

B R E V I O R A

Museum of Comparative Zoology

CAMBRIDGE, MASS.

FEBRUARY 24, 1960

NUMBER 118

A SURVEY OF THE LEPTODACTYLID FROGS, GENUS *EUPSOPHUS*, IN CHILE

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INTRODUCTION

The interesting leptodactylid genus *Eupsophus* Fitzinger, 1848, consists of three allopatric Neotropical species groups widely disjunct in distribution. One, the *peruanus-wettsteini* group, is found in the plateau of central Peru. The second is composed of several species from southeastern Brazil (*Thoropa* of some authors). A third stock, the subject of the present report, now occurs only in Chile, although fossil evidence (Schaeffer, 1949) suggests that during late and middle Tertiary species of the group ranged much farther to the east. The Chilean forms have been variously referred to the genera *Borborocoetes*, *Cacotus* or *Cystignathus* previous to their current allocation to *Eupsophus* (Parker, 1932).

The following nominal forms of *Eupsophus* have been recognized from Chile: *bibroni* (Bell); *calcaratus* (Günther); *coppingeri* (Günther); *grayi* (Bell); *hidalgi* (Espada); *kriegi* (Müller); *maculatus* (Günther); *masareyi* (Roux); *nodosus* (Duméril and Bibron); *roseus* (Duméril and Bibron); *taeniatus* (Girard); *verrucosus* (Philippi). In addition, a number of names were proposed by Philippi (1902) but his descriptions are inadequate for identification and, since his types are no longer in existence, I follow Vellard (1947) and Schmidt (1954) in disregarding these names. The majority of the species in the genus are known only from their original descriptions, life history information is scanty or wanting, all are of doubtful status, and their affinities are

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unknown (Vellard, 1947; Schmidt, 1954). A detailed revision of *Eupsophus* is thus badly needed.

MATERIAL AND ACKNOWLEDGMENTS

During my extensive stay in Chile during 1956-1957 I concentrated on a preliminary review of the systematics of the Chilean amphibian fauna and particularly emphasized field observation and life history data in my work. On the basis of experience with living *Eupsophus*, together with a study of preserved materials from world collections, it is now possible to critically survey the Chilean portion of the genus. Accordingly, the Chilean forms may be placed into three species groups and only five forms may be accepted as valid. These conclusions are based upon a comparison of all type specimens with material collected at the type localities and throughout the range of the genus in Chile. Measurements are based upon a total of 115 sexually mature examples: 3 *E. coppingeri* (west Patagonian coast); 53 *E. grayi* (Valdivia, Chiloe, Concepcion); 11 *E. nodosus* (Valdivia, Chiloe, Zapallar); 10 *E. roseus* (Valdivia, Chiloe); 38 *E. taeniatus* (Valdivia, Chiloe, Malleco, Puerto Blest, east slope of the Cordilleras). Additional material, especially of *taeniatus*, *nodosus*, and *grayi*, was examined but not measured. All measurements were taken with calipers with an accuracy of 0.5 mm. Characteristics of the pectoral girdle, prevomerine teeth and external morphology were also examined.

Eupsophus is poorly represented in herpetological collections but through the courtesy of Mr. C. M. Bogert, Dr. R. F. Inger, and Dr. E. E. Williams, I have been able to examine and study the samples of this genus in the American Museum of Natural History, the Chicago Natural History Museum, and the Museum of Comparative Zoology at Harvard University, respectively. Specimens in the Instituto de Biologia, Universidad Nacional de Cuyo, Mendoza, Argentina, and Instituto Miguel, Lillo, Universidad Nacional de Tucuman, Argentina, as well as in Centro Investigaciones Zoológicas Universidad de Chile were also studied. Comparative descriptions and photographs of all existing primary types were provided through the efforts of Miss A. C. C. Grandison (British Museum, London), Dr. J. Guibé (Museum National d'Histoire Naturelle, Paris), and Dr. E. Forcart (Naturhistorische Museum, Basel). I wish to acknowledge this valuable assistance.

Other important information relative to the current problem was obtained from the following museums and institutions: Academy of Natural Sciences, Philadelphia; Carnegie Museum, Pittsburgh; Museo Bullock, Angol, Chile; Museo de Concepcion, Chile; Museo Nacional B. Rivadavia, Buenos Aires, Museo Nacional Historia Natural, Santiago de Chile; Museu Nacional, Rio de Janeiro; Museum d'Histoire Naturelle, Geneve; Museum of Zoology, University of Michigan; Naturhistoriska Museum, Stockholm; Peabody Museum, Yale University; Senckenberg Museum, Frankfurt a.M.; United States National Museum; Zoologische Museum, Berlin; Zoologische Museum, Hamburg; Zoologische Sammlung des Bayerischen Staates, Munich. Finally, Dr. Jay Savage, Department of Biology, University of Southern California has read over the completed manuscript and offered numerous helpful suggestions.

SYSTEMATIC NOTES

Species groups. Morphological and biological data support the concept of three phyletic lines in Chilean *Eupsophus*: (1) *coppingeri-nodosus*, (2) *grayi-roseus*, (3) *taeniatus*.

Figure 1 illustrates the anatomical features of the pectoral girdle and prevomerine teeth in the five valid species. Similarities in the structure of omosternum, xiphisternum, and in the prevomerine teeth are evident between *E. coppingeri* (Günther, 1881) and *E. nodosus* (Duméril and Bibron, 1841). *E. taeniatus* (Girard, 1854) differs markedly from these forms in the unnotched xiphisternum. *E. grayi* (Bell, 1843) and *E. roseus* (Duméril and Bibron, 1841) belong to a quite different stock on the basis of their greatly developed omosternum, the peculiar rounded form of the carinate and calcified xiphisternum (most accentuated in *grayi*), and more posterior placement of the vomerine teeth. Affinities between *coppingeri* and *nodosus* are also indicated by other morphologic features (see key).

Synonymous species. *Eupsophus kriegi*, *E. maculatus* and *E. verrucosus* are synonyms of *E. nodosus*. *E. bibroni*, *E. calcaratus* and *E. masareyi* are synonyms of *E. grayi*. The type of *E. hidalgii* (Jiménez de la Espada, 1875) is probably lost and the position of this very poorly described species (only the type is known) appears uncertain. It may be synonymous with *E. taeniatus* on the basis of morphological characters, but no final decision is possible.

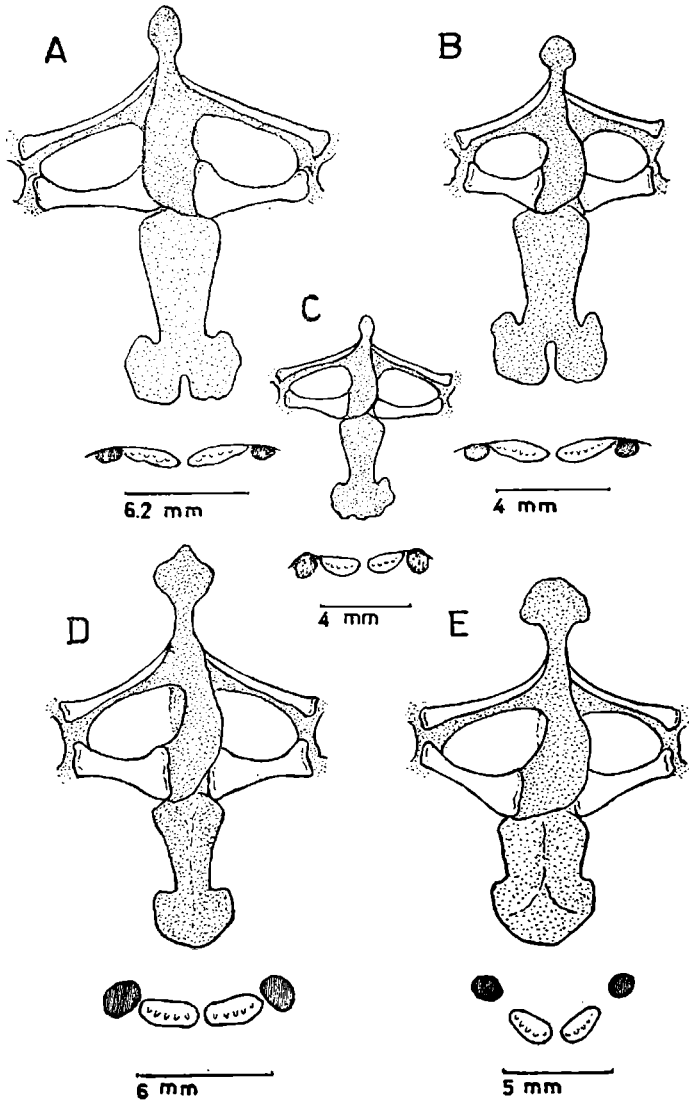


Fig. 1. Pectoral girdles and prevomerine teeth in Chilean *Eupsophus*. A, *E. coppingeri*, Puerto Eden, Patagonia; B, *E. nodosus*, Valdivia; C, *E. taeniatus*, Angol; D, *E. roseus*, Valdivia; E, *E. grayi*, Concepción.

Identity of the pectoral girdle and prevomerine teeth and an analysis of many characters, both in the holotypes of *E. maculatus* (British Museum 60-9-23-4-1947-2-19-99) and *E. nodosus* (Paris Museum, 763) and in my samples, fully support the proposed synonymy of *E. maculatus* (Günther, 1868) with *E. nodosus*. Some local differences due to geographic variation may have influenced Günther in describing *maculatus*. *Eupsophus kriegi* (Müller, 1926) was described from male specimens, and *maculatus* and *nodosus* were at that time known only from females, as pointed out by Philippi (1902). A remarkable sex-dimorphism in *nodosus* apparently has resulted in the continued recognition

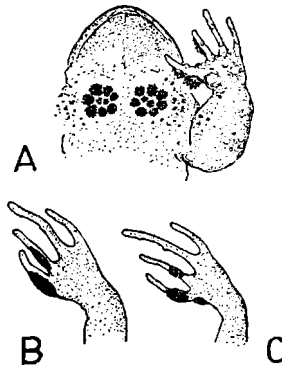


Fig. 2. Secondary sexual features of male *Eupsophus*. A, *E. nodosus*; B, *E. grayi*; C, *E. taeniatus*.

of *kriegi*. Only the two type specimens of Müller's species were known (Valdivia, Munich 141/1925; Quebrada de Penalolen, Santiago de Chile, Munich 35/1931); both were destroyed during World War II. The excellent description by Müller and my observations on living specimens from the central zone of Chile, are sufficient to identify *E. kriegi* as the adult male of *E. nodosus*, characterized by tremendous development of secondary sex characters (Fig. 2).

A direct examination of the neotype (Instituto Miguel Lillo 00162) of Vellard, and a preliminary analysis of geographic variation in *nodosus* make it possible to recognize the redescribed

E. verrucosus (Philippi, 1902) as a juvenile specimen of *nodosus* from the Valdivian forest population.

Synonymy of *Eupsophus bibroni* (Bell, 1843) with *E. grayi* is easily verified by study of the original descriptions of Bell and a re-examination of the holotypes (British Museum 45-5-25-43-1947-2-19-26, and 45-5-25-25-1947-2-17-83, respectively). In my opinion *E. calcaratus* (Günther, 1881) is based upon a juvenile *grayi* from the Chiloe Islands. All external characters correspond in both forms, and the peculiar characters of *calcaratus* (V-shaped glandular dorsal line, tibio-tarsal inner tubercle) occur frequently as individual variants, in insular (Chiloe) and continental populations (Malleco) of *E. grayi*. Besides the holotype, a specimen collected by Cunningham (British Museum 68-9-22-8-1947-2-20-1), only two young individuals from Ancud (Chiloe) are listed in the British Museum as *calcaratus* (personal communication by A. C. C. Grandison). The holotype of *E. masareyi* (Roux, 1910) (Basel 2786) matches extreme individual variants in my Valdivian sample of *grayi*. Specimens such as Museum of Comparative Zoology 13742, from Valdivia, agree quite well with the description by Roux (1910) and also with the type re-examined through the courtesy of Dr. Forcart.

Geographic variation. Geographic variation is an important feature needing further study in populations of these Chilean batrachians. Statistically significant differences are indicated in cephalic shape between the samples from the continent and Chiloe Island (males and females), both in *E. grayi* and *E. taeniatus*. The head of insular specimens is noticeably more elongated. A statistical analysis of Chilean *Eupsophus* will be presented later in a more detailed paper.

Color. Color patterns exhibit some interesting trends in all Chilean *Eupsophus* (Fig. 3). *Eupsophus nodosus* (Fig. 3A) presents characteristic enlarged dorsal spots, dark bands on the legs, and a triangular brownish or greenish spot. *Eupsophus coppingeri* (Fig. 3B) shows a reduced dorsal pigmentation; the enlarged spots and bands are not indicated, but the interocular greenish spot is present and brilliant in life. The manner of the evolution of typical color pattern of *nodosus* is suggested in *E. grayi* (Fig. 3 D and E). In some specimens a whitish dorsal line is evident (Fig. 3E). A line also appears in 40 per cent of the observed

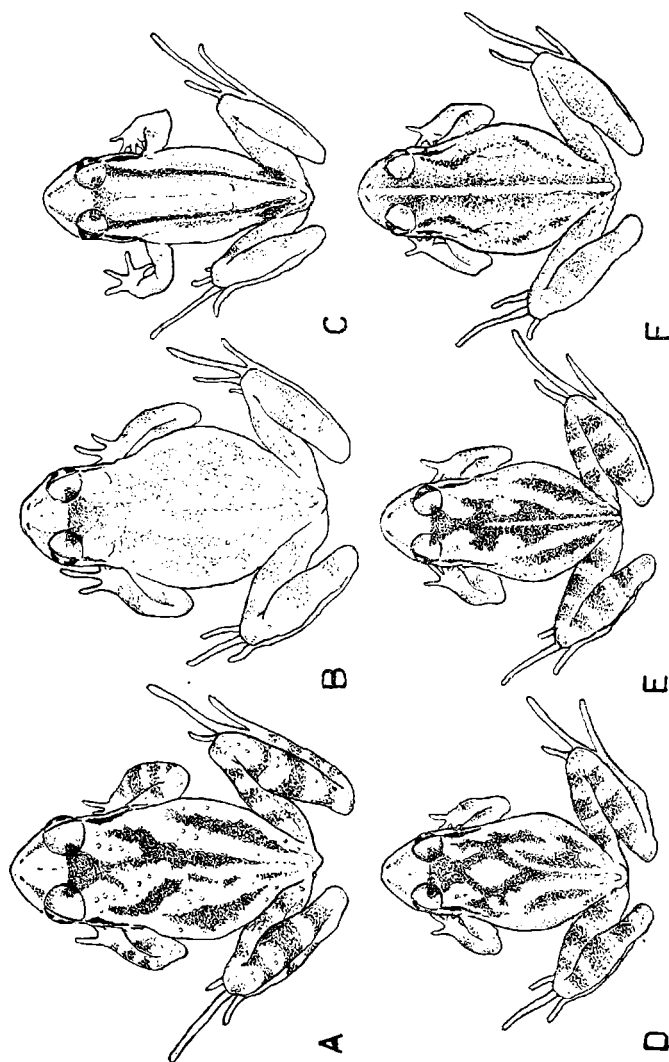


Fig. 3. Color patterns in Chilean *Eupsophus*. A, *E. nodosus*; B, *E. coppingeri*; C, *E. taeniatus*; D, *E. grayi*; E, *E. grayi*; F, *E. roseus*.

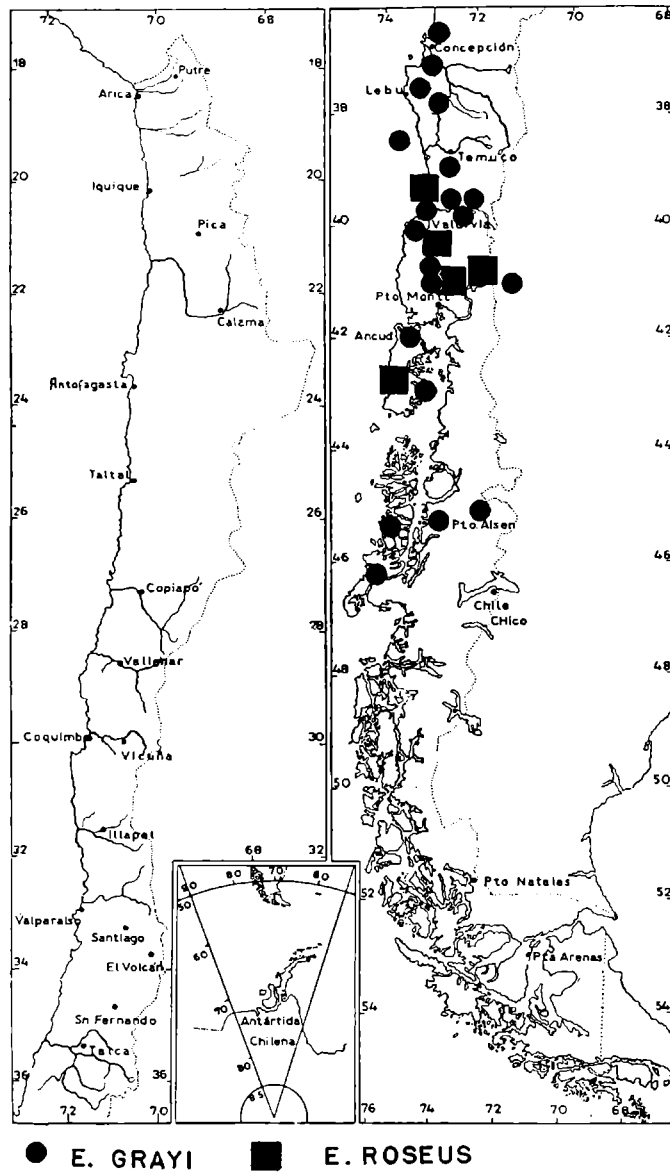
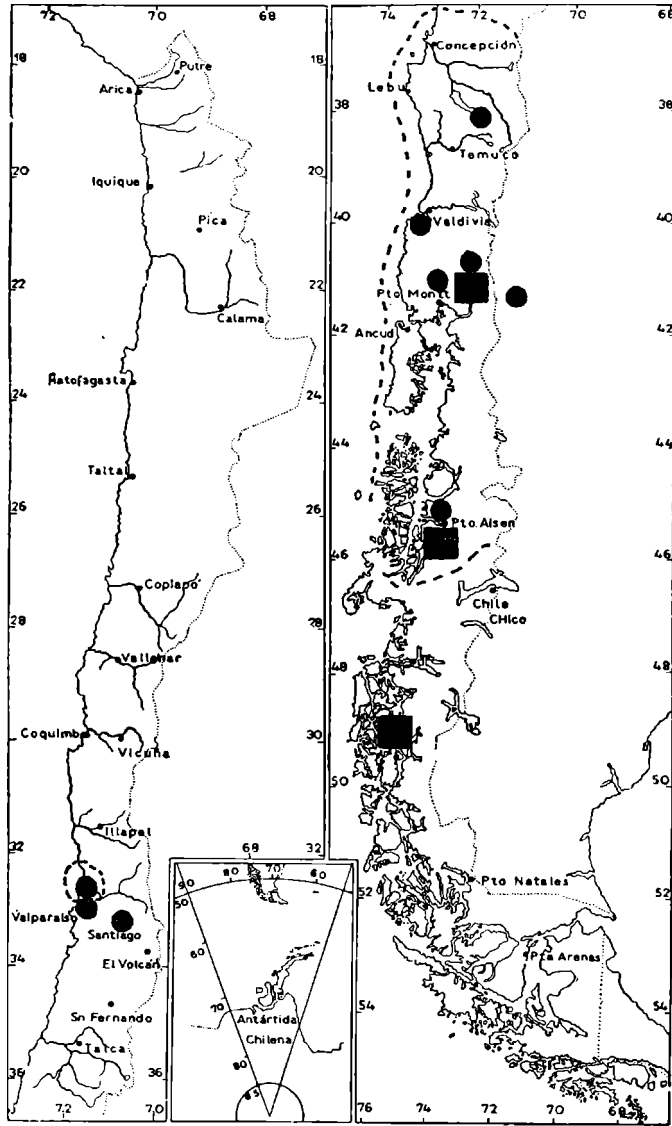


Fig. 4. Distribution of Chilean *Eupsophus*. *Grayi* group.

specimens of *E. roseus* (Fig. 3F), a species which agrees in coloration with some examples of *grayi* but with the spotting reduced or indistinct. The dorsal surface is generally ochraceous, greenish or gray in *Eupsophus*, but in some specimens (the *masareyi* form of *grayi*) a brilliant reddish color has been reported. Individual variation probably is involved. *Eupsophus taeniatus* (Fig. 3C) is the most distinctive Chilean form in color pattern. The interocular spot and brownish dark bands on the legs are occasionally indicated and two peculiar lateral dorsal brownish stripes are also present. Inguinal dark spots are typical of *taeniatus* and sometimes occur in *grayi* on Chiloe Island.

Distribution. Apparently *Eupsophus nodosus* and *E. taeniatus* are primitive, well adapted and formerly widespread species. Similarities in shoulder girdle and prevomerine teeth indicate the relationship between the two forms. *Eupsophus coppingeri* appears to be a specialized form derived from *nodosus* and is sympatric with the southern populations of *Eupsophus nodosus* over a wide area. The distribution of *Eupsophus nodosus* and *E. taeniatus* is significant. Present relict populations of both species are found in the Valparaiso coastal forest and in the valleys of Santiago and probably reveal a late Tertiary invasion, under other climatic and ecological conditions (Capurro, 1952). *Eupsophus nodosus* and *E. taeniatus* also are found, with *E. grayi*, on the eastern slopes of the Cordilleras (Bariloche, Argentina), and Schaeffer (1949) suggests a late Tertiary occurrence of *Eupsophus* in Patagonia.

Eupsophus grayi and *E. roseus* are sympatric in the Valdivian rain forest, but the interspecific and physiological limits of both forms are not yet known. Similarities in the pectoral girdle, prevomerine teeth and color patterns of *grayi* and *roseus* have been pointed out above (Figs. 1 and 3). Evolution of their color patterns from a primitive *nodosus*-like pattern is probable (see Fig. 3). Other significant biological features of Chilean *Eupsophus* are the male secondary sex characters. In the *grayi* and *taeniatus* groups the dark queratinous pads (first and second fingers) are similar, but quite different from the spiny complicated pads of *nodosus*, in which circular spiny areas are also present.



--- *E. TAENIATUS* ● *E. NODOSUS* ■ *E. COPPINGERI*

Fig. 5. Distribution of Chilean *Eupsophus*, *Nodosus* and *taeniatus* groups.

Life history. The life history and development of Chilean *Eupsophus* are poorly known, but *Eupsophus taeniatus* shows similarity (see Cei and Capurro, 1958) to the Brazilian species of *Thoropa* which was called *Borborocoetes* by Boulenger (1891) and Noble (1931) but is referred to *Eupsophus* in the recent paper by Cochran (1955). Eggs of *Eupsophus taeniatus* are pigmented but they are without pigment in the *grayi* and *nodosus* groups.

SUMMARY

Chilean species of *Eupsophus* are reviewed. Only three fundamental groups are recognized: *grayi-roseus*, *nodosus-coppingeri*, *taeniatus*. Synonymy of *E. kriegi*, *E. maculatus* and *E. verrucosus* with *E. nodosus*, and of *E. bibroni*, *E. calcaratus* and *E. masareyi* with *E. grayi* is demonstrated.

Morphological affinities in pectoral girdle, prevomerine teeth and color patterns in Chilean species are analyzed. Secondary sex characters of *grayi*, *nodosus* and *taeniatus* are compared and illustrated. The present distributions of *nodosus* and *taeniatus* express their probable position as ancient and formerly widespread forms. Biological affinities between *E. taeniatus* and Brazilian *Thoropa* are mentioned.

Eupsophus coppingeri and *E. roseus* are specialized and rare forms, sympatric with *grayi* and *nodosus* in the southern Chilean rain forest belt.

A Key to the Chilean Species of Eupsophus

- 1a. Prevomerine teeth between anterior edges of choanae; cartilaginous omosternum very reduced, much shorter than epicoracoid cartilages; xiphisternum not calcified, notched or irregular at posterior margin, longer than epicoracoid cartilages 2
- 1b. Prevomerine teeth between or behind posterior edges of choanae; cartilaginous omosternum dilated, only slightly shorter than epicoracoid cartilages; xiphisternum partially calcified, rounded at posterior margin, shorter than epicoracoid cartilages 4
- 2a. Xiphisternum irregularly rounded posteriorly; tympanum evident; adults not exceeding 46 mm. in standard length; slender habitus; skin smooth; snout prolonged; gray or greenish, with two lateral dark stripes; belly yellowish *taeniatus*

- 2b. Xiphisternum deeply notched posteriorly; tympanum not evident, covered by granular skin; adults more than 46 mm. in standard length; stout habitus 3
- 3a. Skin tubercular; snout obtuse; a glandular tympanic ridge; head not markedly depressed; gray or greenish with dark irregular dorsal spots; belly whitish *nodosus*
- 3b. Skin smooth; snout truncate; no glandular tympanic ridge; head markedly depressed; olive-brown, with obscure brownish markings; belly salmon-pink *coppingeri*
- 4a. Prevomarine teeth far behind choanae; snout prolonged; skin smooth, no glandular ridges; brownish or greenish with dark dorsal blotches; belly grayish-white; adults no more than 50 mm. in standard length ...
..... *grayi*
- 4b. Prevomarine teeth between posterior margins of choanae; snout rounded; skin smooth but with a few glandular ridges; brownish with obscure dark markings; belly whitish; adults more than 50 mm. in standard length *rosesus*

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