literature on this subject is the chapter "Sex and Secondary Sex Characters" in *The Biology of the Amphibia* by G. K. Noble (1931), while for the Chinese species the work of Clifford H. Pope is most comprehensive (1931).

Although the tailless amphibians have been extensively studied, no comparative and systematic account of the secondary sex characters in any large group of species has appeared. The confused state and lack of uniformity in existing descriptions of these characters, particularly in the Chinese fauna, seemed to indicate that a detailed study of them would be of considerable value. My interest in this field began with studies on the sex behavior and secondary sex characters of the frogs and toads of North China. It was during the course of these studies that the peculiar linea masculina, a hitherto unknown secondary sex character, was discovered in *Kaloula borealis*. The linea masculina proves to be characteristic of the males of many species of salientians of various families, and is conspicuous even in the common species used for laboratory dissection in Europe and America (Liu, 1935). Knowing my interest in this topic and in the Chinese amphibian fauna, Professor A. H. Wright suggested a detailed study of the secondary sex characters of the frogs and toads of China, of which this paper is the result. He has given constant and valuable advice, and arranged for my work with other American herpetologists interested in the Chinese fauna. I am deeply indebted to him for his friendly interest.

This paper deals only with the Chinese Salientia available in the various museums of the United States. Special emphasis has been

placed on accurate description of the external secondary sex characters. An effort has been made to bring together all the secondary sex characters of importance in problems of habitat relationship, breeding behavior, and phylogenetic relations by re-examination of characters reported in literature, which has resulted in the discovery of some hitherto unreported. The importance of these characters in the discrimination of species and subspecies is particularly evident in the Salientia. Thus, for example, in *Rana n. nigromaculata* (Plate IV) and *Bufo raddei* (Plate III) sexual dimorphism in color is notable. On the other hand, the head of the male *Rana kuhlii* is remarkably different in shape and size from that of the female. Anyone not aware of this sexual disparity would certainly regard them as distinct species. Among certain species the texture of the skin differs extremely in the two sexes. The length of the hind limbs is a character commonly used in describing salientians, but it is without value if only one sex is considered. In *Bufo bufo japonicus*, for example, the leg of the male is much longer than that of the female, while the female of *Rana macrodactyla* has longer legs than does the male. Only in a very few cases do both sexes have hind limbs of the same length. Other characters which are commonly used to define species are the diameter of the tympanum and the development of the web on the hind foot. Both these structures are usually better developed in the males. The web is much better developed in the males of *Kaloula rugifera*, *Rana japonica* and *Bufo bufo japonicus*, but in *Rana pleuraden* the female has the better-developed web.

Of approximately one hundred known species of Chinese salientians, male and female specimens of sixty-three have been examined. The variation in secondary sex characters has been studied through large series of the common forms.

I am much indebted to the authorities of the various museums whose collections I have been privileged to examine, and especially to Mr. Karl P. Schmidt of Field Museum of Natural History, to Dr. Leonhard Stejneger and Dr. Doris Cochran of the United States National Museum, to Dr. Thomas Barbour and Mr. Arthur Loveridge of the Museum of Comparative Zoology, to Dr. E. R. Dunn of the Academy of Natural Sciences of Philadelphia, and to Dr. G. K. Noble and Mr. Clifford H. Pope of the American Museum of Natural History. I am especially grateful to Mr. Schmidt and to Mr. D. Dwight Davis for their interest in my work and for criticisms and suggestions regarding both studies and manuscript during my

stay at Field Museum of Natural History. The advice of Mr. Pope, who is engaged in monographic studies of the Chinese amphibians and reptiles, has also been of special value, and I have made extensive use of his paper on the Chinese Amphibia (1931). At Peiping, during the spring breeding season, Professor Alice M. Boring of the Biology Department of Yenching University has collected frogs and toads in the interests of my project, and I gratefully extend to her my appreciation of her long-continued help and interest.

SECONDARY SEX CHARACTERS OF THE SALIENTIA

For obvious reasons, an overwhelming proportion of the work on the secondary sex characters of frogs and toads has been confined to the species characteristic of Europe and North America. This is unfortunate from several standpoints. The impoverished salientian fauna of Europe offers an extraordinarily meager field to the student of these interesting structures. On the other hand, while North America is much richer in number of species, the variety of secondary sex characters displayed is scarcely larger than in Europe. No frog on either continent offers anything even remotely comparable to the luxuriant development of nuptial spines, coupled with enormous forearm development, seen in *Rana spinosa*. The reason for this extreme conservatism is not at all apparent. Habitats in North America are as varied as are those found in China.

That China offers an invitingly fertile field for a study of sexual modifications among the Salientia is obvious. The frogs and toads of this region exhibit most of the known types of sexual dimorphism. One of the most remarkable of these characters not found in this fauna is the modification of the snout for digging in male frogs of the genus *Leptodactylus* of tropical America. Other conspicuous modifications, usually confined to a single genus in each case, such as the development of broad spatulate fringes on one or more fingers, the hypertrophy of one of the fingers, the piercing of the tympana by the columella, some distinctive types of glands, the peculiar intro-mittent organ of *Ascaphus*, and the hair-like dermal growths of *Astylosternus*, do not appear among the species examined in this study, but have been described and discussed by Noble (1931).

Previous students, with few exceptions, have been acquainted only with the conservative structures found in European and North American species. It is largely for this reason that previous attempts to classify salientian secondary sex characters have been found inad-

equate when applied to the Chinese fauna. In the interest of unity, however, it was imperative that some common denominator be used consistently in this study. The scheme finally adopted was to consider the secondary sex characters of each species under several major headings. These are: modifications for grasping; vocal sacs and voice; tympanum; modifications of the skin; characters of the hind limbs; linea masculina; and dimorphism in size.

Finally, to remove any further ambiguity, the following definitions and brief discussions of these headings are added:

Modifications for grasping.—During the breeding season, structural modifications apparently associated with maintaining a firm grip during amplexus are usually developed in males. These usually consist in strengthening of the arms and a varied development of rough pads or spines. The appearance, structure, distribution and the degree of development of these characters vary enormously in the several species. Different genera have various types of modifications of the fingers, the arms, or other parts of the body, and these have been variously named by authors. The wisest procedure in the present instance seems to be to classify them according to structure in order to clarify the descriptions of the individual species which follow. The various types of nuptial pads, asperities, and spines are as follows:

Pigmented areas: More or less horny hard deposits in the skin, not elevated, usually black. Example, edge of mandible of *Bufo bufo gargarizans*.

Nuptial pad: Elevated area, usually well defined, velvety or granular or very finely spinose, pigmentation variable. Example, *Rana japonica*.

Nuptial asperities: Horny spines, in groups, the individual spines distinguishable, black. Examples, *Rana spinosa* (of the fingers), and *Aeluropyne mammata* (of the breast).

Nuptial spines: Pointed horny isolated structures. Examples, *Leptodactylus ocellatus* (prepollex) and *Rana spinosa* (spines on the breast).

Dagger: Projecting pointed bone, piercing the skin, usually the prepollex, sometimes the terminal phalanges of the fingers. Example, *Babina holsti*.

A unique modification of the fingers of the males in a species of *Kaloula* is described by Parker (1934, p. 80), consisting of small bony projections on the terminal phalanges, which correspond with

external dermal pits. It is difficult to imagine what may be the function of this structure.

Vocal sacs.—These are diverticula of the mouth membrane, which may be expanded by inflation with air. They are either external, when the outer skin is modified, or internal, when there is no modification of the external skin. It should be noted, however, that in either case there is an internal sac composed of diverticula of the mouth lining. A more detailed account of this structure has been given in another paper (Liu, 1935), where the principal types of vocal sacs are arranged as follows:

- I. Median subgular vocal sac (an unpaired vocal sac beneath the throat).
 - A. Internal median subgular vocal sac as in *Bufo raddei*.
 - B. External median subgular vocal sac as in *Hyla chinensis*.
- II. Paired subgular vocal sacs (in subgular region).
 - A. Internal paired subgular vocal sacs as in *Polypedates omeimontis*.
 - B. External paired subgular vocal sacs as in *Rana rugulosa*.
- III. Paired lateral vocal sacs (behind and below the angles of the jaws).
 - A. Internal paired lateral vocal sacs (no modification of the external skin) as in *Rana cantabrigensis* and *Polypedates megacephalus*.
 - B. External paired lateral vocal sacs (external skin modified) as in *Rana nigromaculata*.

Tympanum.—The tympanum shows little sex dimorphism in the Chinese Salientia, although there are a few peculiar modifications of this structure in the Old World forms. The male of the African *Petropedetes newtoni* has the columella thrust through the drum and covered by the derm. The tympanum of the American bullfrog, *Rana catesbeiana*, and allied species is very much larger in the males than in the females. The males of *Rana plancyi* and *R. taipehensis*, among Chinese forms, have the tympanum enlarged.

Modifications of the skin.—The differences of texture, warts, ridges, glands and coloration of the skin of the two sexes may be great or slight according to species. Females may be very much more rugose than males as in *Bufo bufo japonicus*; and on the other

hand the females may exhibit a beautiful coloration and smoother skin as in *Bufo raddei*. For satisfactory comparison of the sexes for skin character it is necessary to have specimens preserved alike. Specimens from strong alcohol cannot be compared with those preserved in weak alcohol, and formalin specimens also vary greatly in individual lots.

The looseness of the skin is an interesting and conspicuous character in the large Chinese toad, *Bufo bufo japonicus*, and in *Aelurophryne mammata*. The skin of the males is very loose in comparison with that of the females, due to the presence of loose, spongy connective tissue beneath it. Glands of different shapes and distribution may be found in the skin of either sex. The dermal glands appearing externally in only one sex may be classified as follows:

- (1) Snout gland: a gland situated at the snout of the male as in *Rana macrodactyla* and *Polypedates dennysi*.
- (2) Subgular gland: a gland found on the throat of the male as in *Hyperolius* spp.
- (3) Shoulder gland: a kidney-shaped or oval gland situated at the anterior base of the arm in males as in *Rana guentheri* and *Rana spinulosa*.
- (4) Lateral glands: large flat glands found on the sides of the body in males, postero-dorsad of the forelimbs, as in *Rana adenopleura*.
- (5) Inguinal glands: rounded glands on the inguinal region of the male as in *Cycloramphus asper*.
- (6) Ventral gland: a large flattened gland situated on the belly of males as in *Kaloula rugifera*.
- (7) Femoral gland: glandular tissue on the ventral surface of the thighs as in *Mantidactylus luteolus*.

Characters of the hind limbs.—In the majority of Salientia the males have longer legs than the females. It is interesting to find, however, that this is not an invariable rule. In the five species of *Polypedates* examined, the reverse is the case.

Degree of development of webs and fringes on the toes is another important secondary sex character in Salientia. The best examples of sex distinction in this respect are the species of *Kaloula*, *Bombina*, *Bufo*, and the wood-frogs. Fringes on the toes are well illustrated by *Bombina* and *Bufo*. In one case hypertrophy of the webs appears in the females (*Rana pleuraden*).

Linea masculina.—This curious structure has been fully described and figured elsewhere (Liu, 1935). It consists of bands of dense connective tissue extending the entire length of both layers of the obliquus muscle, at both their dorsal and ventral borders.

Size.—Sexual dimorphism in size varies greatly. Males are usually smaller than females, but in some forms, such as *Rana spinosa* and its allies, the males are much the larger.

FUNCTIONAL SIGNIFICANCE OF SECONDARY SEX CHARACTERS

In the light of our meager knowledge of the breeding habits of even the common species of frogs and toads, an attempt to consider the functional significance of the sexual modifications of these animals in any but the broadest and most general manner is quite likely to prove sterile. The only recent attempt to view this subject in a broad perspective is that of Noble (1931), and his brief discussion throws but little light on the problem as a whole. Certain modifications, however, function in a manner that is obvious. This is conspicuously true of many of the adaptations in the male for maintaining a firm grip on the back of the female during amplexus. To this class belong the various types of nuptial pads, asperities, spines, and "daggers." To a certain degree the development of these structures seems to be correlated with the breeding habits of the individual species. Thus, the equipment of such species as *Rana spinosa*, *R. phrynoides*, *R. tibetana*, and the wood-frogs (*Rana amurensis*, *R. chensinensis*, and *R. japonica*), is strongly developed, and it can hardly be questioned that this fact is correlated with their mountain torrent habitat. On the other hand, in certain pond-breeding species, such as *Rana plancyi*, *R. fukiensis*, *Ooeidozyga*, *Microhyla*, and *Kaloula* these structures are either poorly developed or entirely absent. Unfortunately this does not hold in many specific instances. Future field observations will show either that the whole theory is unsound (which seems unlikely), or that factors still unknown have superimposed additional modifications.

The situation is further complicated by the fact that species, even within the same genus, seem to have met similar problems with totally different approaches. *Rana spinosa* has solved the problem of breeding in rapidly moving water by developing an astonishing system of mechanical devices. *Rana graminea*, which breeds in similar situations, has apparently been equally successful by reducing the size of the male, thereby lowering his resistance to the water.

It has been suggested frequently that many structures limited to one sex may serve as factors in sex-recognition. In this class fall such modifications as color differences, rugosity of the skin in one or the other sex, and the presence of a substratum of spongy tissue, as in males of *Aelurophryne mammata*, *Bufo bufo japonicus*, and *Bufo b. bankorensis*. At present the best that can be said for this interpretation is that it affords a logical explanation for structures that are otherwise difficult to explain. Any or all of these modifications may function in sex-recognition. That they actually do has never been demonstrated. The results of observations and experiments aimed at discovering the method of sex-recognition in Salientia show that voice is probably the most important factor, with differential behavior and the distinctive body form of the female apparently assisting, in certain species at least. Unfortunately, no work has been done on species where sexual dimorphism is great.

Reversal of certain sexual differences is difficult to interpret or understand. For example, the males of all species of *Bufo* have hind legs longer than those of the females, while in *Polypedates* the proportions are reversed and all females have longer legs. In *Rana* the males have longer legs in 61 per cent of the species, females with longer legs occur in 31 per cent, and in 8 per cent both sexes have legs of the same length. Similarly, the dorsal surface of the body is much more rugose in males of *Bufo raddei* than in females, while in *Bufo bufo japonicus* the females are much more rugose than the males.

The functions of the snout glands of *Rana macrodactyla* and of the males of different species of *Polypedates*, the shoulder gland of *Rana guentheri* and *Rana spinulosa*, the ventral gland of the males of all species of *Kaloula*, and the lateral glands of *Rana pleuraden* and *Rana adenopleura*, are unknown.

Beyond a possible correlation with voice production in males, I am unable to suggest any functional significance of the linea masculina.

SECONDARY SEX CHARACTERS OF THE CHINESE SPECIES

Bombina orientalis Boulenger (Plates I, fig. 1; VIII, figs. 1-4).

Modifications for grasping.—Males with well-defined nuptial pads, the largest on the inner side of the forearm. A second, about half as large, covers nearly the entire inner metacarpal tubercle. Smaller and less sharply defined pads are present on the palm and on the arm just above the palm. The first, second, and third fingers

bear pads similar to those of the arm. The arm is distinctly stronger in males with the hand strongly bent inward. The ratio of the average diameter of the lower arm to the body length is 0.11 in the males, while in the females the average ratio is 0.07. The fingers of the males are narrowly fringed. The fringe is widest at the base, diminishing toward the tip.

Vocal sacs.—None.

Skin.—There appears to be no constant difference between the sexes in the rugosity of the skin of the body; the arm and the tarsus in the male are more heavily tuberculate and spinose. There is no sexual difference in coloration.

Hind limb.—The hind limb is slightly longer in the males, ratio to body length averaging 1.22, than in the females, average ratio 1.17. The web in the males is much more extensive than in the females. The tarsus of the male is slightly swollen and the toes are moderately thickened.

Linea masculina.—Absent.

Size.—No sexual dimorphism in size.

Discussion.—I failed to find the difference in the length of the fingers in the males and females described by Stejneger (1907, p. 53). Nor can I agree with Okada's statement (1931, p. 27) that the snout of males is more pointed and that a distinct pad-like swelling appears only on the inner side of the first finger in the breeding season.

Bombina maxima (Boulenger) (Plates I, figs. 2–5; VIII, figs. 5–8).

Modifications for grasping.—In males, a large diffuse nuptial pad covers the inner side of the arm, extending from the distal portion of the upper arm, covering the inner face of the forearm, and two-thirds of the inner metacarpal tubercle. The inner dorsal aspects of the first, second, and third fingers are provided with horny nuptial pads. There are two patches of nuptial pads on the thorax near the base of each arm.

The arm of the male is distinctly larger than that of the female, with the hand strongly bent inward. The average ratio of the diameter of the arm to the body length is 0.144 in the males, and 0.110 in the females. The fingers are much shorter in the males, especially the first, which is bent. The fingers of the male are fringed, rather widely at the base, diminishing toward the tip. The metacarpal tubercle is larger in the males.

Vocal sacs.—None.

Skin.—The skin of the male is more rugose, with minute spines on the back and sides, also present on the limbs. The number of warts is much greater in the male.

Hind limb.—The hind limb is somewhat longer in the males, and the glands on the tarsus and the toes are much better developed. The toes are nearly fully webbed in the male; slightly more than half in the female.

Size.—Females, averaging 56 mm., are larger than males, which average 46 mm. in length.

Aelurophryne mammata (Günther) (Plates II; X, figs. 1, 2).

Modifications for grasping.—In males there are two well-defined patches of nuptial asperities on the breast. These are conspicuously spinose, and black. More strongly developed spines are found on the inner dorsal sides of the first and second fingers, which are strongly curved toward the palm.

The arm is distinctly stronger and bent inward in males. The ratio of the diameter of the lower arm to the body length is 0.183 in eighteen males; while the ratio is 0.103 in females. The first and second fingers are slightly shorter and obviously stronger in the males than in the females.

Vocal sacs.—None.

Skin.—The skin of the males is extremely loose, with numerous wrinkles or folds. In the females, the skin is much more rugose on the dorsum, with various-sized warts; and very numerous small warts are found on the sides, with the throat and median portion of the belly rather smooth. A large quantity of white spongy connective tissue is present between the skin and the muscles in the males; in the females this is not conspicuous. In the males, the margin of the jaws bears black pigmented areas. There is no color dimorphism in alcoholic specimens.

Hind limb.—The hind limb of the male is longer and stronger than that of the female, especially in the tibial region. The toes are much more webbed and strongly fringed in the males than in the females.

Linea masculina.—Absent.

Size.—The male specimens range in size from 58 to 85 mm., averaging 68.6 mm., while the females range from 53 to 74 mm., averaging 64 mm.

Megophrys boettgeri Boulenger.

Modifications for grasping.—There is a well-defined brown nuptial pad on the inner dorsal side of the middle region of the first finger, granular in appearance during the breeding season. The arm is better developed and stronger in the males than in the females.

Vocal sacs.—A median internal subgular vocal sac, with two round openings on the inside near the angles of the jaw, is present. Pope (1931) gives a detailed description of the croak.

Linea masculina.—Absent.

Size.—Sexual dimorphism in size is slight.

Megophrys kuatunensis Pope (Plate VIII, figs. 13, 14).

Modifications for grasping.—Males are provided with two well-defined nuptial pads with brown, uniformly sized, round dots. A large patch covers the inner dorsal side of the middle region of the first finger and a small round patch is found on the dorsal side near the basal region of the second finger. The arm is a little more developed in the males than in the females.

Vocal sacs.—An internal median subgular vocal sac is present, with two round openings in the inner side near the angles of the lower jaw. In some males the skin of the throat is somewhat folded.

Megophrys pelodytoides (Boulenger).

Modifications for grasping.—There is no modification of the fingers during the breeding season. The arm of the male is slightly stronger than that of the single female specimen available for study.

Vocal sacs.—An internal median subgular vocal sac is present, with two round openings nearly at the angles of the jaw. Boulenger (1908, p. 423) states that the throat of the males is brown, which I fail to find.

Hind limb.—The toes of the males are much more fringed than those of the females.

Linea masculina.—Curious to say, there is a well-developed linea masculina in the males of this species, but not in *M. boettgeri* and *M. kuatunensis*.

Size.—Material available is insufficient to prove sexual dimorphism in size.

Bufo bufo japonicus (Schlegel) (Plate VIII, figs. 11, 12).

Modifications for grasping.—Black granular nuptial pads present, consisting of two patches on the inner dorsal surfaces of the first

and second fingers, and a small narrow elongate patch on the inner dorsal margin of the third. The whole surface of the inner metacarpal tubercle, which is larger than in the females, is covered by the black nuptial pad.

The arm is decidedly stronger in males than in females, the ratio of its diameter to the body length being 0.173, against 0.112 in females. The arm of the males is strongly bent toward the thoracic region, as may frequently be seen in preserved specimens collected during the breeding season.

Vocal sacs.—There are no vocal sacs in this species, but during the breeding season the males can produce a low discontinuous sound as a warning croak. They will croak at any season, if lightly pinched back of the arms.

Skin.—The texture and looseness of the skin are decidedly different in the sexes. The skin of the males is very loose, due to a large amount of underlying spongy connective tissue. The warts of the males are large, smooth and fewer in number, so that the skin of this sex is smoother. The warts of the females are usually provided with spines. Males are usually dark green and females light gray in color.

Hind limb.—In the males, the hind limbs are considerably longer and the fringes of the toes and the web are better developed than in the females.

Linea masculina.—Entirely wanting.

Size.—There is a slight dimorphism in size in this species. Females are larger than males.

Discussion.—The peculiar secondary sexual character, the loose skin, is found only in the males of *Aelurophryne mammata*, *Bufo bufo japonicus* and *Bufo b. bankorensis*. Between the skin and the muscles is a thick layer of loose spongy connective tissue which is white in color, slippery, strong, and very elastic in nature. It may serve as one of the factors for sex-recognition during the breeding season. This character does not seem to have been recognized hitherto.

***Bufo bufo gargarizans* (Cantor).**

Modifications for grasping.—Black granular nuptial pads cover more than two-thirds of the inner dorsal sides of the first and second fingers, and about one-third of the inner dorsal margin of the third finger. A nuptial pad of the same nature is found on the inner side

of the inner metacarpal tubercle. The arm of the male is moderately enlarged and comparatively rougher than that of the female.

Vocal sacs.—None.

Skin.—It is almost impossible to recognize the sexes by the texture of the skin, warts, or coloration in *Bufo b. gargarizans*, in contrast with the directly allied *Bufo bufo japonicus*.

Hind limb.—The hind limb of the males, especially the tibia, tarsus, and foot, is distinctly longer than that of the females.

Linea masculina.—Absent, as in most species of *Bufo*.

Size.—Dimorphism in size is well marked in this species, the females being much the larger. Ten females average 115 mm. in body length, against 85 mm. in an equal number of males.

***Bufo bufo bankorensis* Barbour.**

Modifications for grasping.—The inner dorsal sides of the first and second fingers and the inner margin of the third finger are covered by black granular nuptial pads. A similar pad is found on about two-thirds of the inner ventral portion of the inner metacarpal tubercle. The ratio of the diameter of the lower arm to the body length is 0.144 in the males and 0.106 in the females.

Vocal sacs.—None.

Skin.—The character of the skin is identical with that of *Bufo bufo japonicus* in Peiping. The males are remarkably smooth, with a very loose skin under which a large amount of spongy tissue is found. The warts on the skin of the males are relatively few in number and entirely devoid of spines. In the females, the warts are rather numerous, provided with black spines, and the skin is firm. Males are usually darker in color.

Hind limb.—In the males the hind limb is slightly longer and the webs are better developed.

Linea masculina.—Absent.

Size.—Dimorphism in size is marked, the males being smaller.

***Bufo minshanicus* Stejneger.**

Modifications for grasping.—In this species, the males have brownish black nuptial pads on the inner dorsal aspects of the first and second fingers, with a small patch on the inner dorsal edge of the third finger. The inner ventral surface of the inner metacarpal tubercle is covered by a well-defined patch. The arm of the male is moderately enlarged.

Vocal sacs.—None.

Skin.—The rugosity of the skin is the same in both sexes.

Hind limb.—The males have longer legs.

Linea masculina.—Absent.

Size.—Females are distinctly larger than males, averaging 65 mm. in body length against 56 mm. for males.

***Bufo andrewsi* Schmidt.**

Modifications for grasping.—Black, granular pads are well developed on the inner dorsal sides of the first and second fingers. A third patch covers the inner margin of the third finger, with another small patch on the inner ventral portion of the inner metacarpal tubercle. The arm of the male is a little stronger than that of the female.

Vocal sacs.—None.

Skin.—The skin of the male is somewhat looser and smoother than that of the female.

Hind limb.—In the males, the hind limb appears, from the small series available, to be slightly longer than in the females.

Linea masculina.—Absent.

Size.—Females probably larger than males.

***Bufo raddei* Strauch (Plates III; VIII, figs. 9, 10).**

Modifications for grasping.—Numerous small nuptial pads in males scattered over the inner region of the arm and the whole surface of the inner metacarpal tubercle, which is much larger than that in the female. More strongly pigmented patches are found on the inner dorsal surfaces of the first, second, and third fingers in the males. The arm is larger and more strongly bent in the males. The fingers of the males are slightly fringed and the first finger is strongly curved toward the palm.

Vocal sacs.—The males of this species possess a median subgular internal vocal sac with one or two slit-like openings on the floor of the mouth cavity. Of nineteen males examined, nine have the two openings equally developed; two have the right opening less developed; one the left opening less developed; four have only a right opening and three only a left opening. There are at least two kinds of croak. One is the calling croak, which is very loud and produced with the vocal sac fully inflated, like half a creamy white ball; the notes are of uniform pitch, discontinuous. The other is the

warning croak, which is a low sharp note made when the males are touched or grasped by other males, especially when they are in copula.

Skin.—The skin is much more rugose in males and warts are much more numerous, with groups of dark or deep brown spines. The sexes are very different in coloration. The males are olive green, with a light-colored median stripe and discontinuous lateral stripes on the back, and with groups of deep henna or brown markings. An occasional male may have a color pattern somewhat like that of the female.

Hind limb.—The hind limb is distinctly longer and stronger in males than in females. The foot with the tarsus is slightly longer in the males than in the females. In the males, the inner metatarsal tubercle is stronger and the toes are slightly more fringed than in the females.

Linea masculina.—Absent.

Size.—There is no sexual dimorphism in size.

Discussion.—Pope (1931) states that males are smaller in size, and that this is a constant masculine character. This does not agree with my measurements. For the present study I measured fourteen males and nine females, which were collected when they were paired for breeding. In these there is no sexual dimorphism in size at all. Furthermore, in forty-six adult males and fourteen adult females in the United States National Museum, the average of the body length in males is 58.6 mm., ranging from 45 to 68 mm.; the female average is only 55.8 mm., ranging from 48 to 82 mm.

***Bufo melanostictus* Schneider.**

Modifications for grasping.—The males of this species are provided with well-developed black nuptial pads. The largest patch covers the dorsal side of the first finger, and there is a smaller one on the inner dorsal side of the next finger and a very small one on the inner margin of the distal region of the third finger. Another small, well-defined patch is found on the inner side of the inner metacarpal tubercle. The arms of the males are stronger than those of the females.

Vocal sacs.—A conspicuous median internal vocal sac is present. The vocal sac opening is slit-like. Of fifty-five specimens, fifteen have the two openings equally developed, twenty have only the left opening, sixteen only the right, and in four one opening is vestigial.

Hind limb.—No sign of sexual dimorphism is found in the hind limb.

Linea masculina.—Absent.

Size.—Sexual dimorphism in size is marked; females are larger than males.

Discussion.—The present observations do not wholly agree with those of other authorities. Stejneger (1907, p. 74), Boulenger (1912, p. 272), Van Kampen (1923, p. 80), and Pope (1931) state that males have black nuptial excrescences developed only on the two inner fingers. I find them frequent also on the third finger as in all the species of Chinese *Bufo*. Furthermore, another small patch is found on the inner side of the inner metacarpal tubercle. I find no difference in the webbing of the toes of the two sexes, as described by Stejneger (1907, p. 74) and Okada (1931, p. 57).

Hyla immaculata Boettger.

Modifications for grasping.—A nuptial pad is present on the inner dorsal sides of the first fingers of the males.

Vocal sacs.—Males have a very well-developed external median subgular vocal sac, with two slit-like openings in the inside at the angle of the jaw.

Hind limb.—I fail to detect any significant sexual difference in the hind limb in this species.

Linea masculina.—The male has a well-developed linea masculina.

Size.—Sexual dimorphism is marked; in six specimens of each sex, the length from snout to vent varies from 25 to 30 mm. in males, average 27 mm., and from 27 to 34 mm. in females, average 31.5.

Hyla chinensis Günther (Plate X, figs. 5, 6).

Modifications for grasping.—The males of this species are provided with a well-marked nuptial pad with a pigmented granular skin which covers the inner dorsal side of the basal segment of the first finger. There is no sexual dimorphism in the size of the fore limbs.

Vocal sacs.—An external median subgular vocal sac is present. The skin on the throat is greatly modified, with numerous folds for the expansion of the vocal sac during croaking. The two slit-like openings of the vocal sac are situated near the angles of the jaw.

Linea masculina.—Very conspicuous.

Size.—Males and females are nearly the same in length.

Hyla sanchiangensis Pope.

Modifications for grasping.—A pigmented nuptial pad with a granular appearance covers the inner dorsal side of the basal segment and the inner dorsal surface of the second segment of the first finger. The arm is much stronger in the males than in the females.

Vocal sacs.—The male has a conspicuous subgular external vocal sac with two slit-like openings near the angles of the jaw. The skin over the vocal sac is very loose and is pigmented, especially at the sides. Pope (1931) describes the voice of this species in detail.

Hind limb.—I fail to find any significant difference in the sexes.

Linea masculina.—Well developed.

Size.—Females are slightly larger than males.

Hyla annectans (Jordan).

Modifications for grasping.—A well-defined nuptial pad, with a very fine granular appearance and creamy white in color, is found on the inner dorsal side of the basal segment of the first finger in males.

Vocal sacs.—A very conspicuous external median subgular vocal sac with two slit-like openings is developed in the males.

Hind limb.—The sexes are alike in length of hind limb.

Linea masculina.—Well developed, pink in alcoholic specimens.

Size.—There is no sexual dimorphism in size in this species.

Hyla simplex Boettger.

Modifications for grasping.—The light brown nuptial pad is well developed in this species, on the base of the inner dorsal side of the first finger. The arm of the male is slightly stronger.

Vocal sacs.—A median subgular external vocal sac with two slit-like openings.

Hind limb.—I am unable to find any difference in the sexes in the hind limb.

Linea masculina.—A pink linea masculina is present in alcoholic specimens.

Size.—Sexual dimorphism in size is marked, the males being smaller.

Ooeidozyga lima (Gravenhorst) (Plate X, figs. 3, 4).

Modifications for grasping.—The males of this species are provided with an indistinct nuptial pad on the dorsal side of the basal

segment of the first finger, which is thickened in comparison with that of the female.

Vocal sacs.—There is a median subgular external vocal sac with two short slit-like openings in the inside near the angles of the jaws. Boulenger (1912, p. 225) and Van Kampen (1923, p. 233) state that the vocal sac is internal, but the longitudinal folds of the external skin are clearly developed.

Linea masculina.—A conspicuous pink linea masculina is present in alcoholic males.

Hind limb.—The hind limb is slightly longer in males.

Size.—Males are distinctly smaller than females.

***Ooeidozyga laevis martensi* (Peters).**

Modifications for grasping.—A well-developed, light-colored, nuptial pad is present on the dorsal side of the basal segment of the first finger, which is greatly thickened. The inner dorsal side of the first finger of the female is more darkly pigmented.

Vocal sacs.—The internal median subgular vocal sac has two short slit-like openings on the inner sides near the angles of the jaw.

Hind limb.—There is no significant difference in length of leg in the sexes.

Linea masculina.—A very conspicuous pink linea masculina is present in alcoholic males.

Size.—Males are somewhat smaller than females.

***Rana nigromaculata nigromaculata* Hallowell (Plates IV; XI, figs. 11, 12).**

Modifications for grasping.—A very conspicuous, gray nuptial pad is found on the inner dorsal and inner ventral sides of the first finger of the male. This patch is especially developed on the first segment, which is greatly enlarged in comparison with that of the female. In the males the arm is much stronger than in the females.

Vocal sacs.—The males of this species are equipped with external lateral vocal sacs which are protected by a flap of skin when withdrawn. They are round when fully inflated. There are two distinct kinds of croak, one the warning croak when a male is touched or grasped by another individual of the same sex, and the other the very high-pitched continuous call.

Skin.—The rugosity of the skin varies greatly in this species, and there is no constant difference between the sexes. The males are

variable in coloration. One of the common types is a delicate yellowish green with rather small patches of deeper green scattered irregularly; another common type has an apple green ground-color with black or golden roundish patches irregularly scattered over the entire back. Most of the females have a deep greenish black back with three distinct parallel white stripes.

Hind limb.—The web is usually better developed in the males. The foot of the male is much longer than that of the female.

Linea masculina.—The linea masculina is well developed in the males of this species. It is white in living or freshly preserved specimens and pink in old alcoholic material.

Size.—Sexual dimorphism in size is well marked. Males are smaller than females.

Discussion.—The characters of dorsolateral fold, breadth of head, and shape of snout, regarded as correlated with sex by Okada, (1931, p. 83), do not hold in the living and preserved material studied by myself.

***Rana nigromaculata mongolia* Schmidt.**

Modifications for grasping.—Males with a well-developed gray nuptial pad covering the inner dorsal and inner ventral sides of the first and second segments and the inner margin of the third segment of the first finger. The arm of the male is moderately enlarged.

Vocal sacs.—There are external lateral vocal sacs like those of *Rana n. nigromaculata*. The vocal sac openings are usually round near the inner side of the angle of the mouth. In a few cases they are short and slit-like.

Skin.—In the males, the skin is usually much more rugose than in the females. Sexual dimorphism in coloration is less obvious than in *Rana n. nigromaculata*.

Hind limb.—The web is better developed in some males, but this is not a constant difference.

Linea masculina.—A wide pink linea masculina is present in alcoholic specimens.

Size.—Sexual dimorphism in size is slight.

***Rana nigromaculata reinhardtii* (Peters).**

Modifications for grasping.—Males with gray nuptial pads covering the inner margin of the third segment of the first finger. The arm is a little stronger in the males than in the females.

Vocal sacs.—Vocal sacs are lateral external, like those of *R. n. nigromaculata*.

Linea masculina.—A very conspicuous pink linea masculina is found in alcoholic male specimens.

Size.—Females are distinctly larger than males.

***Rana amurensis* Boulenger.**

Modifications for grasping.—The inner dorsal and inner ventral sides of the first finger of male specimens are covered by a well-developed gray nuptial pad, subdivided into four patches. The first covers the inner ventral basal region of the finger; the second is the largest, spreading over the inner dorsal and inner ventral sides of the distal part of the finger. The other two small patches are found on the dorsal side, and inner and inner ventral side of the last two segments of the finger. There is only one male specimen at hand, but the sexual dimorphism in the diameter of the arm is well marked.

Vocal sacs.—The male of this species has well-developed paired internal subgular vocal sacs just in front of the angles of the mouth. The vocal sac openings are round, near the angles of the jaws.

Skin.—Very numerous fine whitish asperities are developed on the sides, below the dorsolateral folds, in females. The throat of the same sex is more distinctly marbled with brown than that of the males.

Hind limb.—The hind limb is longer in males. I am unable to detect any differences in the web between the sexes.

Linea masculina.—The linea masculina is pink in color in preserved specimens.

Discussion.—A remarkable specific character of the females of this species is the capacity of the oviducts to absorb water. All the females in my collection and in the collection of the Biology Department of Yenching University, Peiping, have their abdomens fully expanded, and in some of them the abdominal wall is ruptured near the pelvic region, where the white jelly-like substance of the enlarged oviduct can be seen. This phenomenon has not been seen in the closely related Chinese wood-frogs of any other species. These peculiar oviducts are used for food in North China, where they are regarded as especially valuable for old people and invalids.

***Rana chensinensis* David (Plate IX, figs. 7–10).**

Modifications for grasping.—The first finger of the male bears a well-developed nuptial pad which is subdivided into four patches by transverse furrows, as in other wood-frogs.

Vocal sacs.—Moderate paired internal subgular vocal sacs are developed in the males, with two round openings near the angles of the mouth.

Hind limb.—The web is much better developed in the male than in the female.

Linea masculina.—A narrow pink linea masculina is found in alcoholic males.

Size.—There is distinct sexual dimorphism in size, though the difference is not great.

Rana japonica Günther.

Modifications for grasping.—The nuptial pads, which are like those of other wood-frogs, are strongly developed during the breeding season. The fore limb of the male is greatly enlarged and is bent strongly toward the breast in males preserved during the breeding season.

Vocal sacs.—The tympanum is slightly larger in males than in females. The tympanum averages 3.8 mm. with a ratio to the body length of 0.077 in eleven males and averages 3.6 mm. with a ratio of 0.075 in seven females.

Hind limb.—The length of the hind limb is slightly greater in males than in females. Webs are much better developed in male specimens. In the male the web reaches the middle of the fourth segment of the fourth toe, while in the female it reaches only to the base of the third segment of the fourth toe, and the web is somewhat more excised in females.

Linea masculina.—A pink linea masculina is found in males in alcoholic material.

Rana spinosa David (Plates VI, figs. 1, 2; X, figs. 9, 10).

Modifications for grasping.—The males have the breast studded with highly developed conical black nuptial spines. Strong spines with a round tubercular base are scattered over the breast proper and smaller ones are found on the posterior portion of the throat and the anterior region of the belly. A varying number of small spines may be present on the margins of the jaws and posterior part of the belly. Back of each arm there are usually a few large spines. More slender and elongate sharp spines form nuptial asperities at the inner dorsal side and the tip of the inner metacarpal tubercle, which is enormously developed; on the inner dorsal side of the first

finger, especially at the region of the joint of the first and second segments; on the inner dorsal side of the second finger; and, a few, on the inner margin of the third finger. The arms of the males are greatly thickened, especially the lower arm. The ratio of the diameter of the lower arm to the body length is 0.179 in the eighteen largest males, and 0.132 in nineteen females.

Vocal sacs.—An internal median subgular vocal sac is developed in the males. The opening of the vocal sac is usually round; in one case (A.M.N.H. 5410), the opening is slit-like.

Skin.—The skin of the male is somewhat looser than that of the female. Usually the throat of the female is more marbled than that of the male.

Size.—Sexual dimorphism is uniform in this character but the difference between the sexes is slight. The average length of males is 100.4 and of females 95.4 mm.

Rana phrynoides Boulenger (Plates VI, figs. 3, 4; IX, figs. 3, 4; X, figs. 7, 8).

Modifications for grasping.—Strong nuptial asperities are developed on the prepollex, and on the inner dorsal sides of the first, second, and third fingers. There are two patches of spines on the breast. In some of the males, very weak spines are found on the sides of the body, the throat, and the palm. The arm of the male is tremendously developed in comparison with that of the female.

Vocal sacs.—A median subgular internal vocal sac with two round openings.

Hind limb.—The hind limb is distinctly longer in males than in females, and the web of the male is slightly better developed.

Linea masculina.—There is no linea masculina in the males of this species, though it is very conspicuous in the males of the closely related forms, *Rana spinosa* and *Rana tibetana*.

Discussion.—Boulenger describes males as having spines on the two inner fingers and Pope (1931) uses this character to distinguish *spinosa* from *phrynoides*, as the former has spines on three fingers. I find that the younger males have spines only on the two inner fingers, but an adult male specimen (No. 2472) in the Museum of Comparative Zoology has spines on the three inner fingers.

It is interesting to find occasional development of male characters in female specimens. A female specimen (No. 2473) in the Museum of Comparative Zoology has spines developed on the pre-

pollex, and on the first and second fingers. Nearly mature ova fill the abdominal cavity.

Rana tibetana Boulenger.

Modifications for grasping.—Nuptial spines are highly developed in the males of this species. Strong spines, each on a round tubercle, are scattered over the middle of the belly and sides of the body; weaker spines with smaller bases are found on the throat, on the dorsolateral parts of the body, and on the posterior parts of the arms and ventral aspects of the legs. The margins of the upper and lower jaws, the sides of the head and the sole of the foot are covered with still finer spines and tubercles. Closely set nuptial asperities are found on the internal apical portion of the inner metacarpal tubercle and on the inner dorsal sides of the first, second, and third fingers.

The arm of the male is distinctly stronger than that of the female, with the basal segment of the first finger greatly enlarged and the tip of this finger bent toward the palm. The eleven largest males and twelve largest females were measured from a series of 140 specimens from Szechwan. The average diameter of the lower arm in eleven males is 24 mm. and in twelve females it is 14 mm.; the ratio of this to the body length is 0.24 in the eleven males and 0.14 in the twelve females. The inner metacarpal tubercle of the males is much larger than that of the females.

Vocal sacs.—Paired lateral internal vocal sacs with two round openings located posteriorly.

Skin.—In addition to the spines mentioned above, the skin of the dorsal sides of the thigh and the hip is much more rugose in males than in females. There is no sexual dimorphism in coloration in alcoholic material.

Hind limb.—The hind limbs of males are much longer than those of females. The dilations of the tips of the toes are distinctly larger in males.

Linea masculina.—The males are provided with a wide pink linea masculina.

Size.—The eleven largest males and twelve largest females, from series of 140 specimens from Szechwan average respectively 107.5 mm. and 99.5 mm.

Discussion.—Two specimens with enlarged arms and nuptial spines (Field Museum Nos. 19031 and 19041a) prove to be females,

with ova and oviducts fully developed. Both these specimens lack the *linea masculina*, which appears to indicate that this is a strongly fixed male character. Davis and Law (1935) have recently presented experimental evidence on this point. They found that the *linea* persisted in castrated males of *Rana pipiens*, and failed to appear in females from which the ovaries had been removed.

***Rana plancyi* Lataste** (Plate IX, figs. 1, 2).

Modifications for grasping.—A gray granular nuptial pad is developed on each of the first fingers of the male. A large patch covers the inner dorsal and inner ventral sides of the basal segment of the thumb, and a much smaller patch is found on the inner margin of the second segment of the same finger. The arm of the male is slightly stronger than that of the female.

Vocal sacs.—There are two small internal subgular vocal sacs just on the inner margin of the lower jaws. Externally a very small area of modified skin, which is much thinner in structure and looser in texture, is visible below the angles of the jaw. During the breeding season, a sharp short whistling sound is produced by the males. This kind of vocal sac represents a transitional stage from the internal type to the external and from the subgular to the lateral, as it is subgular internally and lateral externally.

Tympanum.—The tympanum is distinctly larger in the male than in the female, and much closer to the posterior corner of the eye. In the males, the ratio of the diameter of the tympanum to the body length is 0.114, and only 0.086 in the females.

Hind limb.—Measurements show that the hind limb of males is slightly shorter than that of females.

Linea masculina.—Very conspicuous pink bands are found in the alcoholic males.

Size.—Sexual dimorphism in size is well marked in this species, males averaging 46.2 mm., females 60 mm.

Discussion.—Okada (1931, p. 89; pl. 8, fig. 1) describes specimens of *R. plancyi* as a new subspecies of *Rana nigromaculata* under the subspecific name of *chosenica*. From his tables of measurements, his conclusion appears to be due to misidentification of sex in the specimens referred by him to *Rana plancyi*.

***Rana fukienensis* Pope.**

Modifications for grasping.—The males of this species have a well-defined and granular nuptial pad. A large portion of the pad covers

the inner dorsal and inner ventral sides of the basal segment of the thumb, with a smaller portion on the inner margin of the second segment of the same finger. The arm of the male is stronger than that of the female, the ratio of its diameter to the body length being 0.107 in males and 0.093 in females.

Vocal sacs.—The vocal sacs of this species are like those of *Rana plancyi*. The internal sacs are more subgular than lateral and externally there is an indication of modified skin below the angles of the jaw which is more lateral than subgular. The vocal sac openings are round.

Tympanum.—The tympanum is larger in the males, the ratio of its diameter to the body length being 0.100 in males and 0.084 in females.

Hind limb.—The hind limb of the male is somewhat shorter than that of the female.

Linea masculina.—Alcoholic male specimens have a very conspicuous pink linea masculina.

Size.—Males are smaller than females; average body length of four males 42 mm., of eight females 67 mm.

***Rana pleuraden* Boulenger (Plate XI, figs. 15, 16).**

Modifications for grasping.—The inner dorsal side of the basal segment of the first finger of the male is covered by a well-defined creamy white granular nuptial pad.

Vocal sacs.—The males of this species are provided with paired external subgular vocal sacs. The skin on the sides of the throat is thinner than that of the females with inconspicuous longitudinal folds. The vocal sac openings vary greatly. Some have two round openings on the inside of the angles of the jaw, some have two slit-like openings, and some have a round opening on one side and a slit-like opening on the other.

Skin.—There is a very large flat gland on each side of the body in the male, above and behind the shoulder.

Hind limb.—There is a slight difference in the length of the hind limb, the ratio of its length to the body length being 1.59 in the males and 1.64 in the females, the females thus apparently having longer legs than the males, the reverse of the usual relation.

Linea masculina.—A conspicuous pink band is present.

Size.—Sexual dimorphism in size is slight.

Discussion.—The present description of the vocal sacs agrees with Boulenger (1920, p. 91), and differs from Pope (1931, p. 539), who failed to detect the external indications of the vocal sacs.

***Rana adenopleura* Boulenger.**

Modifications for grasping.—A well-defined creamy white granular nuptial pad on the dorsal and distal parts of the first segment of the first finger. The arm of the male is moderately enlarged.

Vocal sacs.—Paired subgular external vocal sacs are found on the sides of the throat, where the skin is slightly modified to form loose longitudinal folds. Two round vocal sac openings are situated on the lateral sides of the floor of the mouth near the angles of the jaw.

Tympanum.—The tympanum is a little larger in males.

Skin.—On the upper posterior side of each arm is a large flattened gland, the lateral gland, of a creamy color. There is no other sexual differentiation in the skin.

Hind limb.—The length of the hind limb is apparently the same in the sexes. A peculiarly interesting character in this species is the better development of the web in females. In the females the webs reach nearly to the distal end of the second segment on the lateral sides of the fourth toe, while in the males only about one-fourth of the second segment of the same toe is webbed.

Linea masculina.—The linea masculina is well defined.

Size.—Females are slightly larger than males.

***Rana andersonii* Boulenger.**

Modifications for grasping.—Light gray granular nuptial pads well developed, covering the inner dorsal side of the basal segment and the inner margin of the second and third segments of the first finger. The arm is a little better developed in males.

Vocal sacs.—Two well-developed external subgular vocal sacs, located at the ventral side of the angle of the jaw. Folds formed by the modified skin run obliquely toward the angle of the jaw.

Tympanum.—The tympanum of the male is much larger than that of the female. The ratio of its diameter to the body length in males is 0.079, and in females 0.044.

Linea masculina.—A well-developed pink linea masculina is found in alcoholic specimens.

Size.—Sexual dimorphism in size is extreme. The sixteen largest males range from 44.49 mm. with an average 46.4 mm.; and the

sixteen largest females range from 87.97 mm. with an average 90.3 mm.

Rana grahami Boulenger (Plate VIII, figs. 15, 16).

Modifications for grasping.—A large gray granular pad on the inner dorsal side of the basal segment of the first finger and a very much less developed pad on the second and third segments of the same finger. The arm of the male is somewhat stronger than that of the female.

Vocal sacs.—Males have paired subgular internal vocal sacs with two round openings.

Hind limb.—The legs are slightly longer in males than in females and the web is better developed in males.

Linea masculina.—In preserved males there is a conspicuous pink linea masculina.

Size.—Sexual dimorphism in size is well marked.

Rana chunganensis Pope.

Modifications for grasping.—A nuptial pad with a granular surface, creamy white in color, is well developed. It covers the inner dorsal side of the basal segment and the inner margin of the second and third segments of the first finger. The arm is moderately enlarged in males.

Vocal sacs.—The males of this species are provided with paired external subgular vocal sacs with two round openings near the angles of the jaw.

Linea masculina.—The linea masculina appears to be entirely absent in this species.

Rana graminea Boulenger (Plate X, figs. 11, 12).

Modifications for grasping.—A well-developed light-colored nuptial pad covers the inner margin of the inner metacarpal tubercle, the inner dorsal side of the basal segment and the inner edge of the rest of the segments of the first finger. The basal portion of the thumb is greatly enlarged but the inner metacarpal tubercle is not as conspicuous as in females. The arms are much more strongly developed in males.

Vocal sacs.—Very conspicuous paired external subgular vocal sacs are present. They are not purely subgular in position, as in *Rana rugulosa*, but represent an intermediate type between the lateral and subgular positions.

Tympanum.—The tympanum of males is much larger than that of females. The ratio of its diameter to the body length is 0.100 in males and 0.085 in females. The tympanic membrane in the males is much more transparent.

Skin.—In the females, the skin on the dorsal side is much more rugose than in the males. Smith and Pope state that the coloration of the males is more uniformly green than that of the females.

Linea masculina.—Absent.

Size.—Sexual dimorphism in size is remarkable. The sixteen largest males range from 44.52 mm. with an average of 47.6 mm., while in the eleven largest females the range is from 84 to 108 mm. with an average of 101.9 mm.

***Rana guentheri* Boulenger** (Plate XI, figs. 9, 10).

Modifications for grasping.—The nuptial pads on the inner dorsal sides of the thumbs are only slightly developed in this species.

Vocal sacs.—Paired subgular external vocal sacs with round openings situated near the commissures of the jaw.

Tympanum.—The diameter of the tympanum is greater in the male than in the female. The average measurement in ten large males is 5.6 mm. (ratio to body length 0.086), and 4.8 mm. in ten large females (ratio to body length 0.072).

Skin.—There is a prominent kidney-shaped gland at the anterior base of each arm, below the postriental glandular fold, in males. The postriental fold itself is much more conspicuous in males than in females.

Linea masculina.—A conspicuous linea masculina is present in alcoholic material.

Size.—Females are slightly larger than males.

***Rana kuhlii* Duméril and Bibron** (Plates V, figs. 1-4; XI, figs. 1, 2).

Modifications for grasping.—A large nuptial pad covers the dorsal, inner, and inner ventral sides of the first finger, and a smaller pad is found on the inner dorsal side of the second finger. Another elongated and well-defined pad is found on the inner posterior region of the distal end of the lower arm, near the base of the first finger. The arms of the males during the breeding season are slightly stronger than those of the females.

Vocal sacs.—Not yet found in this species; field studies are required, as the skin of the throat is loose and folded.

Skin.—The skin of the back and sides is much more rugose in males than in females.

Linea masculina.—A conspicuous pink linea masculina is present in alcoholic specimens.

Special secondary sex characters.—The males of this species have a very large depressed head. The ratio of the length of the head to the body length (without head) is 0.82 in the males and 0.56 in the females. The head of the male is longer than wide, while in the female the measurements are about equal. Two bony prominences in the front of the lower jaw are much better developed in males than in females.

Discussion.—Boulenger (1920) states that the males have no vocal sacs, and the fore limbs are without nuptial excrescences. Pope (1931) gives a detailed description of the secondary sex characters of this species, but he did not observe the nuptial pad on the distal end of the arm and on the second finger.

***Rana latouchii* Boulenger.**

Modifications for grasping.—A well-developed nuptial pad is found on the inner dorsal side of the basal segment of the first finger of the males. The arm is much stronger in males.

Vocal sacs.—Paired internal subgular vocal sacs with two round openings are present.

Hind limb.—The hind limb of the male is slightly longer than that of the female, and the web is much more fully developed.

Linea masculina.—A pink linea masculina is present.

Size.—Sexual dimorphism in size is marked. The range in size of the sixteen largest males is from 35 to 40 mm., averaging 37.3 mm., and from 40 to 50 mm., averaging 46.4 mm., in the sixteen largest females.

***Rana limnocharis* Wiegman (Plate XI, figs. 3, 4).**

Modifications for grasping.—There are two feebly separated nuptial pads. One covers the inner portion of the inner metacarpal tubercle and the inner basal part of the thumb; the other patch is found on the dorsal side of the first finger.

Vocal sac.—The males of this species are provided with a median subgular external vocal sac, usually with two slit-like openings

situated near the corners of the mouth. The skin of the throat of the males forms loose folds. Males produce a discontinuous sharp high croaking during the breeding season or during rains in summer.

Linea masculina.—A fine pink linea masculina is present.

Size.—The average length of the body in the twenty largest females is from 46 to 48 mm. and 39.2 mm. in the twenty largest males of the same series, of more than four hundred specimens from Szechwan in Field Museum. This corresponds closely to the average of 43.6 mm. in the thirty-one females and 37.9 mm. in the twenty-four males in the United States National Museum.

Discussion.—Stejneger (1907, p. 129) and Boulenger (1920, p. 29) state that males of this species have paired external vocal sacs. The anatomy of many males and observations of croaking in life, show that there is only one median subgular external vocal sac with two latero-posterior lobes. Males of this species are provided with distinctly slit-like openings to the vocal sac, like those of *Bufo*, which are most unusual in *Rana*.

***Rana macrodactyla* (Günther) (Plate XI, figs. 5, 6).**

Modifications for grasping.—In the male a definite white granular nuptial pad is found on the inner dorsal side of the basal segment of the first finger.

Skin.—There is a prominent elevation on the tip of the snout in males.

Hind limb.—The hind limb is slightly longer in the females.

Linea masculina.—Present.

Size.—The average length of males examined is 28.5 mm. It is 39.6 mm. in females.

Discussion.—Boulenger (1920, p. 156) states that the male is devoid of secondary sex characters. I find that the male of this species can easily be distinguished by the prominence on the snout, larger tympanum and the nuptial pad on the inner dorsal side of the first finger.

***Rana montivaga* Smith (Plate IX, figs. 11, 12).**

Modifications for grasping.—A well-developed gray granular nuptial pad covers the inner dorsal side of the thickened first finger. The forearm is much stronger in males.

Vocal sacs.—Mature males have small paired subgular internal vocal sacs with round openings situated near the angles of the jaws.

These vocal sacs and vocal sac openings are found only in two males, one 51 mm. in length and the other 44 mm. They are absent in a male 42 mm. in length and in another male with a body length of 41 mm. It is interesting that the vocal sacs and vocal sac openings apparently do not develop until the animal is sexually mature.

Linea masculina.—The linea masculina is wanting in the males of this species available for examination.

Rana rugulosa Wiegman.

Modifications for grasping.—Males of this species are provided with a moderately developed nuptial pad which covers the inner dorsal side of the first two segments and the inner edge of the third segment of the first finger. There is no difference in the development of the fore limbs in the sexes.

Vocal sacs.—Well-developed external subgular vocal sacs, forming longitudinal folds on each side of the throat with round openings near the angles of the jaws.

Linea masculina.—Very conspicuous in alcoholic specimens.

Size.—Females are larger than males, averaging 109 mm. in body length as compared with 91 mm. in males.

Rana spinulosa Smith (Plate XI, figs. 7, 8).

Modifications for grasping.—A conspicuous nuptial pad on the inner dorsal side of the basal segment of the first finger. The arm of the male is somewhat stronger than that of the female.

Vocal sacs.—Paired subgular vocal sacs, just distinguishable externally. The round openings are near the angles of the jaws.

Skin.—I am unable to find any difference in the skin in the sexes except the shoulder glands of the males, situated at the anterior side of the basal part of the arm.

Linea masculina.—The linea masculina is present but inconspicuous and white in color in preserved males.

Size.—Males appear to be distinctly smaller than females.

Rana taipehensis Van Denburgh (Plate XI, figs. 13, 14).

Modifications for grasping.—Wanting in this species.

Tympanum.—The tympanum of the male is much larger than that of the female.

Vocal sacs.—Absent.

Hind limb.—The hind limbs are longer in female than in male specimens. The ratio to the body length is 1.66 in the single male available and 1.82 in the ten females.

Linea masculina.—A white linea masculina is present in the preserved male.

Staurois ricketti (Boulenger) (Plate IX, figs. 5, 6).

Modifications for grasping.—A large patch of nuptial asperities with unpigmented coarse granules covers the inner dorsal side of the basal segment of the first finger. The arm is slightly stronger in the male.

Skin.—The skin is rather rugose on the sides of the body in males.

Hind limb.—The leg of the male is slightly longer than that of the female. This difference is chiefly due to the greater length of the tibia and of the foot with tarsus in the males. In this species the diameter of the thigh is greater in the males (0.256 mm.) than in the females (0.222 mm.).

Linea masculina.—Wanting in this species.

Size.—Males are slightly smaller than females.

Polypedates dennysi (Blanford) (Plate VII).

Modifications for grasping.—Two patches of light-colored nuptial pads, one on the inner dorsal side of the basal segment of the first finger with a narrow projection along the inner margin to the base of the disk; and another smaller well-defined patch on the distal region of the inner dorsal portion of the first segment of the second finger. The lower arm of the male is slightly stronger than that of the female. In the female, the inner metacarpal tubercle is better developed and with a sharper inner edge; in the male, the inner edge is covered by the nuptial pad.

Vocal sacs.—An internal median vocal sac with two slit-like openings.

Skin.—The skin is more rugose, especially on the limbs, in the males. The disks on the fingers of the females are slightly larger than those of the males.

Linea masculina.—The linea masculina is pink and conspicuous.

Size.—Sexual dimorphism in size is well marked. The eighteen males range from 77.5 to 93 mm. with an average of 86.6 mm.; and the fifteen largest females range from 99 to 112 mm. with an average of 106.4. The body of the male is much more slender than that of the female.

Discussion.—The males of this species, like other *Polypedates*, have a more pointed fleshy snout than the females. This character does not seem to have been mentioned in previous literature.

Polypedates leucomystax (Gravenhorst).

Modifications for grasping.—A creamy white nuptial pad covers the inner dorsal side of the first finger, with a much smaller pad on the dorsal side of the basal segment of the second finger. The disks on the fingers are larger in the females than in the males. The diameter of the lower arm is nearly the same in both sexes.

Vocal sacs.—An internal median subgular vocal sac with two short slit-like openings.

Linea masculina.—A narrow pink linea masculina is found in the males.

Size.—Dimorphism in size is well marked, sixteen large males averaging 50.1 mm. in body length, while sixteen large females have an average of 70.1 mm.

Polypedates megacephalus Hallowell.

Modifications for grasping.—Two patches of granular, creamy white nuptial pads, the larger on the inner dorsal side of the first finger, with another much smaller one on the inner basal segment of the second finger. The disks on the fingers are considerably smaller in the males than in the females.

Vocal sacs.—Paired internal lateral vocal sacs, instead of the single internal median vocal sac of *P. leucomystax*, indicate that this is a distinct species.

Linea masculina.—Very conspicuous.

Size.—Sexual dimorphism in size is marked, the sixteen largest males ranging in length from 45 to 52 mm. with an average of 48 mm., and the sixteen largest females from 60 to 69 mm. averaging 64.3 mm.

Polypedates omeimontis Stejneger (Plate IX, figs. 13, 14).

Modifications for grasping.—Two patches of creamy white nuptial pads, the larger on the inner dorsal side of the first finger and the smaller on the distal portion of the first segment of the second finger. The disks of the fingers are slightly better developed in the females than in the males. The average diameter of the disk of the third finger is 5.7 mm., with a ratio to the body length of 0.08 in the females, while in the males the average is 4 mm., with a ratio of 0.57.

Vocal sacs.—Vocal sacs internal, with two long slit-like openings, as in toads.

Snout.—The snout of the males is much more pointed, with a thick fleshy tip which is not found in the females. This character is best developed in *Polypedates dennysi*.

Linea masculina.—A narrow white linea masculina is present.

Size.—The females are distinctly larger than the males, the average of the body length being 69.6 mm. in the females and 55.7 in the males.

Polypedates oxycephalus (Boulenger) (Plate XII, figs. 3, 4).

Modifications for grasping.—A conspicuous light-colored nuptial pad covers the whole inner dorsal surface of the first finger, which is greatly enlarged during breeding season. Another much smaller patch covers the inner edge of the middle portion of the basal segment of the second finger. The disks on the fingers are smaller in the males, especially the disk of the first finger. Males have slightly stronger arms than females.

Vocal sacs.—An internal median vocal sac is present.

Snout.—The snout of the male is much more pointed than that of the female.

Hind limb.—The legs are slightly longer in females than in males. Females have larger disks on the toes.

Linea masculina.—I fail to find any linea masculina in this species.

Size.—Females are much larger than males.

Philautus doriae Boulenger.

Modifications for grasping.—This species appears to have no nuptial pads or other modifications for grasping.

Vocal sacs.—The male has an internal median subgular vocal sac with short slit-like openings.

Hind limb.—The hind limbs of the males are slightly longer than those of the females.

Linea masculina.—Conspicuous and pink in color in alcoholic specimens.

Size.—The average size of males is 21.1 mm., with a range of 19 to 23 mm., and 26.6 mm. in the females, with a range of 23 to 30 mm.

Philautus vittatus Boulenger.

Modifications for grasping.—A well-defined nuptial pad covers the inner dorsal side of the basal segment of the first finger in the male.

Vocal sacs.—Males have an internal median subgular vocal sac with short slit-like openings near the angles of the jaws.

Linea masculina.—A light pink linea masculina is present in alcoholic specimens.

Size.—Sexual dimorphism in size is slight. Males are smaller than females.

***Kalophrynus pleurostigma* (Mueller).**

Modifications for grasping.—There are no modifications for grasping except that the arm of the male is slightly stronger than that of the female. The ratio of the diameter of the lower arm to the body length is 0.088 in males and 0.074 in females.

Vocal sacs.—An internal median subgular vocal sac with two slit-like openings is present in male specimens. Very slight indications of looser and darker skin on the throat indicate the vocal sac externally.

Linea masculina.—Conspicuous in alcoholic male specimens.

Size.—Male specimens average 36 mm. in body length, and females average 43 mm.

***Kaloula borealis* (Barbour) (Plate XII, figs. 5, 6).**

Modifications for grasping.—There is little modification in the males for grasping during the breeding season, except that the males have arms a little stronger than the females. The ratio of the diameter of the lower arm to the body length is 0.10 in the sixteen largest males and 0.08 in the sixteen largest females.

Vocal sacs.—Males of this species are provided with an external median subgular vocal sac, strongly pigmented externally, with long slit-like openings near the angle of the jaw.

Skin.—A peculiar secondary sex character may be seen in the males of the Chinese species of *Kaloula* in the modification of a part of the ventral skin. In *Kaloula borealis*, the male has a modified U-shaped patch of thickened, granular, and darker skin on the thoracic region between the arms.

Hind limb.—In the males, the web is much more fully developed and the toes are better fringed than in the females. There is no sexual dimorphism in the length of the hind limb.

Linea masculina.—The linea masculina was first discovered in this species, since the skin on the belly is so thin and transparent that the two wide white (rarely pink) bands may be seen in living specimens.

Kaloula rugifera Stejneger (Plates IX, figs. 17, 18; XII, figs. 9, 10).

Modifications for grasping.—The basal portion of the thumb is slightly enlarged and lighter in color, with no other grasping modifications.

Vocal sacs.—A median subgular internal vocal sac, with two slit-like openings on the floor of the mouth, is present.

Skin.—In males, a thickened area of glandular skin covers the whole belly, which is much lighter in color than that of females.

Hind limb.—In the males the toes are fully webbed, while they are only about one-third webbed in the females.

Linea masculina.—A wide pink band in the males.

Kaloula verrucosa (Boulenger) (Plates IX, figs. 15, 16; XII, figs. 7, 8).

Modifications for grasping.—Males are almost without modifications for grasping, except that the lower arm is a little better developed. Parker (1934, p. 80, figs. 35, 36) has described the peculiar pits of the tips of the fingers associated with bony points and knobs on the terminal phalanges.

Vocal sacs.—An external median subgular vocal sac, with long slit-like openings in the inner side of the lower jaw, is present. Skin of the throat over the vocal sac is strongly pigmented, with a very fine white median line.

Skin.—A large modified area of skin is present on the belly of the males.

Hind limb.—The males have the toes much more fully webbed.

Linea masculina.—A very conspicuous linea masculina is present.

Size.—Sexual dimorphism in size is slight, the average body length being 41.6 mm. in the males, and 44.7 mm. in the females.

Microhyla butleri Boulenger.

Modifications for grasping.—I fail to find any modification in the males for the purpose of grasping during the breeding season.

Vocal sacs.—Males can readily be distinguished by the dark-colored external median vocal sac, with a skin fold formed by the posterior extension of the vocal sac crossing the breast just anterior to the insertions of the arms.

Linea masculina.—A conspicuous pink linea masculina is present.

Microhyla heymonsi Vogt (Plate XII, figs. 1, 2).

Modifications for grasping.—None.

Vocal sacs.—An external median subgular vocal sac is well developed, with a skin fold formed by the posterior extension of the vocal sac crossing the breast just anterior to the insertion of the arm. The skin of the sac is much more pigmented and a little more rugose than that of the females.

Linea masculina.—A pink linea masculina is always present in the males.

Microhyla ornata (Duméril and Bibron).

Modifications for grasping.—None.

Vocal sacs.—A median subgular external vocal sac with slit-like openings near the angles of the jaws.

Linea masculina.—A bright pink linea masculina is found in alcoholic specimens.

Microhyla pulchra (Hallowell).

Modifications for grasping.—There is no sign of any modification for grasping during the breeding season in the males of this species.

Vocal sacs.—An external median subgular vocal sac has a skin fold at its posterior border crossing the breast just anterior to the fore limbs. The skin covering the vocal sac is darker, thicker, and more rugose in males.

Linea masculina.—The sex can always be distinguished by the pink linea masculina in the males.

Hind limb.—The hind limb is slightly longer in males. Its ratio to the body length is 1.92 in sixteen males and 1.80 in sixteen females.

Size.—Sexual dimorphism in size is well marked, the average of sixteen males being 23.5 mm., while in sixteen females it is 28.1 mm.

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EXPLANATION OF PLATES

PLATE I

- Fig. 1. *Bombina orientalis*, three males, to show strong bending of arms.
Fig. 2. *Bombina maxima*, to show enlarged arm and well-developed web in male.
Fig. 3. *Bombina maxima*, female, to show slender arm and less developed web.
Fig. 4. Ventral view of male *Bombina maxima*, to show nuptial pads on fingers and breast, strong arm, and more developed web.
Fig. 5. Ventral view of female of *Bombina maxima*.

PLATE II

Aelurophryne mammata

- Fig. 1. Male, dorsal view, to show looseness of skin, enlarged arm, and shape of body.
Fig. 2. Female, to show differences from male.
Fig. 3. Male, ventral view, to show nuptial spines in two groups on breast, nuptial spines on fingers, and nuptial asperities on anterior ventral margin of jaw.
Fig. 4. Female, ventral view, to show differences from male.

PLATE III

Bufo raddei

- Fig. 1. Typical male coloration.
Fig. 2. Ventral view of same animal, to show nuptial pads.
Fig. 3. Rare type of male color pattern.
Fig. 4. Typical female, to show color pattern.
Fig. 5. Another type of female coloration.

PLATE IV

Rana nigromaculata nigromaculata

- Fig. 1. Type of male color pattern.
Fig. 2. A second type of male color pattern.
Fig. 3. Variant male coloration.
Fig. 4. Variant male coloration.
Fig. 5. Rare type of male coloration approaching coloration of females.
Fig. 6. Typical female.

PLATE V

Rana kuhlii

- Fig. 1. Dorsal view of male, to show long and broad head.
Fig. 2. Female, to show shorter and narrow head.
Fig. 3. Ventral view of male.
Fig. 4. Ventral view of female.

PLATE VI

- Fig. 1. *Rana spinosa*, ventral view of male, to show nuptial spines, nuptial asperities, and enlargement of arm.
Fig. 2. *Rana spinosa*, ventral view of female.
Fig. 3. *Rana phrynoides*, ventral view of male, to show same characters as those of male *Rana spinosa*.
Fig. 4. *Rana phrynoides*, ventral view of female with a few nuptial asperities on first finger and on prepollex (abnormal).

PLATE VII

Polypedates dennysi

- Fig. 1. Male, to show the slender body and pointed snout.
 Fig. 2. Female, to show stouter body and blunt snout.
 Fig. 3. Ventral view of male.
 Fig. 4. Ventral view of female.

PLATE VIII

- Fig. 1. *Bombina orientalis*, hand and arm of male, to show nuptial pad and thicker arm.
 Fig. 2. *Bombina orientalis*, hand and arm of female.
 Fig. 3. *Bombina orientalis*, foot of male, to show better-developed web.
 Fig. 4. *Bombina orientalis*, foot of female.
 Fig. 5. *Bombina maxima*, hand and arm of male, to show nuptial pad, stronger arm, and bending of the hand.
 Fig. 6. *Bombina maxima*, hand and arm of female.
 Fig. 7. *Bombina maxima*, foot of male, to show better-developed web.
 Fig. 8. *Bombina maxima*, foot of female.
 Fig. 9. *Bufo raddei*, hand and arm of male, to show nuptial pads on arm and fingers, and stronger arm.
 Fig. 10. *Bufo raddei*, hand and arm of female.
 Fig. 11. *Bufo bufo japonicus*, hand and arm of female.
 Fig. 12. *Bufo bufo japonicus*, hand and arm of male, to show nuptial pads on three inner fingers, and stronger arm.
 Fig. 13. *Megophrys kuatunensis*, hand of male, to show nuptial pads on two inner fingers.
 Fig. 14. *Megophrys kuatunensis*, hand of female.
 Fig. 15. *Rana grahami*, hand and arm of male, to show nuptial pad on the first finger and its enlargement.
 Fig. 16. *Rana grahami*, hand and arm of female.

PLATE IX

- Fig. 1. *Rana plancyi*, hand of male, to show enlargement of first finger and nuptial pad.
 Fig. 2. *Rana plancyi*, hand of female.
 Fig. 3. *Rana phrynoides*, hand and arm of male, to show thickness of arm and nuptial asperities on two inner fingers.
 Fig. 4. *Rana phrynoides*, hand and arm of female, to show abnormal development of nuptial asperities on first finger.
 Fig. 5. *Staurois ricketti*, hand of male, to show strongly developed prepollex and nuptial pad on it.
 Fig. 6. *Staurois ricketti*, hand of female.
 Fig. 7. *Rana chensinensis*, foot of female.
 Fig. 8. *Rana chensinensis*, foot of male, to show better-developed web.
 Fig. 9. *Rana chensinensis*, hand of male, to show type of nuptial pad in wood-frogs.
 Fig. 10. *Rana chensinensis*, hand of female.
 Fig. 11. *Rana montivaga*, hand and arm of male, to show nuptial pad and slightly better-developed arm.
 Fig. 12. *Rana montivaga*, hand and arm of female.
 Fig. 13. *Polypedates omeimontis*, hand of male, to show nuptial pads.
 Fig. 14. *Polypedates omeimontis*, hand of female.
 Fig. 15. *Kaloula verrucosa*, foot of male, to show better-developed web.

- Fig. 16. *Kaloula verrucosa*, foot of female.
 Fig. 17. *Kaloula rugifera*, foot of female.
 Fig. 18. *Kaloula rugifera*, foot of male, to show fully developed web.

PLATE X

- Fig. 1. *Aelurophryne mammata*, ventral view of male, to show nuptial asperities on fingers and breast, strong arms, and looseness of skin.
 Fig. 2. *Aelurophryne mammata*, ventral view of female.
 Fig. 3. *Ooeidozyga lima*, ventral view of male, to show median subgular vocal sac with V-shaped ridge of skin.
 Fig. 4. *Ooeidozyga lima*, ventral view of female.
 Fig. 5. *Hyla chinensis*, ventral view of male, to show external median subgular vocal sac with loose skin.
 Fig. 6. *Hyla chinensis*, ventral view of female.
 Fig. 7. *Rana phrynooides*, ventral view of male, to show nuptial asperities, spines on breast, and strongly developed arms.
 Fig. 8. *Rana phrynooides*, ventral view of female, to show abnormal development of nuptial asperities on prepollex.
 Fig. 9. *Rana spinosa*, ventral view of male, to show nuptial asperities and spines on breast.
 Fig. 10. *Rana spinosa*, ventral view of female.
 Fig. 11. *Rana graminea*, ventral view of female.
 Fig. 12. *Rana graminea*, ventral view of male, to show external paired subgular vocal sacs and nuptial pad on first finger.

PLATE XI

- Fig. 1. *Rana kuhlii*, ventral view of male, to show large head and loose skin on throat.
 Fig. 2. *Rana kuhlii*, ventral view of female, to show short and pointed head.
 Fig. 3. *Rana limnocharis*, ventral view of male, to show loose skin on vocal sac.
 Fig. 4. *Rana limnocharis*, ventral view of female.
 Fig. 5. *Rana macrodactyla*, ventral view of female.
 Fig. 6. *Rana macrodactyla*, ventral view of male, to show snout gland or very much pointed snout of male.
 Fig. 7. *Rana spinulosa*, lateral view of female.
 Fig. 8. *Rana spinulosa*, lateral view of male, to show gland on shoulder region.
 Fig. 9. *Rana guentheri*, lateral view of male, to show kidney-shaped shoulder gland and vocal sacs.
 Fig. 10. *Rana guentheri*, lateral view of female.
 Fig. 11. *Rana n. nigromaculata*, lateral view of male, to show external lateral vocal sac.
 Fig. 12. *Rana n. nigromaculata*, lateral view of female.
 Fig. 13. *Rana taipehensis*, lateral view of male, to show large tympanum.
 Fig. 14. *Rana taipehensis*, lateral view of female.
 Fig. 15. *Rana pleuraden*, lateral view of male, to show lateral gland back of arm and vocal sac.
 Fig. 16. *Rana pleuraden*, lateral view of female.

PLATE XII

- Fig. 1. *Microhyla heymonsi*, ventral view of male, to show external median subgular vocal sac, dark throat, and fold between bases of arms.
 Fig. 2. *Microhyla heymonsi*, ventral view of female.

- Fig. 3. *Polypedates oxycephalus*, ventral view of male, to show pointed snout.
Fig. 4. *Polypedates oxycephalus*, ventral view of female.
Fig. 5. *Kaloula borealis*, ventral view of male, to show U-shaped ventral gland.
Fig. 6. *Kaloula borealis*, ventral view of female.
Fig. 7. *Kaloula verrucosa*, ventral view of male, to show ventral gland.
Fig. 8. *Kaloula verrucosa*, ventral view of female.
Fig. 9. *Kaloula rugifera*, ventral view of male, to show ventral gland.
Fig. 10. *Kaloula rugifera*, ventral view of female.

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MALES AND FEMALES OF CHINESE FROGS
Bombina orientalis and *Bombina maxima*



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MALES AND FEMALES OF A CHINESE FROG
Aelurophryne mammata



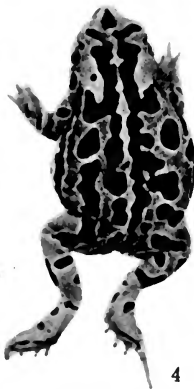
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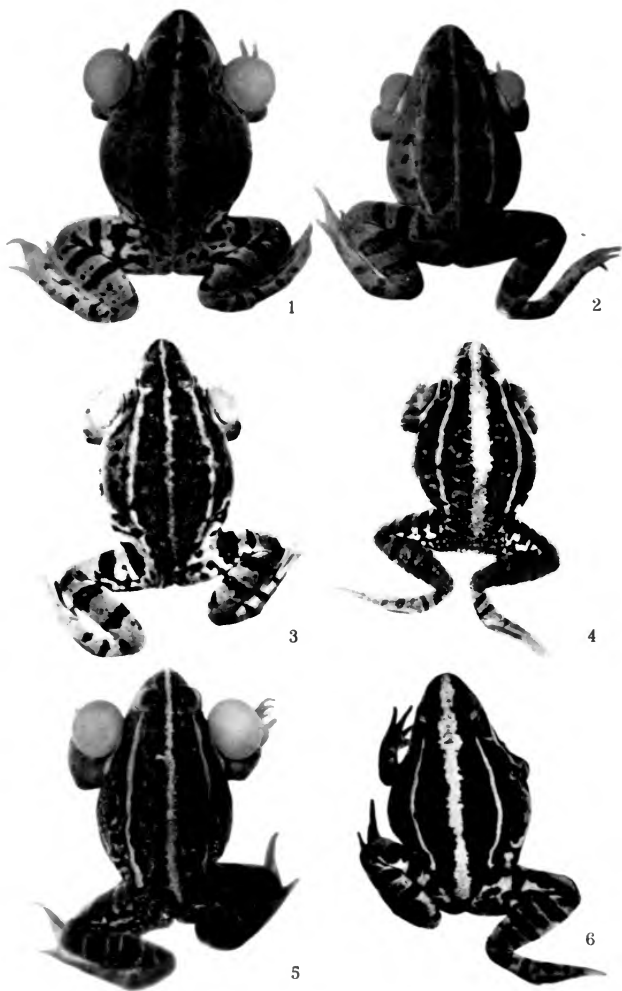
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COLORATION OF SEXES IN A CHINESE TOAD

Bufo raddei



COLORATION OF SEXES IN A CHINESE FROG
Rana nigromaculata nigromaculata



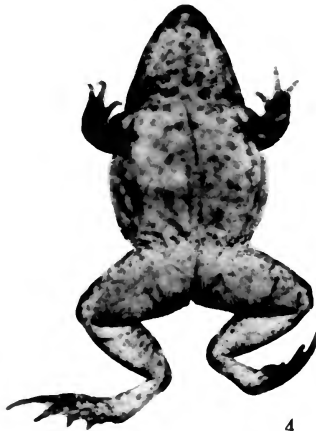
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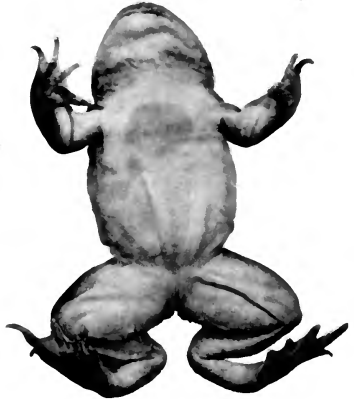


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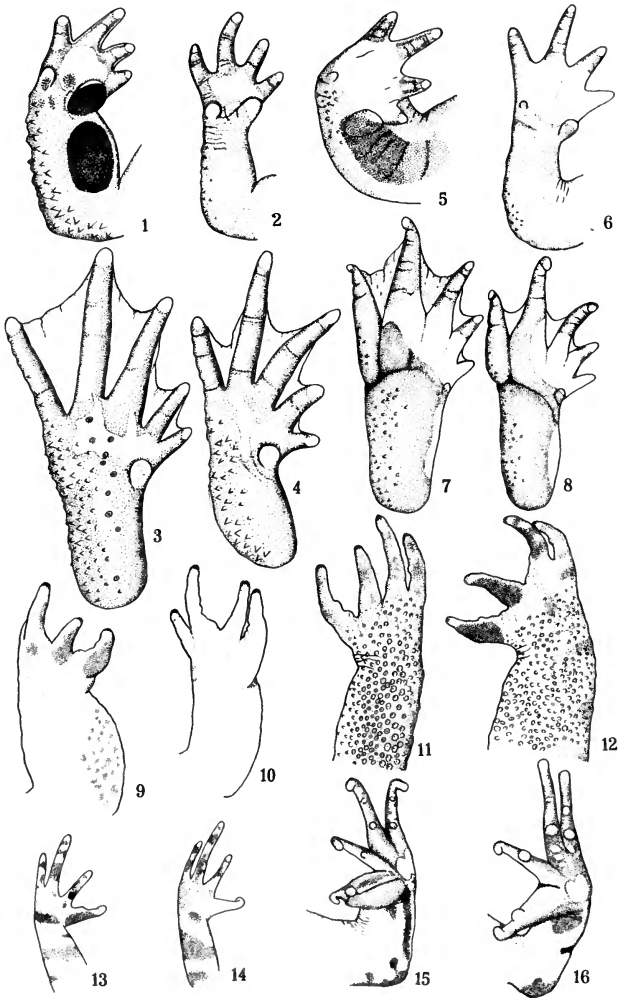
MALES AND FEMALES OF A CHINESE FROG
Rana kuhlii



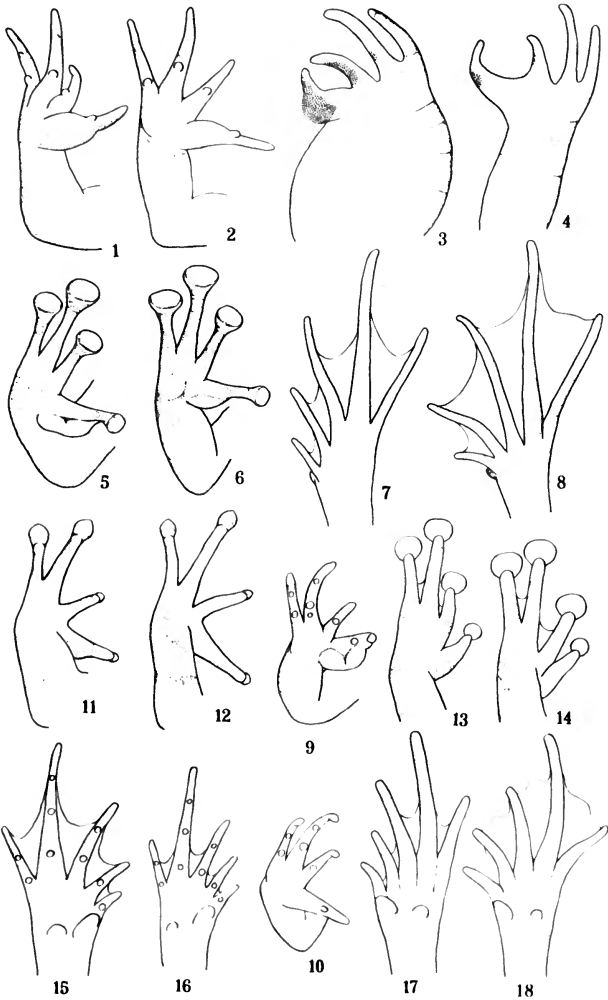
MALES AND FEMALES OF CHINESE FROGS
Rana spinosa and *Rana phrynooides*



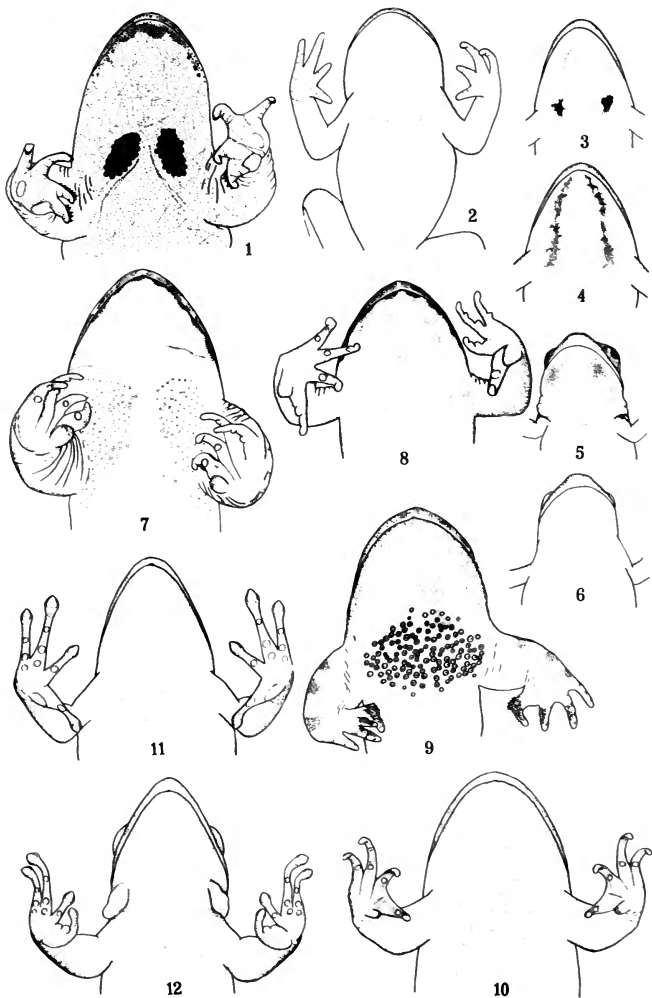
MALES AND FEMALES OF A CHINESE FROG
Polypedates dennysi



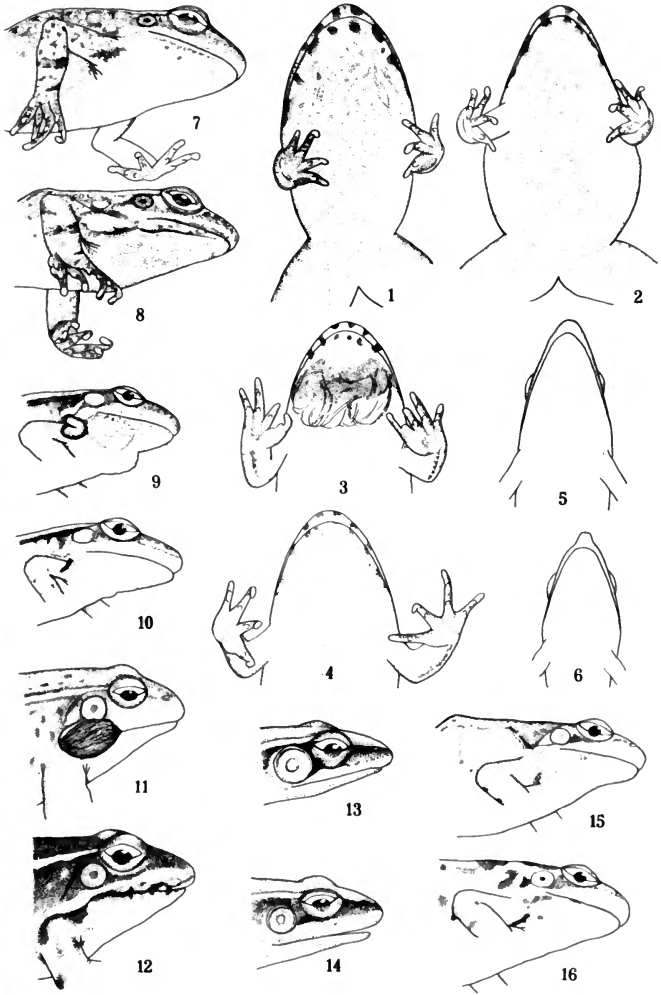
SEX CHARACTERS IN CHINESE FROGS AND TOADS
Bombina, Bufo, Megophrys, and Rana



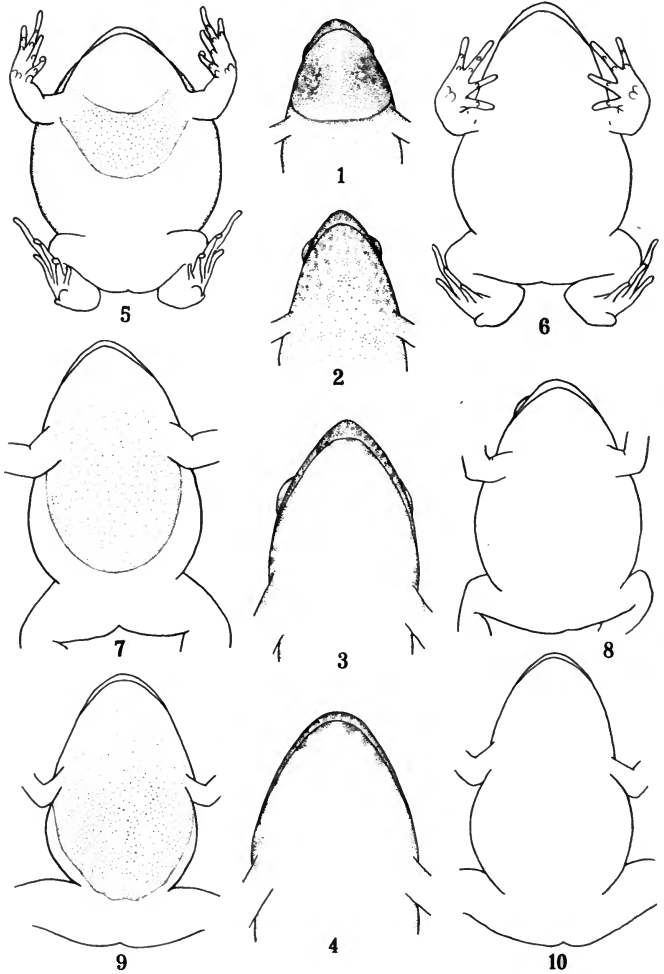
SEX CHARACTERS IN CHINESE FROGS
Rana, Staurois, Polypedates, and Kaloula



SEX CHARACTERS IN CHINESE FROGS
Aelurophryne, *Oeidozyga*, *Hyla*, and *Rana*



SEX CHARACTERS IN CHINESE FROGS
Rana



SEX CHARACTERS IN CHINESE FROGS
Microhyla, *Polypedates*, and *Kaloula*

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