

A Survey of Internal Oral Features
of Leptodactyloid Larvae
(Amphibia: Anura)

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ABSTRACT

Wassersug, Richard J., and W. Ronald Heyer. A Survey of Internal Oral Features of Leptodactyloid Larvae (Amphibia: Anura). *Smithsonian Contributions to Zoology*, number 457, 99 pages, 66 figures, 1 table, 1988.—The internal oral anatomy of larvae from 34 genera (52 species) of leptodactyloid larvae are examined and described. These represent most of the South American leptodactylid genera plus *Heleophryne* from Africa and a sample of both myobatrachine and limnodynastine genera from Australia.

Full descriptions are provided for at least one species of each genus and additional species comparisons are made as appropriate. Comparative synopses, which emphasize unique or unusual features, are also presented for each genus.

In general, larval oral morphologies are distinctive at the generic level, but specific features correlate better with ecology than with phylogeny. Nevertheless, certain phylogenetic conclusions are possible based on the larval data, which are discussed in detail. Major evolutionary trends in leptodactyloid larval internal oral anatomy are discussed that involve elaboration or simplification of surface structures.

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Contents

	Page
Introduction	1
Acknowledgments	1
Materials and Methods	1
Morphological Descriptions	2
African Leptodactylid	2
<i>Heleophryne natalensis</i> Hewitt	2
South American Leptodactylids	3
<i>Adenomera marmorata</i> Fitzinger	3
<i>Alsodes monticola</i> Bell	4
<i>Alsodes</i> species	5
<i>Atelognathus patagonicus</i> (Gallardo)	6
<i>Atelognathus reverberii</i> (Cei)	7
<i>Batrachyla taeniata</i> (Girard)	8
<i>Caudiverbera caudiverbera</i> (Linnaeus)	9
<i>Ceratophrys aurita</i> (Raddi)	10
<i>Crossodactylodes</i> species	12
<i>Crossodactylus gaudichaudii</i> Duméril and Bibron	13
<i>Crossodactylus schmidtii</i> Gallardo	14
<i>Crossodactylus</i> species	15
<i>Cycloramphus stejnegeri</i> (Noble)	15
<i>Eleutherodactylus</i> species	16
<i>Eupsophus roseus</i> (Duméril and Bibron)	17
<i>Hylodes</i> cf. <i>asperus</i> (Müller)	18
<i>Hylorina sylvatica</i> Bell	20
<i>Lepidobatrachus laevis</i> Budgett	21
<i>Leptodactylus chaquensis</i> Cei	22
<i>Leptodactylus fuscus</i> (Schneider)	23
<i>Leptodactylus gracilis</i> (Duméril and Bibron)	23
<i>Leptodactylus knudseni</i> Heyer	25
<i>Leptodactylus mystacinus</i> (Burmeister)	26
<i>Leptodactylus pentadactylus</i> (Laurenti)	27
<i>Leptodactylus wagneri</i> (Peters)	27
<i>Macrogenioglottus alipioi</i> Carvalho	27
<i>Megaelosia goeldii</i> (Baumann)	29
<i>Odontophrynus americanus</i> (Duméril and Bibron)	31
<i>Odontophrynus occidentalis</i> (Berg)	32
<i>Paratelmatobius lutzii</i> Lutz and Carvalho	33
<i>Physalaemus petersi</i> (Espada)	34
<i>Physalaemus pustulosus</i> (Cope)	35
<i>Pleurodema borellii</i> (Peracca)	36
<i>Pleurodema brachyops</i> (Cope)	37
<i>Pleurodema bufonina</i> Bell	37
<i>Pleurodema cinerea</i> Cope	39
<i>Pleurodema nebulosa</i> (Burmeister)	40
<i>Proceratophrys appendiculata</i> (Günther)	41
<i>Proceratophrys boiei</i> (Wied)	43

<i>Pseudopaludicola</i> species	44
<i>Rhinoderma darwinii</i> (Duméril and Bibron)	45
<i>Telmatobius jelskii</i> (Peters)	46
<i>Telmatobius marmoratus</i> (Duméril and Bibron)	47
Australian Leptodactyloids	48
<i>Crinia tasmaniensis</i> (Günther)	48
<i>Heleioporus</i> species	50
<i>Limnodynastes tasmaniensis</i> (Günther)	51
<i>Megistolotis lignarius</i> Tyler, Martin, and Davies	52
<i>Mixophyes balbus</i> Straughan	54
<i>Platyplectron ornatus</i> (Gray)	55
<i>Pseudophryne bibronii</i> (Günther)	56
<i>Taudactylus diurnus</i> Straughan and Lee	57
Discussion	58
Generic Synopses	59
African Leptodactyloid	59
South American Leptodactyloids	59
Australian Leptodactyloids	74
Ontogenetic Variation	76
Individual Variation	76
Character Variation	76
Ecological Correlates	81
Phylogenetic Correlates	88
Inter-Continental Leptodactyloid Relationships	88
Relationships Involving the Australian Leptodactyloids	92
Relationships Involving the New World Leptodactyloids	92
Major Evolutionary Trends	94
Summary and Conclusions	95
Literature Cited	97

A Survey of Internal Oral Features of Leptodactyloid Larvae (Amphibia: Anura)

*Richard J. Wassersug
and W. Ronald Heyer*

Introduction

Internal oral features of frog larvae provide information both on morphological adaptations to different larval habitats and on higher taxonomic relationships among frogs (e.g., Wassersug, 1980; Wassersug and Heyer, 1983; Inger, 1983). Larval representatives of many families have now been surveyed; the leptodactyloid frogs of Africa, South America, and Australia are an important exception. The major purpose of this paper is to describe the morphology of internal oral features from a broad spectrum of leptodactyloid larvae, emphasizing the leptodactylids of South America. Our interest in leptodactyloid larval anatomy is threefold: (1) to see whether morphological features correlate with habitat in the same way as demonstrated in other anuran larvae, (2) to determine whether features exist that can be used to elucidate the relationships of the African, South American, and Australian leptodactyloid lineages to each other and to other families of frogs, and (3) to determine whether there are features that can be used to elucidate inter- and intrageneric relationships among the South American leptodactylids.

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Materials and Methods

South American larvae were assembled that sampled all the major lineages as determined from studies on adults (primarily) (Lynch, 1971; Heyer, 1975) and various habitats utilized by larval leptodactylid frogs. Only one species of the African genus, *Heleophryne*, was sampled. A small sample of Australian genera, including representatives of both myobatrachines and limnodynastine frogs, was included to determine whether there are features that distinguish or unite the leptodactyloid larvae from all three continents.

Larvae were dissected and morphological features recorded

using the methodology presented in Wassersug (1976a; 1984) and Wassersug and Duellman (1984). The larval descriptions were based on light microscopic examination and confirmed with scanning electron microscopy (SEM). All photographs were made with SEM. All line drawings were prepared with camera lucida.

Terminology follows Wassersug (1976a; 1980) for internal features and Altig (1970) for external features; the abbreviations BFA (buccal floor arena), BRA (buccal-roof arena), cb (ceratobranchial), and SVL (snout-vent length) are used throughout. Some comments on pulmonary development are included with the descriptions of internal oral surface features. Detailed descriptions are provided for a representative of each genus.

Where more than one species of a genus was examined, only those features that differ are listed, as appropriate, for the additional species.

The larvae of *Cycloramphus izecksohni* (as *duseni*), *Thoropa miliaris* and *Thoropa petropolitana* were illustrated and described elsewhere (Wassersug and Heyer, 1983). These larvae are not redescribed but are included in the discussion of this paper.

Morphological Descriptions

AFRICAN LEPTODACTYLOID

Heleophryne natalensis Hewitt

FIGURE 1

MATERIAL.—No number (two specimens dissected, one used for all data except lung development stage 36, SVL 25.3 mm), collected in St. Hilier, South Africa, 25 November 1977, by G. Setaro.

REFERENCE.—Van Dijk (1966) provides information on the external anatomy.

GENERAL REMARKS.—In a second specimen dissected (stage 25) lungs small, less than 25% length of buccal floor; uninflated.

VENTRAL ASPECT.—*Buccal Cavity:* Buccal floor flask-shaped with a long narrow "neck" extending posterior from lower beak to buccal pockets and with a very wide base between buccal pockets and esophagus. Infralabial papillae organized in 2 parallel ridges per side oriented from anterolateral to posteromedial, smaller simpler anterior ridge capped by larger flap-like posterior ridge; posterior ridge with a free dorsal margin directed anteriorly and medially; each infralabial ridge with 4–6 marginal papillae with secondary pustulation; papillae relatively tall and thin; large gap between the infralabial papillae and the tongue anlage. Two simple, small, lingual papillae. Diamond-shaped BFA with papillae restricted to straight ridges defining BFA posterior margin; 9 papillae on one side, 10 on other, all small and irregular. No pre-pocket papillae. A few pustulations on each side posterior

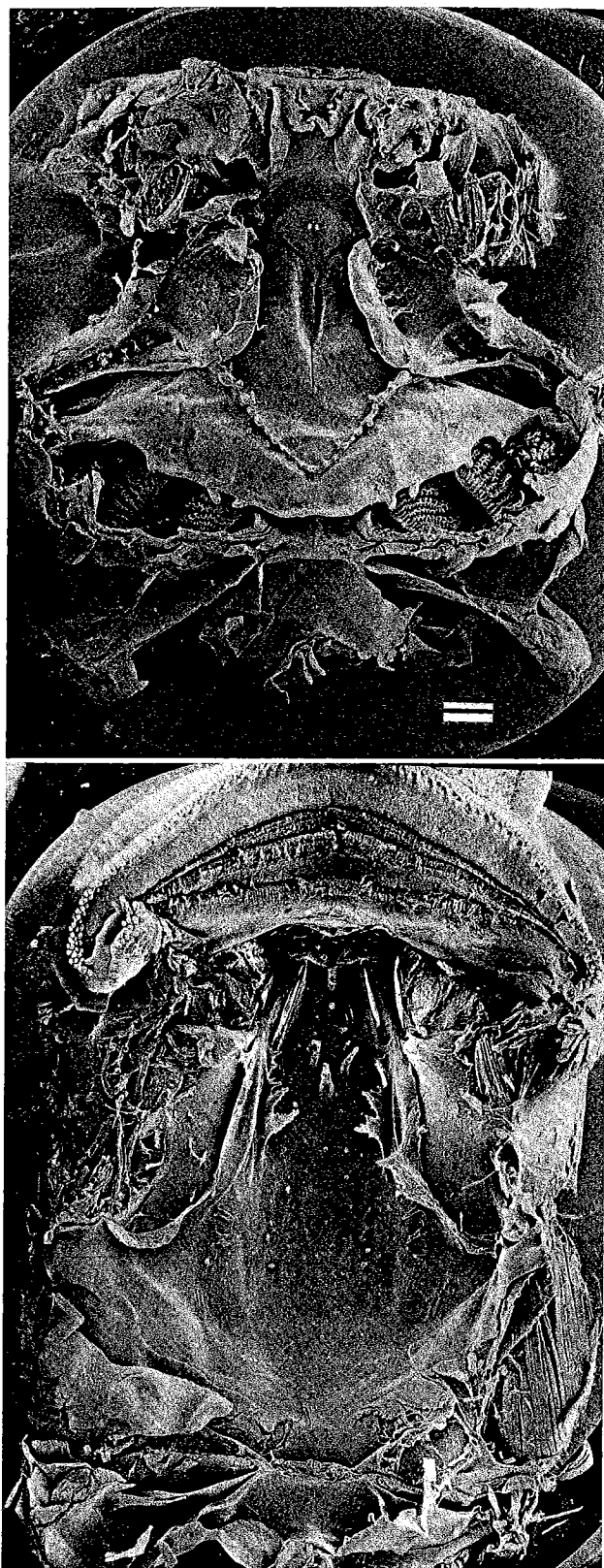


FIGURE 1.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Heleophryne natalensis*; scale line = 1 mm.

and lateral to BFA and just anterior to middle portion of free velar surface. Very large buccal pockets; oblique conspicuous depressions; apparently perforated. Moderately long, free, velar surface; secretory pits not conspicuous; posterior margin with 3 simple papillae associated with individual filter cavities; papillae absent from medial portion of velar surface; median notch shallow. Secretory pits few and limited to posterior velar margin.

Pharyngeal Cavity: Branchial baskets small, shallow, 25% wider than long; not large for tadpole of this size, but disproportionately large in relation to entire bucco-pharyngeal floor area. Filter cavities narrow, shallow; oriented at 45° from the midline; 3rd filter cavity particularly small and nearly fully capped by 3rd filter plate; 2nd filter plate with straight dorsal margin; 3rd filter plate with upwardly arched dorsal margin; filter plates approximately as long as tall; 3rd filter plate covering about 50% of 3rd filter cavity; cb 1 with 8 filter rows, cb 2 with 8, cb 3 with 8, cb 4 with 7. Filter mesh of extremely low density; numerous secondary folds, tertiary folds rare and short. Filter rows rarely abutting; filter canals large, 20%–40% canopied by filter ruffles. Branchial food traps shallow; no secretory ridges. Apices of secretory cells erupting in random fashion as in *Ascaphus* and *Bombina* (Figure 57a). Glottis 50% exposed; small; lips thin; laryngeal disc broad but shallow. Esophageal region very narrow.

DORSAL ASPECT.—**Buccal Cavity:** Like floor, roof flask-shaped; elongated and very narrow anteriorly, very broad posteriorly. Nares far forward; median ridge 30% of distance from upper beak to esophagus. Approximately 7 small pustulations in a Y-shaped pattern (arms anterior) in center of prenarial arena; stem of "Y" extending back into space between nares. Nares extremely long; almost parallel; internarial distance large; both anterior and posterior narial walls lacking papillae and pustulations; posterior narial wall 6 times as long as tall. Because of nearly longitudinal orientation of nares, postnarial arena not defined anteriorly. A single, medial, conical papilla with roughened anterior surface just posterior to posterior end of nares, apparently the homologue of median ridge in other tadpoles. A slightly smaller, similarly shaped papilla (homologue of postnarial papilla in other tadpoles?) lying anterolateral to medial ("median ridge") papilla on each side. Two still smaller papillae lying anterior to these "postnarial papillae." A few yet smaller pustulations and papillae scattered between internal nares and prenarial median ridge. Instead of distinct lateral-ridge papillae, 2 parallel long, thin flap-like ridges on each side extending from posterolateral 1/3 of internal nares to a distance as far back as the palatoquadrate-ceratohyal articulation; these ridges with extremely jagged, papillate posterior margin. BRA undelineated; BRA papillae absent; 2–4 small lateral-roof papillae in long rows on each side. Glandular zone with distinct anterior margin except on the midline; no secretory pits; relatively short zone, <10% length of buccal roof; barely continuous on midline; no marginal papillation.

Pharyngeal Cavity: Three pressure cushions per side; most of medial cushion not present in specimen; middle and lateral cushions distinct, small ovals of subequal size. Ciliary groove destroyed in dissection.

SOUTH AMERICAN LEPTODACTYLOIDS

Adenomera marmorata Fitzinger

FIGURE 2

NOMENCLATURAL NOTE.—Fitzinger's otherwise unpublished description of *A. marmorata* was published by Steindachner (1867) so that the proper author indication is *A. marmorata* Fitzinger in Steindachner.

MATERIAL.—USNM Field 4497 (one specimen dissected, stage 36, SVL 5.6 mm). Collected from a foam nest under moss on a roadcut at Boracéia, São Paulo, Brazil, 13 December 1976, by W.R. Heyer.

REFERENCE.—The larva is similar to that of *A. hylaedactyla* (Heyer and Silverstone, 1969) in lacking beaks and denticles and in having large yolk stores.

GENERAL REMARKS.—Lungs moderately large; collapsed, not inflated. Very reduced, short, stubby gill filaments, no particular branching or proliferation.

VENTRAL ASPECT.—**Buccal Cavity:** Floor of mouth oval, about as wide as long. Two pairs of infralabial papillae, 1st pair anterior and medial, simple round knobs; posterior and lateral pair similar in form to first pair but twice as tall with rounded apices (Figure 52a). Lingual papillae represented as 2 pustules. BFA not defined; about 20 large round pustulations in middle posterior portion of buccal floor and near medial end of buccal pockets; no other papillae/pustulations on buccal floor. Buccal pockets average size; 5 times as wide as long; oriented 45° from transverse plane; perforations not determinable. Moderate free velar surface, 1/4 length of rest of buccal floor; no visible spicular support; posterior margin gently curved with 3 distinct peaks on each side (excluding median notch), each peak lying above 2nd, 3rd, and 4th filter plates respectively; middle portion with simple, transverse edge; median notch small, sharp slit; no secretory pits.

Pharyngeal Cavity: Branchial baskets transversely oval, 25% wider than long; each basket about 1/5 remaining area of buccal floor; very shallow; 2nd and 3rd filter plates extremely shallow, such that only 1 effective filter cavity. Second filter plate small, 3rd and 4th larger and subequal in size; obliquely oriented from midline; filter plates with simple straight dorsal edges, 5–6 times as wide as tall, not imbricated; cb 1 too short to determine number of filter rows, cb 2 with 5, cb 3 with 5, cb 4 with 4. No filter mesh. Filter rows represented by uneven vermiform ridges, rows narrow, non-abutting; filter canals 2–3 times as wide as filter rows, open. Branchial food traps effectively absent; no secretory ridges. Glottis 60% visible from above, large, occluded; lips thick, not particularly tall; laryngeal disk not conspicuous. Esophageal funnel very broad

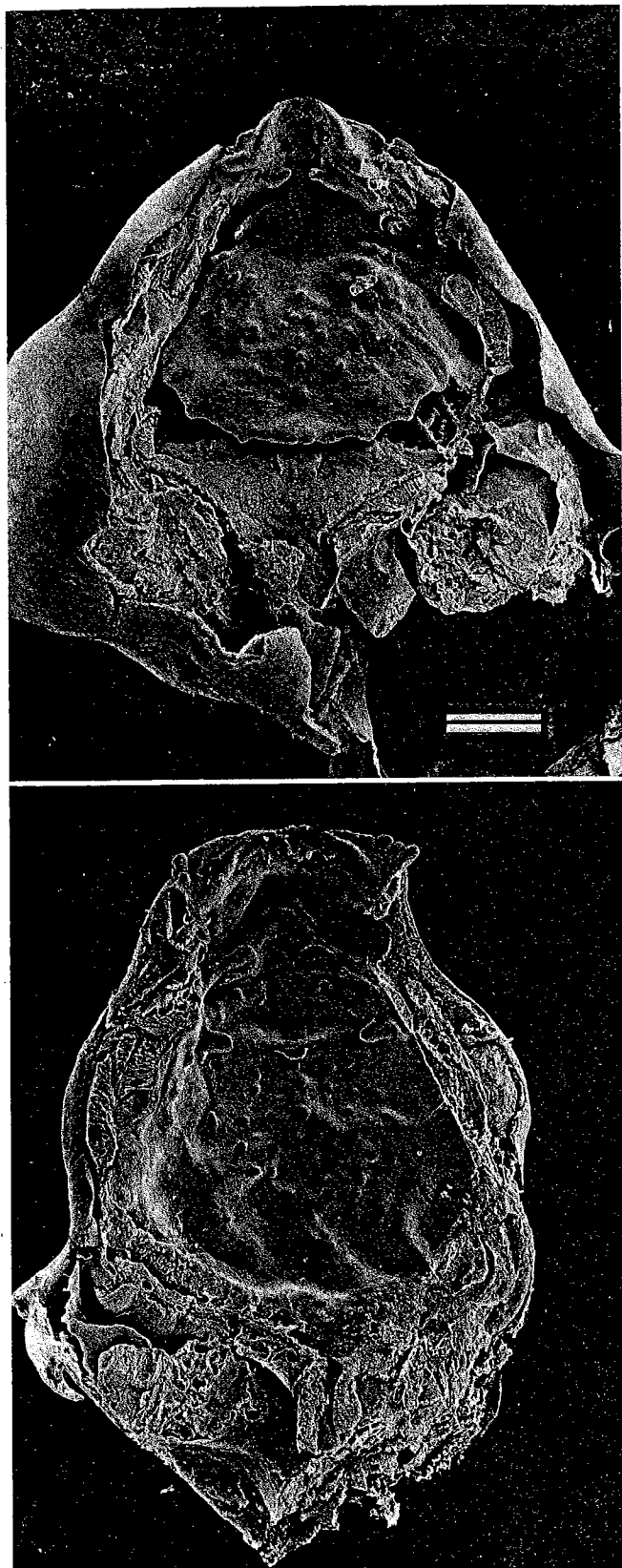


FIGURE 2.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Adenomera marmorata*; scale line = 400 μ m.

and large.

DORSAL ASPECT.—Buccal Cavity: Roof of mouth an elongated oval, 20% longer than wide; nares about 25% distance from front of mouth to esophagus; median ridge about 40% distance from front of mouth to esophagus. Gently curved, anteriorly directed, V-shaped depression in prenarial arena. Nares of average size; internarial distance about $1/10$ length of buccal floor; about 20° orientation from transverse plane; anterior narial wall heavy and thick, particularly medially; no prenarial papillae; posterior narial wall straight, lacking palps or projections. Single, small, blunt, comb-shaped, postnarial papilla on each side located directly posterior to medial third of nares. Median ridge very small trapezoidal flap lacking marginal or surface sculpturing. Lateral-ridge papillae similar in shape to, but slightly larger than, median ridge, blunt, laterally and medially compressed flaps. BRA absent; about 30 pustulations on midportion of buccal roof. No distinct glandular zone; no secretory pits. No dorsal velum.

Pharyngeal Cavity: No pressure cushions. Ciliary groove present, with cilia, but cilia in very narrow, shallow band.

Alsodes monticola Bell

FIGURE 3

MATERIAL.—KU 160574 (two specimens dissected, description based on specimen stage 34, SVL 25.7 mm). Collected from Lago Nahuel Huapi, Neuquén, Argentina.

REFERENCE.—Lavilla, 1983, describes the external morphology.

GENERAL REMARKS.—Only those features that differ from *Alsodes* species (following account) are described. Lungs large, 20% longer than buccal floor, thin, not inflated. Stomach contents largely silt.

VENTRAL ASPECT.—Buccal Cavity: BFA bounded by about 50 papillae; papillae smaller and less complex than in *Alsodes* species, only the largest papillae medial to buccal pockets bifurcate; 30–40 simple papillae within arena. Eight prepocket papillae, majority in transverse row, pointing posteriorly over pockets. Buccal pockets smaller than in *Alsodes* species. Spicules in free velar surface slightly smaller than in *Alsodes* species; papillae of posterior margin smaller and not touching large papillae surrounding median notch.

Pharyngeal Cavity: Cb 1 with 6 filter rows, cb 2 with 7, cb 3 with 8, cb 4 with 6. Filter rows closer than in *Alsodes* species, but not abutting. Filter canals fully exposed, largest subequal to width of filter rows. Glottis dorsally oriented, 80% exposed; laryngeal disk not visible.

DORSAL ASPECT.—Buccal Cavity: Anterior narial wall simple, lacking projections; posterior narial wall simpler than in *Alsodes* species. Postnarial arena defined by 2 papillae on each side, anteromedial pair larger with terminal rugosities, located midway between medial margin of nares and median ridge, second pair directly posterolateral to 1st pair, smaller and simpler. Lateral-ridge papillae similar in shape but much

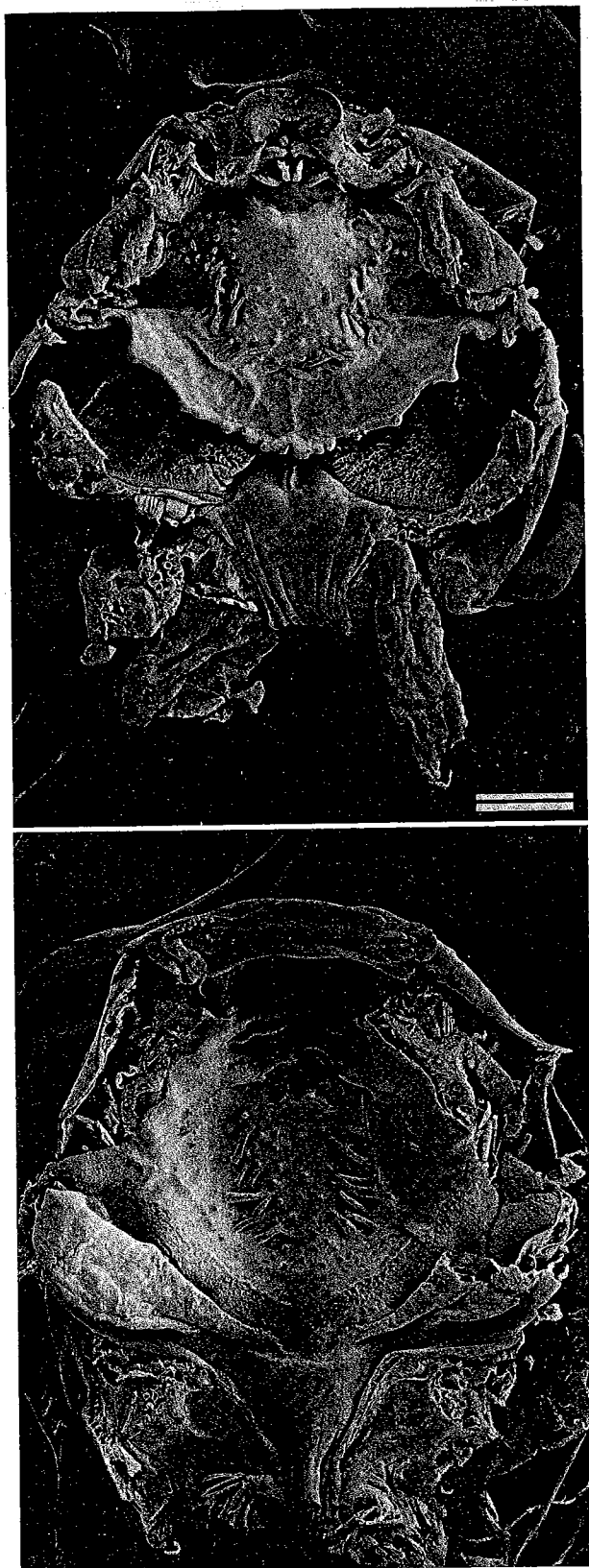


FIGURE 3.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Alsodes monticola*; scale line = 1 mm.

smaller than in *Alsodes* species, in proportion more similar to other tadpoles, 4 papillae per side. BRA defined by 10–15 papillae on each side (Figure 63a).

Alsodes species

MATERIAL.—KU 162244 (one specimen dissected, stage 37, SVL 28.6 mm.) Collected from Parque Nacional Nahuelbuta (Cabreras), 1030 m, Malleco, Chile. Specimen disintegrated prior to illustration.

REFERENCE.—Formas (1981b) indicated that the Kansas series of specimens from Cabreras represents a new species being described by Alberto Veloso, who is presumably describing the external morphology of the tadpole.

GENERAL REMARKS.—Lungs about 20% longer than buccal floor; inflation indeterminable.

VENTRAL ASPECT.—*Buccal Cavity:* Floor of mouth pentagonal, broad, length and width equal. Four subequal infralabial papillae, 2 anteromedial, 2 posterolateral; simple, cylindrical, with irregular apices, posterior pair bifurcated. Four lingual papillae arranged in slight arc; simple, medial 2 largest. BFA a broad U-shaped; arena bounded by about 40 BFA papillae, 20 per side with the following unusual features—dense cluster of rather large attenuate papillae along posterior limit of BFA; more than usual papillae in anterior portion of BFA; largest BFA papillae (those immediately medial to buccal pockets) laterally compressed, huge pinwheel-like structures with long pointed apices; within arena about 60 cylindrical simple papillae of subequal size. Dense cluster of 8–10 prepocket papillae; attenuate; sizes various. Pustulations within buccal floor largely limited to posterior and lateral margins of BFA or to region directly anterior to buccal pockets; relatively few pustulations on buccal floor proper. Buccal pockets large; about 4 times as wide as long; transversely oriented; not perforated. Free velar surface long, total surface about $\frac{1}{4}$ area of remainder of floor; conspicuous spicular support; spicular tips flattened; posterior velar margin gently arching except where interrupted by distinct round marginal papillae, smallest papillae directly over opening of 2nd filter plate, next largest papilla anterior and medial to esophagus, last pair largest, directed medially halfway between 2nd pair and median notch and touching large papillae surrounding median notch; median notch very deep, bounded by single large papilla on each side; very large secretory pits on marginal papillae.

Pharyngeal Cavity: Branchial baskets in shape of right triangles with hypotenuses running anterolaterally to posteromedially; baskets as wide as long; total area of both baskets about 50% buccal floor area; baskets shallow. First filter cavity about 50% of branchial basket in dorsal view with 2nd filter cavity almost as large, 3rd filter cavity exceptionally small, completely obscured from dorsal view by 3rd filter plate and ventral velum; 2nd and 3rd filter plates horizontally oriented, 2nd filter plate with weak medial peak, 3rd filter plate free edge arching medially following posterior and medial edge of

branchial basket, length and width about equal for 2nd and 3rd plates, filter plates extremely imbricate; cb 1 with 8 filter rows, cb 2 with 10, cb 3 with 8, cb 4 with 7. Filter mesh density low; on 2nd and 3rd filter plates some very wide filter rows with quaternary folds, but few rows abutting and many separated by space equalling row itself; filter mesh on 1st and 4th plates narrow and lacking tertiary folds. Filter canals mostly exposed, some wider than filter rows, less than 20 to more than 80% canopied. Branchial food traps large; largely limited to ventral surface of ventral velum; secretory ridges conspicuous, large, straight, uniform (see Figure 59 for *A. monticola*). Glottis vertically oriented, open, fully exposed; small but distinct lips; poorly defined but broad laryngeal disk. Esophageal funnel broad and large.

DORSAL ASPECT.—*Buccal Cavity*: Roof of mouth same shape as floor; nares about 25% distance from front of mouth to esophagus; median ridge about 40% distance from front of mouth to esophagus. Single, simple, posteriorly directed papilla in prenarial arena; no other topographic features in prenarial arena. Nares of average size; large internarial space, about equal to length of one naris; 40° orientation from transverse plane; anterior narial wall shallow, with gently curved anteromedial projection and distinct cylindrical papilla extending from anterior wall directly posterior over middle of nares; posterior narial wall with wavy margin; no distinct narial-valve projection. Postnarial arena very elongate; defined by 5 papillae on each side, papillae with predominantly transverse orientation posteriorly and rostrocaudal orientation anteriorly; largest papillae more posterior, compressed and curved with rugose anterior free edges; all postnarial papillae fairly far posterior such that space between postnarial papillae and nares larger than postnarial arena itself; smooth within arena proper. Median ridge small; triangular; thick with bifurcate apex; some pustulation on most anterior surface. Lateral-ridge papillae gargantuan, about 5 times size of median ridge; laterally compressed flaps with 3 attenuate pointed fingers on one side, 4 on other. BRA wedge-shaped; BRA defined by about 15 papillae on each side; all simple, relatively attenuate papillae, largest lateral. Many small papillae within BRA and few pustulations concentrated more posteriorly in arena. Glandular zone short; large secretory pits of low density except directly in front of esophagus; pits extending onto pressure cushions. Dorsal velum average length but extremely shallow and dorsoventrally compressed; medial gap about as wide as dorsal velum on each side; no marginal papillation.

Pharyngeal Cavity: Single, extremely shallow pressure cushion. Ciliary groove extremely shallow.

Atelognathus patagonicus (Gallardo)

FIGURE 4

MATERIAL.—KU 160469 (one specimen dissected, stage 37, SVL 27.5 mm). Collected from Laguna Blanca, 1275 m, Neuquén, Argentina.

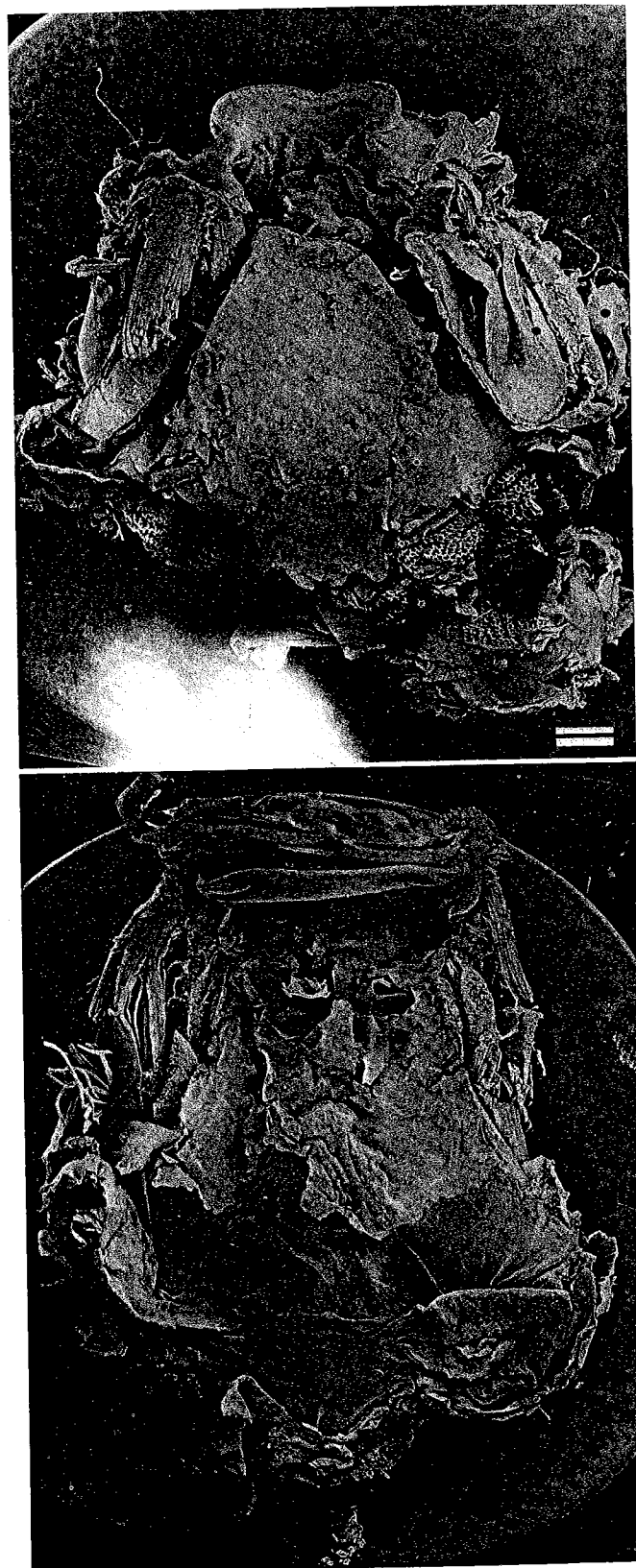


FIGURE 4.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Atelognathus patagonicus*; scale line = 1 mm.

REFERENCE.—Lavilla, 1983, described the external morphology.

GENERAL REMARKS.—This specimen was partially damaged in dissection; only those features that can be discerned are compared and these are stated only if different from those of *Atelognathus reverberii* (following account).

VENTRAL ASPECT.—*Buccal Cavity*: Infralabial papillae subequal in size. About 20 BFA papillae on each side; not bifurcate. Less than 6 prepocket papillae. About 6 papillae in posterior $\frac{1}{2}$ of BFA. Cb 1 with at least 6 filter rows, cb 2 with 11 or 12, cb 3 with at least 10, cb 4 with at least 8.

DORSAL ASPECT.—*Buccal Cavity*: Postnarial arena papillae smaller than in *A. reverberii*. Median-ridge base just more than $\frac{1}{2}$ height. Both edges of lateral-ridge papillae serrate, lateral-ridge papillae smaller than median ridge.

Atelognathus reverberii (Cei)

FIGURE 5

MATERIAL.—USNM 204798 (one specimen dissected, stage 34, SVL 23.0 mm). Collected from Somuncura Plateau, Laguna Raimunda, Rio Negro, Argentina, 20 December 1967, by J.M. Cei.

REFERENCE.—Cei (1980) described and figured the tadpole (as *Telmatobius reverberii*).

GENERAL REMARKS.—Lungs long and thin, 10% longer than length of buccal floor; not inflated.

VENTRAL ASPECT.—*Buccal Cavity*: Floor of mouth triangular, length about equal width. Four infralabial papillae in transverse line; compressed cones with rugose margins; medial pair 50% size of lateral pair; medial pair pointing dorsally, lateral pair medially; none bifurcate; none abutting on midline. Four lingual papillae in an anteriorly directed arch; all simple, attenuate papillae; anterior medial pair with knobby apices, twice size of lateral pair. BFA an elongate oval bounded by about 25 papillae on each side; BFA papillae sickle-shaped, larger ones with knobby, bifurcate apices. Cluster of at least 6 very small papillae anteromedial to buccal pockets merging with BFA papillae. Few small papillae immediately posteromedial to buccal pockets merging with more posterior BFA papillae; at least 10 simple, attenuate papillae of unequal size in posterior $\frac{1}{2}$ of BFA and equal number of pustulations scattered among them. Buccal pockets short, about as wide as long; shallow; obliquely oriented at about 45° from transverse plane; perforated. Free velar surface of average length (Figure 56a); thin spicular support; posterior margin gently curved with very distinct marginal cusps just over dorsal free edges of 2nd, 3rd, and 4th filter plates; median notch average size with rounded symmetrical cusps on each side; secretory pits faint, largely limited to peaks on free velar margin.

Pharyngeal Cavity: Branchial baskets as long as wide, irregularly oval; large; each branchial basket more than 70% remaining buccal floor area; very deep; 1st filter cavity about equal in size to 2nd; 3rd 50% smaller (Figure 56a). Second

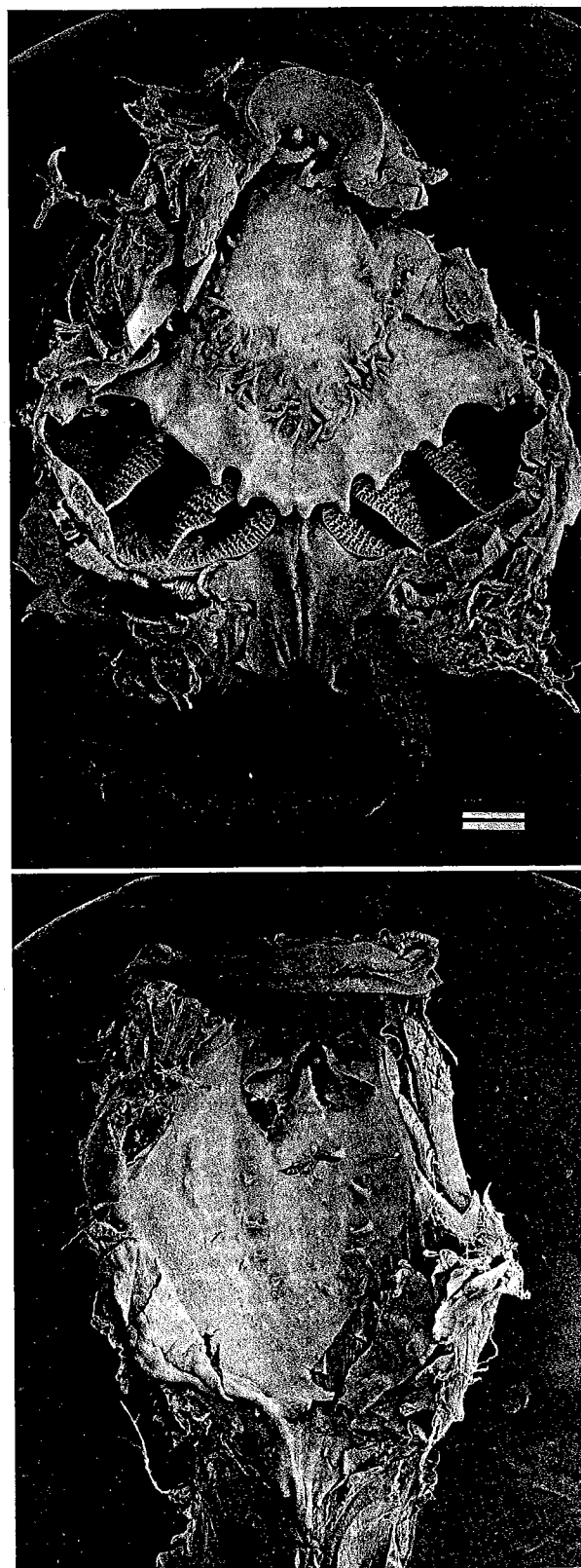


FIGURE 5.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Atelognathus reverberii*; scale line = 1 mm.

filter plate with slightly bowed-down edge, 3rd filter plate dorsal edge arching upward slightly; 2nd filter plate 2–3 times as long as high, 3rd filter plate about as long as high; moderately imbricate with 3rd filter plate covering about 50% of 3rd filter cavity, tipped about 45° from vertical; cb 1 with 10 filter rows, cb 2 with 12, cb 3 with 10, cb 4 with 8. Filter mesh moderate to dense; many quaternary and higher order folds (Figure 56a). Filter rows of varying width, more posterior and lateral rows in 1st and 2nd filter cavities exceptionally wide; slightly separated. Filter canals less than $\frac{1}{3}$ width of rows; 80%–100% canopied. Branchial food traps with distinct secretory ridges. Glottis open; 50% visible; small; narrow lips; laryngeal disk not well defined. Esophageal funnel of average dimensions.

DORSAL ASPECT.—*Buccal Cavity*: Roof of mouth anteriorly truncated diamond-shape, length about equal to width; nares about 25% distance from front of mouth to esophagus; median ridge about 40% distance from front of mouth to esophagus. Prenarial arena with faint pustulations scattered in a relatively transverse arrangement posteriorly. Nares of small to average size; internarial distance large, about 70% or more naris length; transversely oriented; anterior narial wall globose medially, otherwise prenarial papillae absent; posterior wall thin, lacking distinct narial-valve projection. Two postnarial arena papillae on each side in a relatively transverse row; larger and more medial pair very elongate cones with roughened anterior surfaces and pointed apices almost abutting anteromedially; 2nd pair much smaller, simple, conical. Median ridge an exceptionally tall trapezoid with the base just less than $\frac{1}{2}$ height; free edge with pustulations; 2 pustulations in sagittal plane of posterior surface. Lateral-ridge papillae laterally compressed with smooth posterior edges and serrate anterior edges, each papilla terminating in a point; as tall as median ridge, but base not as broad. BRA egg-shaped; defined by about 10 papillae on each side; all BRA papillae simple, straight or slightly curved conical structures with pointed apices. Couple of very small papillae between median ridge and postnarial papillae; 2 or 3 papillae isolated in most lateral portion of buccal roof; about 20 small papillae and pustulations randomly scattered in BRA. Glandular zone long, of medium-sized, densely packed, secretory pits; front edge with simple V-shape. Dorsal velum of short to average length; broadly interrupted on midline; very smooth free edge.

Pharyngeal Cavity: Pressure cushions very faint, 2 per side. Ciliary groove shallow, average width.

Batrachyla taeniata (Girard)

FIGURE 6

MATERIAL.—KU 162052 (one specimen dissected, stage 34, SVL 13.7 mm). Collected from Parque Nacional Nahuelbuta, Malleco, Chile.

REFERENCE.—Cei (1980, fig. 109e,f) described and figured the tadpole.

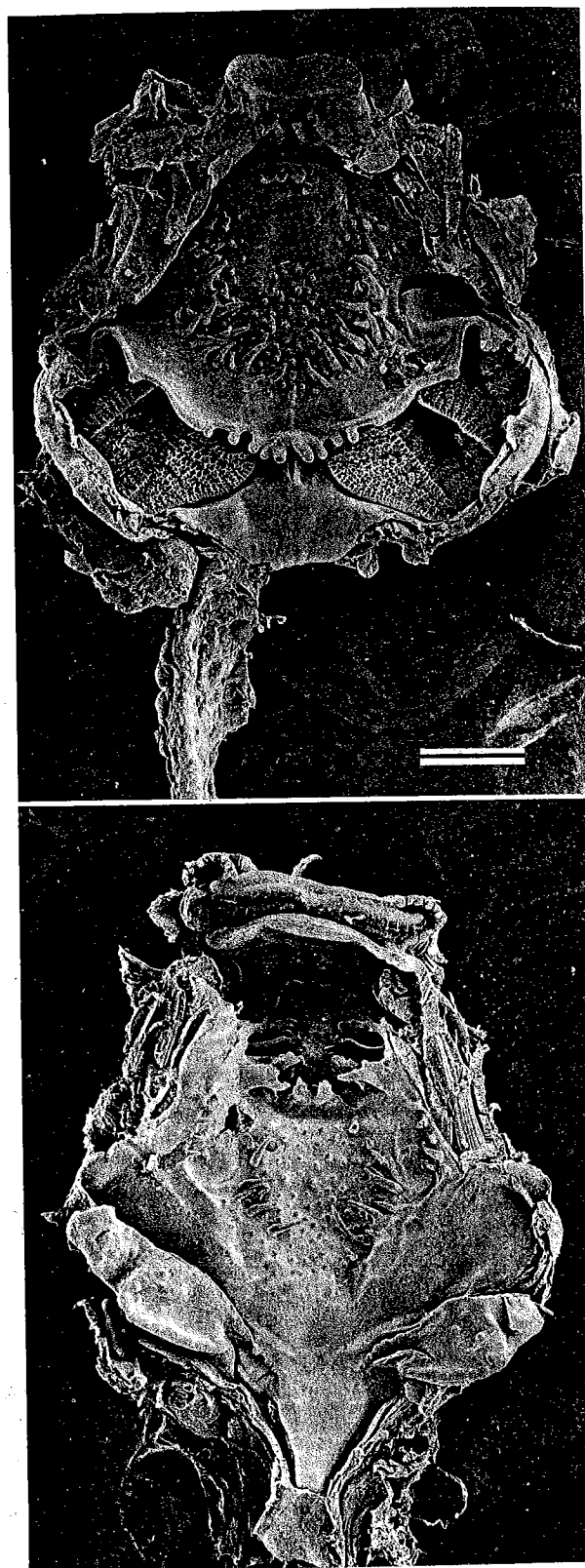


FIGURE 6.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Batrachyla taeniata*; scale line = 1 mm.

GENERAL REMARKS.—Well-developed gill filaments. Lungs large, thin, 10% longer than buccal floor.

VENTRAL ASPECT.—*Buccal Cavity:* Floor of mouth triangular, of about equal length and width. Four infralabial papillae in a transverse row; 2 near midline directed dorsally, 2 more lateral directed anteromedially; papillae about equal in size, slightly compressed anteroposteriorly, with roughened anterior surfaces. Four quite tall and distinct lingual papillae in a transverse row, medial pair slightly larger than lateral pair, larger ones with terminal rugosities. BFA an elongate oval defined by 20–25 papillae on each side; largest BFA papillae medial to buccal pockets arising as a pair from a common base, rest of BFA papillae simple. About 6 small prepocket papillae positioned anteromedial to buccal pockets. Many pustules on posterior $\frac{1}{2}$ of BFA. Buccal pockets of average size, twice as wide as long; oriented transversely; perforated. Free velar surface of average length; total area about $\frac{1}{3}$ rest of buccal floor; velum supported by long spicules; posterior velar margin semicircular with 5 round marginal papillae not counting papillae surrounding median notch, most lateral papilla on each side over edge of 2nd filter plate, rest of papillae clustered near median notch; median notch distinct, deep, surrounded by rounded papillae; broad zone of secretory pits along entire free edge and completely covering marginal papillae.

Pharyngeal Cavity: Branchial baskets oval, almost round; fairly large, each branchial basket about $\frac{1}{2}$ remaining buccal floor area; 60% as deep as wide. Only 2 filter cavities per side, subequal in size—dorsal margin (top) of 3rd filter plate abutting directly with ventral margin (bottom) of 4th filter plate, therefore no filter rows on medial side of 3rd filter plate, nor any 3rd filter cavity; branchial baskets obliquely oriented from midline; dorsal edges of 2nd and 3rd filter plates slightly curved downward, dorsal edge of 4th filter plate arching acutely upward towards glottis; filter plates twice as long as high, no imbrication; cb 1 with 8 filter rows, cb 2 with 11, cb 3 with 11, cb 4 with 9. Filter mesh dense; intricately folded with tertiary and higher order folds. Filter rows of average width, 80%–100% abutting; filter canals narrower than filter rows, 80%–100% canopied. Well-developed branchial food traps, extending $\frac{1}{3}$ distance into front of filter cavities; secretory ridges numerous, narrow, occasionally discontinuous, of uniform width. Glottis 100% visible from above; open; lips narrow; laryngeal disk not visible. Esophageal funnel relatively narrow.

DORSAL ASPECT.—*Buccal Cavity:* Roof of mouth elongate, trapezoid-shaped; nares 20% distance from front of mouth to esophagus; median ridge 40% distance from front of mouth to esophagus. Prenarial arena with transversely oriented shelf, shelf with rounded lateral edges in mid-arena. Nares large; internarial distance just less than width of naris; nares oriented transversely; anterior narial wall not thickened, but with jagged free edge; no prenarial papillae; posterior narial wall a thin flap with a weak narial-valve projection. Postnarial arena a triangular-shaped zone bounded by 3 papillae along anterior

and lateral edges and by median ridge posteriorly; postnarial papillae conical with flattened and roughened anterior edges, largest papilla the most posterolateral on each side. Median ridge a moderately large, triangular flap with a deeply forked apex. Lateral-ridge papillae in a line with postnarial papillae and directly lateral to median ridge; papillae small, laterally compressed flaps with distinct apex and regular anterior free edges. BRA a narrow elongate oval defined by 6–8 relatively uniform, simple, attenuate papillae on each side. An even, dense field of pustulations within BRA and a small papilla in middle of arena; five papillae in an anteromedial to posterolateral row on lateral edge of buccal roof on each side. Glandular zone with distinct and relatively smooth, V-shaped, anterior edge with apex directed posteriorly; near midline, zone about $\frac{1}{8}$ length of buccal roof and twice that laterally; large and dense secretory pits along anterior edge of glandular zone. Dorsal velum broadly interrupted medially, with faint papillae just along medial terminus; otherwise velum with smooth, straight edge.

Pharyngeal Cavity: Two nearly oval-shaped pressure cushions per side; more anterior and lateral pressure cushion smaller, more posterior and lateral pressure cushion 2–3 times as large. Ciliary groove of average dimensions.

Caudiverbera caudiverbera (Linnaeus)

FIGURE 7

MATERIAL.—KU 162056 (one specimen dissected, stage 39, SVL 45.0 mm). Collected from 19 km S. Parral (Río Perquilauquen), Linares, Chile.

REFERENCE.—Ceï (1962) described and figured the larva (as *Calyptocephalella gayi*).

GENERAL REMARKS.—Internal anatomy not well preserved, precluding evaluation of certain features. Keratinized mouthparts fell off during specimen examination. Fresh water clam shell in gill filaments. Lungs moderate-sized, about 30% longer than length of buccal floor; inflated.

VENTRAL ASPECT.—*Buccal Cavity:* Floor of mouth triangular with rounded margins, wide, 30% wider than long. Four infralabial papillae; 1 pair anterior and medial, 2nd pair posterior and lateral, papillae equidistant; papillae small but tall, cylindrical with irregular margins, blunt to finely pointed. Four simple lingual papillae in straight transverse row. BFA an elongate oval, open anteriorly; BFA defined by 10–15 papillae on each side; BFA papillae small, thin, conical; larger papillae with some curvature and rugosities, not bifurcate. No prepocket papillae. Dense field of pustulations in posterior $\frac{1}{3}$ of BFA and anterior to buccal pockets. Buccal pockets small, 4 times as wide as long; oriented about 30° from transverse plane; perforated. Free velar surface of typical tadpole proportions, total area about 30% rest of buccal floor; conspicuous spicular support; spicules relatively thin; posterior velar margin gently curved except medially where disrupted by irregular papillae; small irregular peaks over filter cavities,

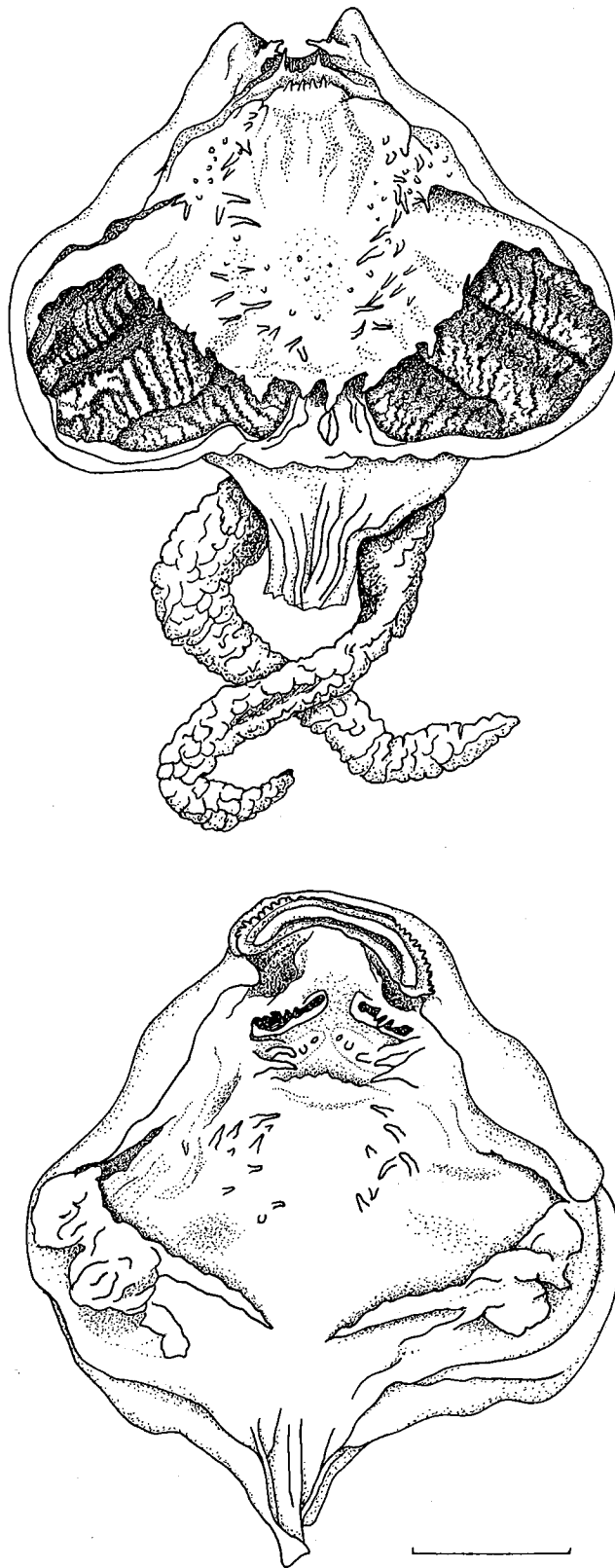


FIGURE 7.—Camera lucida drawings of floor (above) and roof (below) of oral cavity of *Caudiverbera caudiverbera*; scale line = 5 mm.

3 projections per side including those bounding median notch; median notch deep, surrounded by 2 conical projections; secretory pits present, pattern indeterminate due to poor preservation.

Pharyngeal Cavity: Branchial baskets about as long as wide, round, large, each about 70% buccal area, almost as deep as wide. Filter cavities subequal in size. Second dorsal plate with straight dorsal margin, 3rd dorsal plate with upwardly arched dorsal margin, 2nd plate twice as long as tall, 3rd plate 30% longer than tall; slightly imbricated; cb 1 with 12 filter rows, cb 2 with 12, cb 3 with 12, cb 4 with 11. Filter mesh relatively dense; filter rows not abutting; rows complexly folded, some very wide; filter canals $\frac{2}{3}$ width of rows, 50%–80% canopied. Branchial food traps present, details indeterminable due to poor preservation; secretory ridges wide and ill-defined. Glottis small but open; fully exposed; lips indistinct; vaguely definable laryngeal disk. Esophageal funnel relatively narrow.

DORSAL ASPECT.—Buccal Cavity: Roof of mouth triangular, slightly wider than long; nares about 20% distance from front of mouth to esophagus; median ridge about 30% distance from front of mouth to esophagus. Small, vague, anteriorly directed V-shaped swelling descending ventrally from prenarial arena. Nares large; internarial distance relatively short, about 60% length of naris; 45° orientation from transverse plane; anterior narial wall thin with series of 3 or 4 small, simple, posteriorly directed papillae arising from midportion of anterior wall; posterior narial wall with slight narial-valve projection. Postnarial arena poorly defined triangular area bounded by 3 papillae on one side, 2 on other and a few pustulations; small and simple postnarial papillae located $\frac{1}{2}$ distance between median ridge and nares. Median ridge with arched free edge; very wide, about 3 times as wide as tall; very faint sculpturing on free ventral edge; anterior surface relatively smooth. Lateral-ridge papillae conical, slightly compressed laterally with pointed apices each $\frac{1}{3}$ size of median ridge. BRA vague, poorly defined U; about 6–10 BRA papillae on each side, papillae all small, simple, irregular. Few pustulations lateral and posterior to BRA. Glandular zone indeterminate due to poor preservation. Dorsal velum of average length; average-sized midline gap; margin lacking papillae.

Pharyngeal Cavity: Two distinct, round, subequal pressure cushions. Ciliary groove very broad.

Ceratophrys aurita (Raddi)

FIGURE 8

MATERIAL.—USNM 241298 (one specimen dissected, stage 31, SVL 16.3 mm). Collected from a temporary pond at Fazenda do Veado, Serra da Bocaina, São Paulo, Brazil, 3 January 1977, by W.R. Heyer.

REFERENCE.—The external morphology of this tadpole has not been described previously. Briefly: spiracle sinistral; anus median, separate from tail fin, lying to left or right of fin;

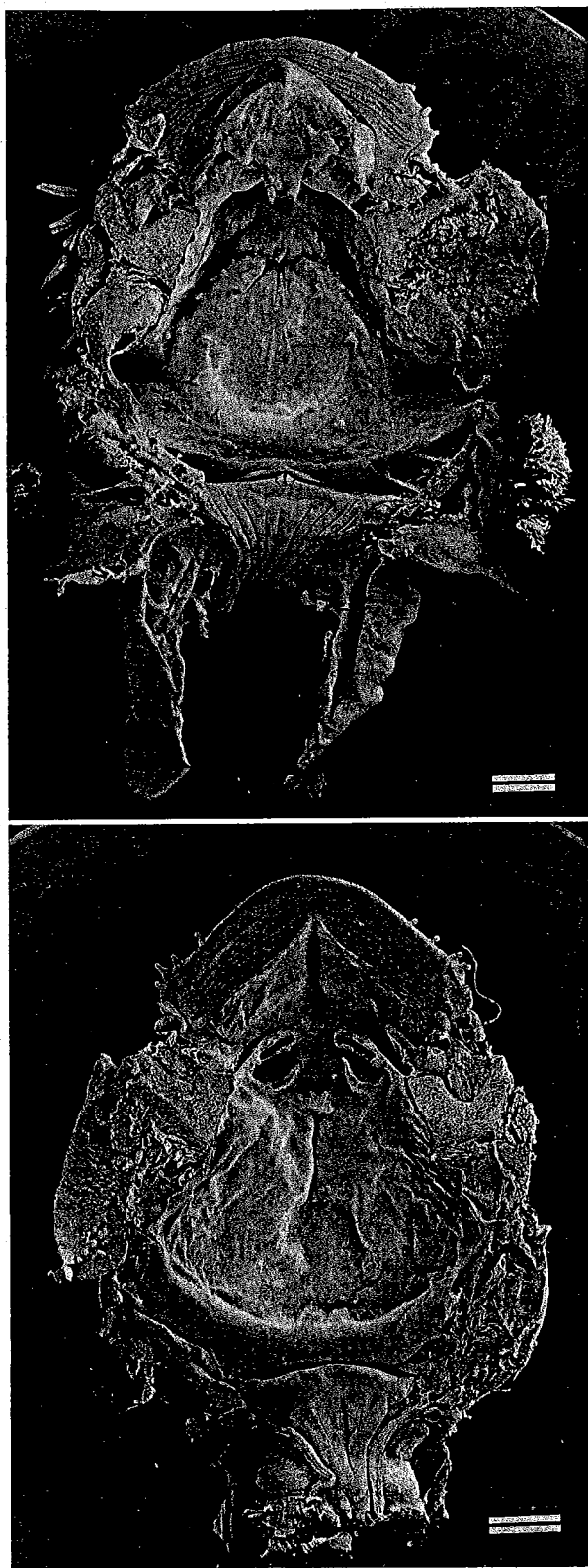


FIGURE 8.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Ceratophrys aurita*; scale lines = 1 mm.

mouthparts anteriorly directed; oral disk not emarginate, single row of marginal papillae interrupted anteriorly; denticle formula 7-8 (5-8)/8-9 (1-6); overall habitus stout, that of pond dwelling carnivorous tadpole (Orton, 1953).

GENERAL REMARKS.—Extensive, luxuriant gill filaments. Lungs of average size, almost equal in length to maximum width of mouth.

VENTRAL ASPECT.—*Buccal Cavity:* Floor of mouth bell-shaped, narrow anteriorly, 10% longer than wide. Three flattened infralabial papillae; 1 papilla transversely oriented on midline with a V cut into its free edge; other 2 papillae anterolateral to this median papilla, lateral papillae obliquely oriented triangular flaps with jagged anterior edges. Two small, simple, lingual papillae. BFA oval; defined by 5 evenly spaced, small, conical papillae with constricted apices, papillae of similar size. Three or four tiny prepocket papules. No papillae or pustulations elsewhere on buccal floor. Buccal pockets small, shallow, horizontally oriented, not perforated. Free velar surface short, largely limited to area over 1st filter cavity; no spicular support; posterior margin smooth, lacking sculpturing/papillation; medial $\frac{2}{3}$ of ventral velum margin thickened and curved dorsally; median notch extremely broad, $\frac{1}{4}$ – $\frac{1}{5}$ width of entire velar surface; no secretory pits.

Pharyngeal Cavity: Branchial baskets extremely small, comma-shaped, only covered by ventral velum laterally, 30% wider than long; each branchial basket approximately $\frac{1}{8}$ – $\frac{1}{10}$ remaining area of buccal floor in dorsal view, no depth to medial $\frac{2}{3}$ of branchial baskets. First filter cavity 6 times as wide as deep; straight dorsal edge on filter plates; cb 1 with 3 filter rows on one side, cb 2 with 5, cb 3 with 3, cb 4 with 3. Filter folds not developed beyond irregular ridge; some secondary but no tertiary folds; no filter rows abutting; filter canals fully exposed, canals equal to or wider than filter rows; gill filaments visible dorsally, coming up through gill slits in 2nd and 3rd gill cavities. No branchial food traps. Glottis fully exposed; small but distinct; antero-posteriorly directed; open, with small but distinct lips on a very wide but ill-defined laryngeal disc. Esophageal funnel of average profile, but esophagus very wide in diameter.

DORSAL ASPECT.—*Buccal Cavity:* Nares far anterior; median ridge about 30% distance from front of mouth to esophagus. Prenarial arena small, bare. Nares large, oblique; anterior wall of average height, slightly thickened both anteromedially and posterolaterally, with some marginal sculpturing, but no distinct papillae; posterior narial wall as tall as wide with a deep sulcus posterior to it; posterior wall thin, with small medial projection on each side. Single postnarial papilla about halfway between midline and posterior limit of nares, conical, slightly flattened in antero-posterior plane with 1 major and 1 minor cusp; apices directed anteriorly. Median ridge small, but tall, crescent with a jagged free margin; largely smooth anterior surface. No lateral-ridge papillae. No BRA papillae. Scattered pustulations medially on buccal roof; pustulations and papillae absent elsewhere on buccal roof. No

glandular zone. Dorsal velum effectively absent, definitely absent on midline.

Pharyngeal Cavity: Two elongate but very shallow pressure cushions associated with 1st and 2nd filter cavities. Ciliary groove very shallow and narrow, cilia present.

Crossodactylodes species

FIGURE 9

MATERIAL.—USNM 241308 (one specimen dissected, stage 30, SVL 7.8 mm). Collected from an arboreal bromeliad at Santa Tereza, Espírito Santo, Brazil, 9 October 1980, by E. Izecksohn and O.L. Peixoto.

REFERENCES.—Peixoto (1981) described and figured the external morphology and provided habitat data for this species as *C. pinto*. Later, Peixoto (1983) determined that the description pertains to either *C. bokermanni* or *izecksohni*, not *pinto*.

GENERAL REMARKS.—Lungs short, unequal in size, smallest about $\frac{2}{3}$ length of buccal floor, largest about equal in length to buccal floor; expanded, sac-like, lacking obvious septation except at caudal end.

VENTRAL ASPECT.—**Buccal Cavity:** Floor of mouth triangular, about 20% wider than long. Three small, conical, short infralabial papillae in a transverse row on each side far anterior; 1 large, hand-like papilla posterior to smaller papillae on each side with long, wrist-like base and short, stubby, finger-like terminal bifurcations, "fingers" touching on midline; at least 2 more papillae anterior to base of larger, more posterior pair. Four tall, thin, lingual papillae arranged in an anteriorly directed arc with medial pair larger than lateral pair. BFA V-shaped; 10 BFA papillae per side, all relatively simple, tall, thin, attenuate, slightly curved, medially directed, some shorter, but mostly uniform in size, not bifurcate. No prepocket papillae. Extensive pustulation within BRA and directly lateral to it both anteriorly and posteriorly. Buccal pockets shallow, less than 50% wider than long, transversely oriented, perforated(?). Free velar surface short; no spicular support; posterior margin recurved; no marginal peaks; weak median notch; scattered, small, secretory pits.

Pharyngeal Cavity: Branchial baskets slightly wider than long, transversely oval; each branchial basket about 50% remaining area of buccal floor; as deep as long; 2nd and 3rd filter cavities forming single common cavity subequal in size to other filter cavity. Dorsal edge of abutting 2nd and 3rd filter plates bowed down sharply; 2nd filter plate 3 times as long as tall, 3rd filter plate 5–6 times as long as tall; 2nd plate tipped 45°, lateral portion of 3rd plate horizontal, medial portion vertical; cb 1 with at least 11 filter rows, cb 2 with 14, cb 3 with 9, cb 4 with 8. Filter mesh slight; secondary folds barely developed, no higher order folds. Filter rows very narrow, filter canals wider than rows; no filter rows abutting, all filter canals exposed. Secretory cells oriented longitudinally but not organized into distinct secretory ridges. Glottis open; 50%

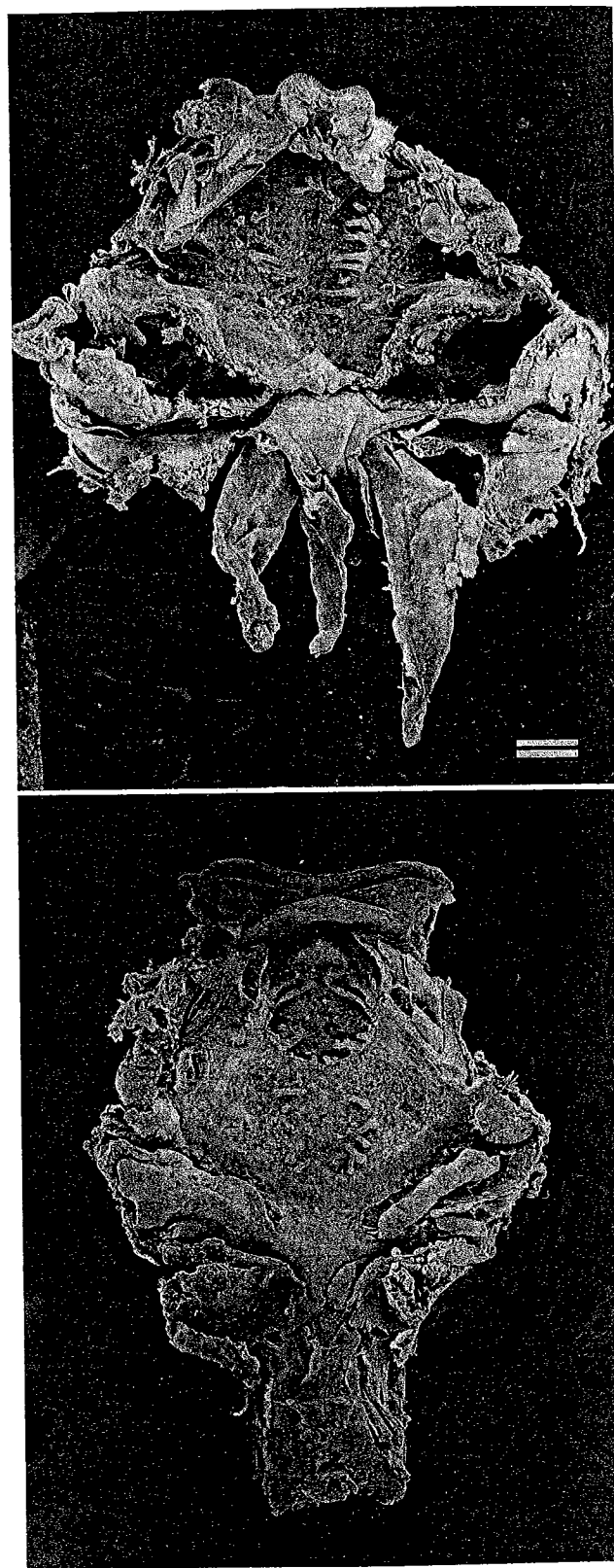


FIGURE 9.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Crossodactylodes* species; scale line = 400 μ m.

covered by ventral velum; very slight lips on broad laryngeal disk. Esophageal funnel of average proportions.

DORSAL ASPECT.—*Buccal Cavity*: Roof of mouth diamond-shaped, 20% wider than long; nares about 25% distance from front of mouth to esophagus; median ridge 40%–50% distance from front of mouth to esophagus. Anteriorly bowed, shallow ridge with irregular ventral margin descending from prenarial arena. Nares very large, internarial distance very small, less than $\frac{1}{5}$ length of naris; 45° – 50° orientation from transverse plane; anterior and posterior narial walls unusual in lacking projections. Postnarial arena an equilateral triangle bounded by row of 2 or 3 very small, postnarial arena papillae plus row of pustulations in line with them anteriorly; half dozen pustulations scattered about postnarial arena. Median ridge very shallow and wide, extending on each side laterally to base of lateral-ridge papillae; 4 times as wide as tall; with sculptured free edge and 2 particularly distinct marginal papillae near midline. Two lateral-ridge papillae per side in direct transverse line with median ridge; medial papilla on each side larger, with irregular rugose surface, not bifurcate; lateral papilla on each side simple, attenuate cone. BRA elongate, U-shaped; bounded by 4 simple, attenuate papillae on one side, 5 on other; BRA papillae relatively uniform in size, most posterior smallest, not bifurcate. Pustulations scattered rather evenly within entire BRA; few pustulations extending just lateral to posterior end of BRA. Glandular zone ill-defined with scattered secretory pits. Dorsal velum of average length; broadly interrupted on midline; no marginal papillation.

Pharyngeal Cavity: Two pressure cushions per side, lateral larger and more oval, medial smaller and poorly defined. Ciliary groove broad and shallow.

Crossodactylus gaudichaudii Duméril and Bibron

FIGURE 10

MATERIAL.—USNM 241310 (one specimen dissected, stage 38, SVL 17.7 mm). Collected from São Gonçalo, Paraty, Rio de Janeiro, Brazil, 7 April 1979, by E. Izecksohn, C.A.G. da Cruz, and O.L. Peixoto.

REFERENCE.—The external morphology has apparently not been described or figured. The larva is externally very similar to that of *C. dispar* (see "Reference" for *C. schmidtii*).

GENERAL REMARKS.—Entrance to mouth narrow; jaws strongly serrate, overlapping. Lungs of unequal size; longer one about equal in length to buccal floor, shorter one about 70% length of buccal floor; not inflated.

VENTRAL ASPECT.—*Buccal Cavity*: Floor of mouth triangular, length about equal to width. Four infralabial papillae; 2 anterolateral papillae elaborate branching structures with many long, rugose, attenuate fingers; fingers abutting on midline and pointing anteriorly out of oral cavity; more posterior pair simple, straight blunt papillae lacking rugosity and bifurcations, pointing dorsally and abutting on midline (Figure 52b).



FIGURE 10.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Crossodactylus gaudichaudii*; scale line = 1 mm.

Four lingual papillae arranged in forward-arching row; subequal, bifurcate, attenuate, with knobby apices. BFA an elongate oval defined by 30–40 tall papillae on each side extending forward to tongue anlage; BFA papillae mostly having attenuate, pointed apices, largest 2 papillae arising from common base directly medial to buccal pockets, not bifurcated; very dense posteriorly. Cluster of about 6 pustulations or papillae directly anterior to buccal pockets. At least a dozen papillae in medial portion of BFA continuous with rows of BFA papillae; cluster of 5 or 6 papillae posteromedial to buccal pockets. Buccal pockets relatively small, 3 times as wide as long; transversely oriented; perforated. Free velar surface long; conspicuous spicular support; posterior margin semicircular with small peak far laterally over edge of 2nd filter plate directed posterolaterally, larger peak over free edge of 3rd filter plate directed posteromedially, remaining midportion very extensively but irregularly sculptured with many knobby processes; median notch broad but shallow; secretory pits conspicuous on marginal papillae of ventral velum but between papillae limited to thin posterior band.

Pharyngeal Cavity: Branchial baskets triangular in shape, about as long as wide; each branchial basket equal to slightly more than 50% of remaining buccal floor area; branchial baskets very shallow, deepest part located laterally, depth $\frac{1}{5}$ width of branchial basket; 2nd filter cavity largest; 1st 50% size of 2nd, 3rd barely visible under free edge of ventral velum and 3rd filter plate about $\frac{1}{10}$ size of 2nd. Second filter plate with straight dorsal edge; edge of 3rd filter plate arching up gently, but largely hidden by ventral velum; 2nd and 3rd filter plates about twice as long as tall, tipped more than 45° from vertical; cb 1 with 9 filter rows, cb 2 with 10, cb 3 with 8, cb 4 with 5. Filter mesh not particularly dense; abundant secondary and some tertiary folding, little higher order folding. Filter rows not abutting, very uneven in size, of particularly low density medially. Filter canals ranging from less than 60% width of filter rows and about 80% canopied to twice width of filter rows and 80%–90% exposed. Branchial food traps shallow; well-developed secretory ridges in straight, even rows. Glottis open; 60% covered by ventral velum; small; lips narrow, thin; laryngeal disk broad but faintly defined. Esophageal funnel very broad, average size.

DORSAL ASPECT.—Buccal Cavity: Roof of mouth diamond-shaped, 15%–20% longer than wide; nares about 25% distance from front of mouth to esophagus; median ridge about 40% distance from front of mouth to esophagus. Prenarial arena with some faint longitudinal folding, but no distinct depressions or projections. Nares long; internarial distance short, about 30% length of naris; nares oriented 45° from midline; anterior wall simple although a tall, anteriorly pointing, curved, rugose papilla arising just ventral to midpoint of narial wall on each side; posterior narial wall curving gently downward, but no distinct narial-valve projection. Postnarial arena defined by dense row of 10–15 papillae on each side beginning as simple structures anteriorly and increasing in size posteriorly, rows running longitudinally to point about $\frac{1}{2}$ distance between

nares and median ridge, then papillar rows turning sharply lateral extending as far as base of lateral-ridge papillae; larger postnarial papillae with serrated anterior margins. Median ridge of average size; very serrated free edge; rugose surfaces. Lateral-ridge papillae elaborate laterally compressed flaps with long, finger-like projections pointing medially; 4 per side; some with terminal, attenuate bifurcations. Field of pustulations just lateral to anterior clusters of postnarial papillae; 2 small, blunt, subequal papillae in transverse row in front of median ridge in postnarial arena. BRA elongate rectangle defined by 30–40 attenuate, tall papillae of varying size on each side; a particularly dense cluster of small papillae defining posterior limit of BRA; many BRA papillae with twisted apices and rugosities, only 1 or 2 bifurcate. Continuous dense field of pustulations and small, conical, blunt papillae within BRA; at least half dozen attenuate papillae on lateral limit of buccal roof on each side, continuous as band posterolaterally merging with most posterior BRA papillae. Glandular zone of average length; well defined along anterior edge; medially with large secretory pits of unusually low density, continuing onto ventral surface of dorsal velum. Dorsal velum of average length; broadly interrupted medially; medial margins curving posteriorly towards esophagus; middle half of dorsal velum on each side with dorsoventrally flattened papillate fringe.

Pharyngeal Cavity: Pair of weakly defined pressure cushions, more lateral about 3 times size of more medial. Ciliary groove very broad and very shallow.

Crossodactylus schmidti Gallardo

FIGURE 11

MATERIAL.—USNM 253671 (one specimen dissected, stage 33, SVL 20.9 mm). Collected from a stream at Hotel El Tirol, 19.5 km by road NNE Encarnación, Itapúa, Paraguay, 14 November 1976, by Mercedes S. Foster.

REFERENCE.—Ceï (1980) described the tadpole and stated that it was very similar to the species he illustrated, *C. dispar*.

GENERAL REMARKS.—Only those features that differ from *C. gaudichaudii* are described. Lungs smaller than in *C. gaudichaudii*.

VENTRAL ASPECT.—Buccal Cavity: Smaller, more medial pair of infralabial papillae with rugosities. Medial pair of lingual papillae about twice as large as lateral pair, simpler than in *C. gaudichaudii*, lacking knobby apices. BFA with 25–35 papillae on each side. About 3 or 4 pustulations/papillae directly anterior to buccal pockets. Midportion of posterior margin of free velar surface jagged, with longer peaks than in *C. gaudichaudii*; median notch very deep; posterior velar margin on each side of median notch overlapping.

Pharyngeal Cavity: Second filter plate with slightly curved-downward, dorsal edge; 2nd and 3rd filter plates not as horizontal as in *C. gaudichaudii*; cb 1 with 10 filter rows, cb 2 with 10, cb 3 with 9, cb 4 with 6. Filter mesh denser, abundant tertiary folding. Some filter rows abutting ventrally, rows of more or less even size. Filter canals more canopied



FIGURE 11.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Crossodactylus schmidtii*; scale line = 1 mm.

than in *C. gaudichaudii*. Glottis fully covered by ventral velum.

DORSAL ASPECT.—Buccal Cavity: Median ridge about 50% distance from front of mouth to esophagus. Anterior narial wall with 1 large attenuate papilla plus small papilla anterior to large papilla. Lateral-ridge papillae with 4–6 long, finger-like projections with apices closer on midline than in *C. gaudichaudii*. Double row of postnarial papillae running parallel to oblique nares on each side, largest papillae posterior and lateral, grading into pustulations anteriorly, most medial row with largest papillae, approximately total of 9 papillae on either side in addition to 3 papillae in a more posterior triangular array directly in front of median ridge. BRA defined by 20–30 papillae on each side. BRA papillae simpler than in *C. gaudichaudii*, not as rugose, none bifurcate. About 4 papillae on lateral limit of buccal roof, isolated from BRA papillae. Dorsal velum shorter than in *C. gaudichaudii*; medial margins not curving as greatly towards esophagus.

Pharyngeal Cavity: Two pair of roundish pressure cushions, medial cushion 50% larger than lateral cushion.

Crossodactylus species

FIGURE 12

MATERIAL.—USNM 241309 (one specimen dissected, stage 36, SVL 16.3 mm). Collected from São Gonçalo Paraty, Rio de Janeiro, 7 April 1979, by E. Izecksohn, C.A.G. Cruz, and O.L. Peixoto.

GENERAL REMARKS.—This larva is like that of *C. dispar*, but adult *dispar* were not collected at this locality (Peixoto, pers. comm.). Only those features that differ from *C. gaudichaudii* are described. Lungs smaller than in *C. gaudichaudii*; longer of the two lungs about 40% length of buccal floor.

VENTRAL ASPECT.—Buccal Cavity: More posterior pair of infralabial papillae not as simple, with more rugose tips than in *C. gaudichaudii*.

Pharyngeal Cavity: Ceratobranchial 1 with 11 filter rows, cb 2 with 11, cb 3 with 10, cb 4 with 5.

DORSAL ASPECT.—Buccal Cavity: Median ridge wider than in *C. gaudichaudii*.

Cycloramphus stejnegeri (Noble)

MATERIAL.—USNM 209370 (one specimen dissected, stage 31, SVL 7.5 mm). Collected from under a log beside a stream with an attendant female near Teresópolis, Rio de Janeiro, Brazil, 10 December 1977. The specimen disintegrated during preparation for SEM; no figure is available.

REFERENCE.—The external morphology and ecological habitat were described by Heyer and Crombie, 1979 (as *Craspedoglossa stejnegeri*).

REMARK.—*Cycloramphus stejnegeri* has terrestrial, non-feeding larvae (Heyer and Crombie, 1979).

VENTRAL ASPECT.—Buccal Cavity: Floor of mouth slightly wider than long. Large, globose, infralabial papillae with



FIGURE 12.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Crossodactylus* species; scale line = 1 mm.

elevated anteriorly directed edge; 1 on each side. One pustulation on each side in position of lingual papilla. BFA tear-drop shaped; no BFA papillae, but several pustulations defining the arena; 2 largest pustulations anterior to buccal pockets. No prepocket papillae. Rest of buccal floor lacking papillae or pustulations. Very shallow buccal pockets, about twice as long as wide; obliquely oriented; not perforated. Free velar surface relatively long, about 20%–25% area of rest of buccal floor; no spicules visible in free velar surface; posterior margin of ventral velum wavy, lacking distinct peaks over filter cavities; very shallow median notch. Thickened epithelium with buff-like texture on posterior margin of ventral velum characteristic of glandular tissue, but individual secretory pits not visible under light microscopy.

Pharyngeal Cavity: Branchial baskets small, round in dorsal profile; total branchial basket area about 40% of buccal area; branchial baskets extremely shallow, 1 small common filter cavity. Filter plates with straight dorsal edges, filter plates 2–3 times as long as tall with slight imbrication; cb 1 with 1–3 filter rows, cb 2 with 4, cb 3 with 4, cb 4 with 3. Filter mesh reduced; filter rows consisting of single simple knobs; no filter folds; no filter rows abutting. Branchial food trap area extensive, but no filter ridges evident under light microscopy. No glottis evident. Esophageal funnel narrow; esophagus huge.

DORSAL ASPECT.—Buccal Cavity: Roof of mouth triangular, about 20% longer than wide; nares lying about 20% distance from front of mouth to esophagus; presumed median ridge (present as a pustule only) midway between front of mouth and esophagus. Prenarial arena lacking papillae, pustules, or ridges. Nares small, very close to each other on midline; nares obliquely oriented from transverse plane; anterior narial wall shallow, poorly defined, lacking papillae; postnarial wall about 5 times as long as wide; no narial-valve projection. No postnarial papillae. Single median pustulation in median-ridge position. One short, squat, unbifurcated, lateral-ridge papilla on each side. BRA absent; no BRA papillae; few scattered pustulations over medial and posterior portion of buccal roof. No obvious glandular zone or concentration of secretory tissue characteristic of a glandular zone. Dorsal velum short; broadly interrupted; lacking marginal papillation.

Pharyngeal Cavity: Single, small, oval, pressure cushion arising from dorsal velum. No obvious ciliary groove.

Eleutherodactylus species

FIGURE 13

MATERIAL.—No number (one specimen dissected, stage 37, total length 4.3 mm). No data, gift from University of Southern California.

GENERAL REMARKS.—Small lung buds present.

VENTRAL ASPECT.—Buccal Cavity: Floor of mouth an elongate oval. All buccal floor and roof papillation, as well as branchial food traps and gill filters and other such structures

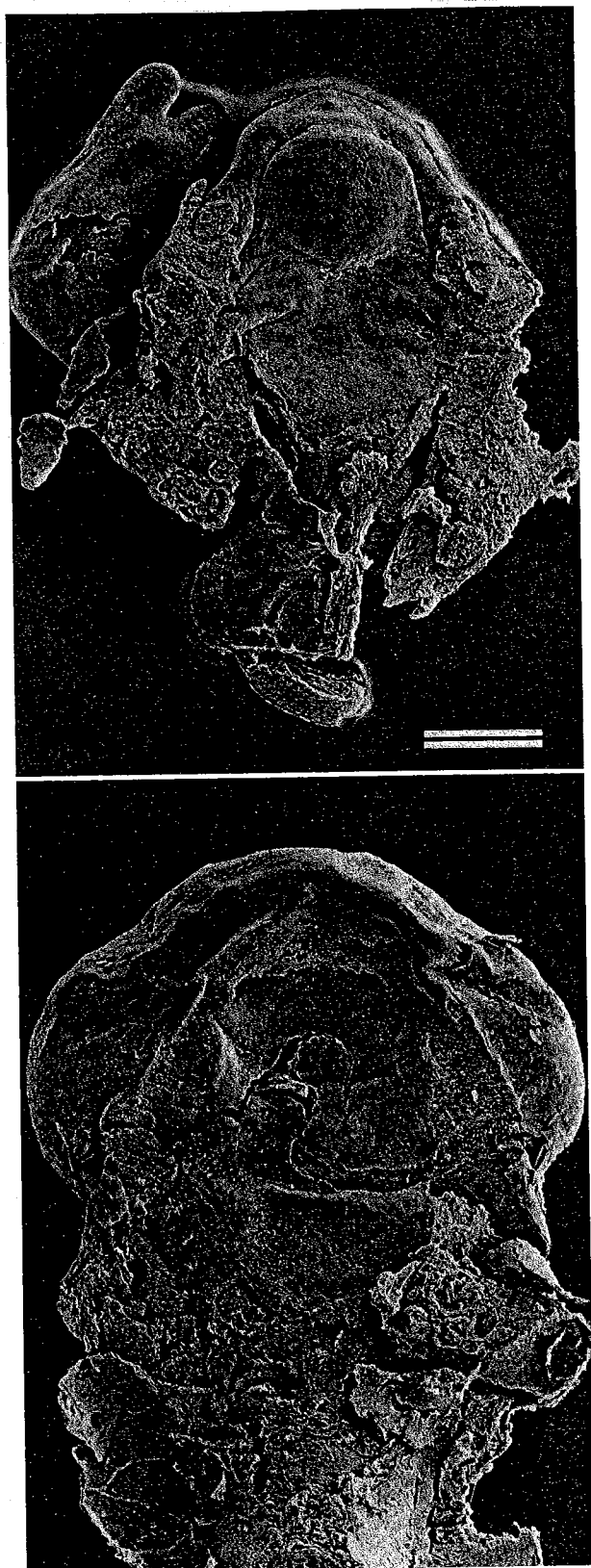


FIGURE 13.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Eleutherodactylus* species; scale line = 400 μ m.

associated with a larval way of life, absent. Mouth wide and arch of jaw filled with developing tongue.

Pharyngeal Cavity: Three naked gill slits visible. No glottis visible. Esophageal funnel broad, esophagus of broad diameter.

DORSAL ASPECT.—Buccal Cavity: Single medial egg tooth visible on upper jaw. Internal nares oblique elongate ovals lacking valves. Rest of buccal roof smooth, free of topographic relief.

Eupsophus roseus (Duméril and Bibron)

FIGURE 14

MATERIAL.—KU 162057 (one specimen dissected, stage 29, SVL 14.9mm). Collected from 11 km W Angol (Arroy Los Lleulles), 710 m, Malleco, Chile.

REFERENCE.—Ceï (1980:283, fig. 111 I,J) described the larva.

GENERAL REMARKS.—Beaks torn off in dissection.

VENTRAL ASPECT.—Buccal Cavity: Floor of mouth roundish. Four infralabial papillae in a transverse row; subequal in size; lateral pair anteroposteriorly flattened; all papillae with rugose anterior surfaces. Four tall, attenuate, lingual papillae in transverse arch; anteromedial pair twice as long as posterolateral pair. BFA V-shaped, defined by 20–30 papillae on each side; BFA papillae small to medium in size, attenuate. Large cluster of 8–12 prepocket papillae merging medially with row of BFA papillae. Cluster of 10–12 cylindrical, blunt, subequal papillae in middle of buccal floor. Buccal pockets very wide, about 5 times as wide as long, moderately deep; pockets transversely oriented (no perforation data available). Free velar surface of average extent, each side about 20% rest of buccal floor area; velum with spicular support; posterior margin with broad V-shape overall, but extensively crenulate with distinctive peaks over the top of each filter plate; median notch asymmetrical, broad; small secretory pits visible in uniform, thickened band along margin of velum.

Pharyngeal Cavity: Branchial baskets transverse ovals, about 20% wider than long; each branchial basket about 60% remainder of buccal floor area, $\frac{1}{2}$ as deep as wide. First and 2nd filter cavities subequal, 3rd $\frac{1}{2}$ size of first two; oriented obliquely; dorsal edge of 2nd filter plate relatively straight, dorsal edge of 3rd filter plate curving upward and covering about $\frac{1}{3}$ of the 3rd filter cavity; 2nd filter plate about 30% longer than tall, 3rd filter plate as long as tall; filter plates tipped about 45° from horizontal plane; cb 1 with 8 filter rows, cb 2 with 10, cb 3 with 11, cb 4 with 10. Filter mesh very dense with many tertiary folds; filter row width variable, not particularly wide; filter rows all abutting or nearly so; filter canals almost as wide as filter rows, nearly to fully canopied. Branchial food traps distinct with well-developed, narrow, secretory ridges of uniform width. Glottis open; fully exposed; lips tall but thin; laryngeal disk small and indistinct. Esophageal funnel broad.



DORSAL ASPECT.—*Buccal Cavity:* Roof of mouth relatively narrow oval; nares 25% distance from front of mouth to esophagus; median ridge 40% distance from front of mouth to esophagus. Single, large, medial papilla descending from prenarial arena; some irregular pustulations lateral to medial prenarial papilla. Nares large; internarial distance $\frac{1}{4}$ that of naris length; nearly transverse orientation; anterior narial wall slightly thickened and rugose medially; distinct, tall, posteriorly directed papilla rising from middle $\frac{1}{3}$ of anterior narial wall; posterior narial wall a thin flap with a weak narial-valve projection. Three postnarial papillae in an oblique line approximately parallel to nares on each side; postnarial papillae conical, pointed, with rugose anterior margins; most medial on each side larger than more lateral papillae. Median ridge a triangular flap with jagged anterior surface and free edge. Lateral-ridge papillae laterally compressed flaps with 2–4 marginal projections, approximately equal in size to median ridge. BRA U-shaped, defined by approximately 10 small, cylindrical, subequal papillae on each side, none bifurcate. About 12 pustulations and 6 papillae randomly scattered about BRA. Glandular zone present with distinct secretory pits, poorly defined on midline. Dorsal velum of average length, interrupted on midline, with some light sculpturing on free medial edge.

Pharyngeal Cavity: Dorsal pharynx region destroyed in dissection.

Hylodes cf. asperus (Müller)

FIGURE 15

MATERIAL.—USNM 241311 (one specimen dissected, stage 31, SVL 22.7 mm). Collected from a stream at Tijuca, Rio de Janeiro, Brazil, 17 November 1978, by O.L. Peixoto.

REFERENCE.—The *Hylodes asperus* group is in need of systematic revision. The tadpoles at hand differ in details of shape and coloration from those described and figured by Bokermann (1963), but are similar in all other aspects.

GENERAL REMARKS.—Guts containing sandy material. Beaks narrow, very extensively sculptured with distinct sharp serrations; a distinctly large median cusp on upper beak with a thickening of the beak at base of median cusp. Lung buds present but small, about $\frac{1}{2}$ length of buccal floor; not inflated. Luxuriant gill filaments.

VENTRAL ASPECT.—*Buccal Cavity:* Floor of mouth broadly triangular, 30% wider than long. Two pair of infralabial papillae in a transverse row; more medial pair small, simple, thin; lateral pair complex, multiple-branched structures completely filling space at entrance of mouth, projecting primarily medially. Two tall, thin, pointed, lingual papillae. BFA pentagonal, much longer than wide; 25–30 BFA papillae on

FIGURE 14.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Eupsophus roseus*; scale line = 1 mm.

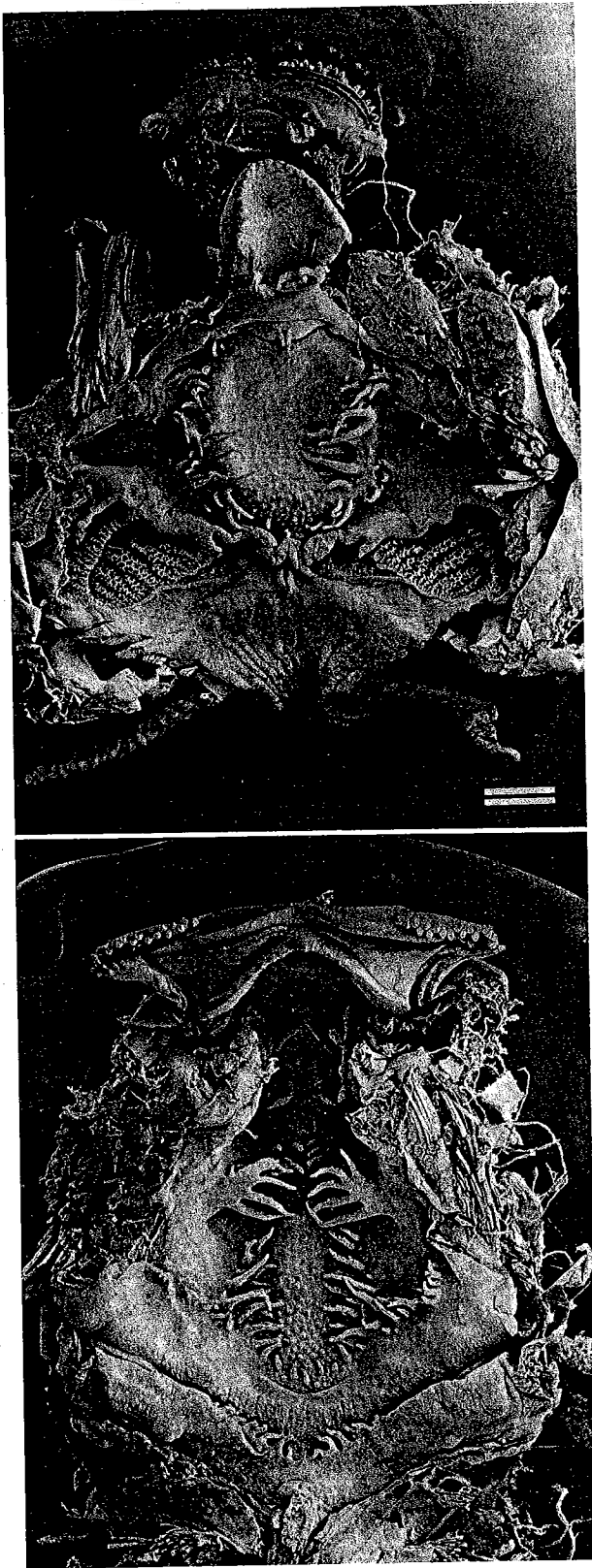


FIGURE 15.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Hylodes cf. asperus*; scale line = 1 mm.

each side defining arena; BFA papillae characteristically tall, thin, taller papillae curved; largest BFA papillae (those directly medial to buccal pockets) distinctly bifurcate, others with rugosities on anterior surfaces, but not bifurcate. Four or five prepocket papillae of various sizes on each side, like BFA papillae, curved, attenuate, pointed, with rugose anterior margins. Papillae between posterior portion of BFA and buccal pockets extending as a field laterally behind medial portion of buccal pockets; 6 papillae on each side grading into BFA papillae; pustulations everywhere on buccal floor except along posterior margin of velum and anterior to tongue anlage. Buccal pockets shallow; very long and wide, about twice as wide as long; transversely oriented; perforated. Free velar surface with irregular, very wavy, posterior margin; conspicuous spicular support, spicules thin; free velar surface with small cusp directed laterally over 2nd filter plate, larger posterolaterally directed cusp over 3rd filter plate, fringe of 7 thick papillae along midportion over larynx; median notch asymmetrical; abundant secretory pits along whole free edge of velum.

Pharyngeal Cavity: Branchial baskets 50% wider than long, shaped like isosceles triangle with small longitudinally oriented base; each branchial basket about equal to $\frac{1}{3}$ remaining area of buccal floor; baskets shallow, 5–6 times as wide as deep; 1st and 2nd filter cavities continuous, collectively 8–10 times 3rd filter cavity. Dorsal edge of 2nd plate curved downward, 3rd convex; 2nd filter plate twice as long as tall, 3rd $1\frac{1}{2}$ times as long as tall; 3rd filter cavity largely obscured in dorsal view by dorsal edge of 3rd filter plate and ventral velum; filter plates extremely tipped; cb 1 with 11 filter rows, cb 2 with 13, cb 3 with 10, cb 4 with 5. Filter mesh denser in more lateral portions of branchial baskets; larger rows with tertiary and higher order folds. Filter rows of uneven width; lateral rows tending to abut, medial rows not tending to abut. Filter canals smaller than filter rows laterally, larger than filter rows medially; 20%–100% canopied. Branchial food traps with uneven, faint secretory ridges. Glottis 40% covered by ventral velum; large; lips thin but of uniform thickness; no laryngeal disk. Esophageal funnel extremely broad.

DORSAL ASPECT.—Buccal Cavity: Roof of mouth triangular, same shape as floor; nares about 30% distance from front of mouth to esophagus; median ridge about 50% distance from front of mouth to esophagus. V-shaped shallow ridge with thickened walls pointing anteriorly in roof of prenarial arena. Nares large, close together, internarial distance about $\frac{1}{4}$ length of naris; 45° orientation from transverse plane; anterior wall simple with 2 small prenarial papillae on middle $\frac{1}{3}$ on one side, 3 on other side; posterior wall with weak narial-valve projection. Multiple rows of papillae oriented in an anteromedial to posterolateral direction defining sides of triangular postnarial arena; more medial and posterior postnarial papillae largest, those more anterior smallest, largest papillae all curved, pointing medially or posteromedially with serrated anterior

margins, postnarial papillary rows grading into pustulations anteriorly; couple of small blunt papillae within posteromedial portion of postnarial arena proper. Median ridge very small triangular structure; very gently sculptured free edge. Lateral-ridge papillae gargantuan, hand-like flaps, compressed laterally, with 5 very attenuate, finger-like projections pointing medially. BRA elongate, almost rectangular-shaped; bounded by 15–25 BRA papillae per side; BRA papillae thin, tall, with jagged margins; BRA papillae of widely varying size, 2 or 3 largest distinctly bifurcate. Distinct row of papillae on lateral portion of buccal roof on each side oriented on line running anterolaterally to posteromedially, merging posteriorly with more caudal BRA papillae; lateral-roof rows with 12–15 small very irregularly shaped papillae; dense field of pustulations within BRA proper. Glandular zone with very abrupt, wavy, anterior margin, medial secretory pits extremely large and elongated to form comb-like secretory zone, pits in this comb-like zone elongated along rostro-caudal axis, more lateral pits smaller, denser, and more randomly arranged. Dorsal velum very short, maximum length about $\frac{1}{10}$ length of buccal roof; slightly interrupted on midline; medial portion extensively papillate.

Pharyngeal Cavity: Very faint swellings in pressure cushion area. Ciliary groove narrow, laterally expanding into broad funnel.

Hylorina sylvatica Bell

FIGURE 16

MATERIAL.—KU 162054 (one specimen dissected, stage 36, SVL 24.4 mm). Collected from 25 km NE Parqua, 70 m, Llanquihue, Chile.

REFERENCE.—Cei (1980:286, fig. 111K) described and illustrated the tadpole.

GENERAL REMARKS.—Filamentous gills fine, sparse. Description prepared from SEM specimen that had some damage in preparation. Lungs of a second wet specimen about equal to length of buccal floor.

VENTRAL ASPECT.—*Buccal Cavity:* Floor of mouth diamond-shaped in dorsal view, about 20% wider than long. Two pairs of infralabial papillae in transverse row; medial pair smaller with rugose apices and anterior surfaces, more lateral pair larger and anteroposteriorly flattened. Four lingual papillae in slightly forwardly arched transverse row, medial pair larger. BFA elongate egg-shaped, bounded by 25–35 papillae on each side; BFA papillae relatively simple, attenuate, conical; largest 2 or 3 papillae on each side (immediately medial to buccal pockets) arising from common ridge-like base. Prepocket area with 10–15 scattered papillae of uneven size; all simple, conical. Region of 10–15 papillae posteromedial to buccal pocket and directly lateral to BFA, merging posteriorly with BFA papillae; about 6 anteriorly directed, conical papillae in posteromedial portion of BFA; about 100 pustulations scattered about posterior $\frac{1}{2}$ of BFA. Buccal pockets long, deep,

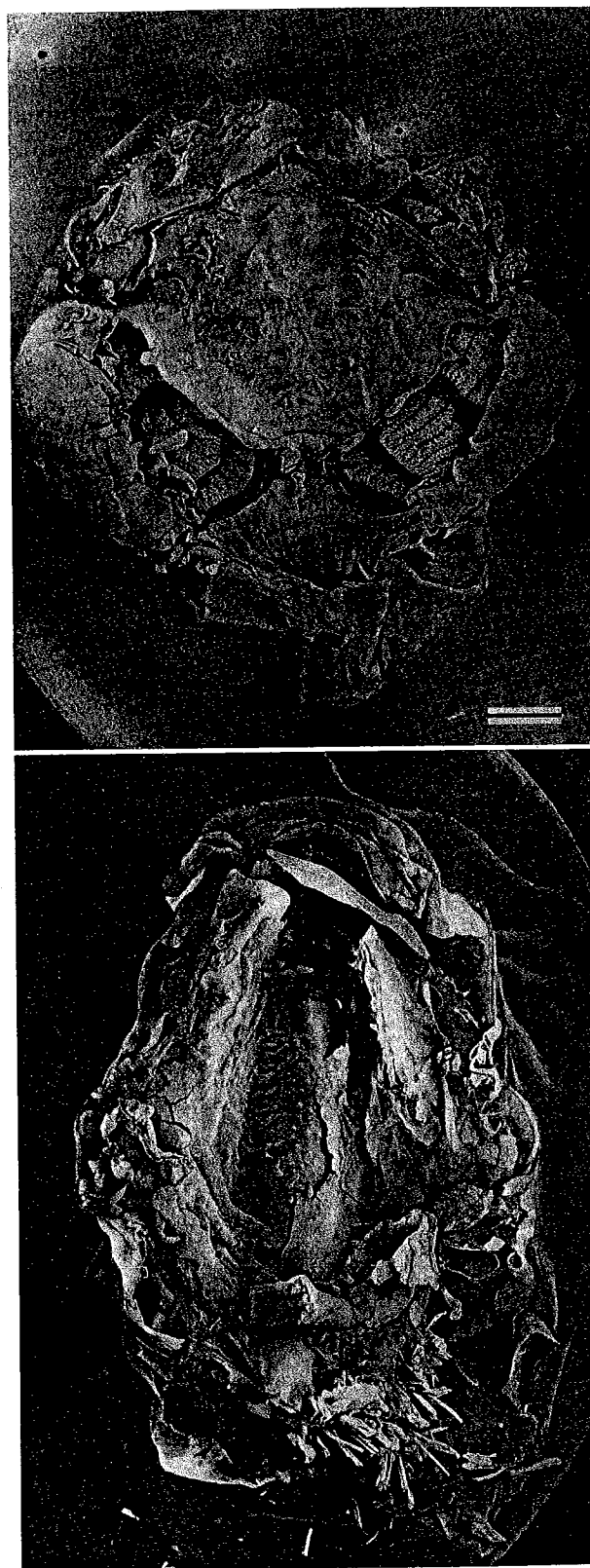


FIGURE 16.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Hylorina sylvatica*; scale line = 1 mm.

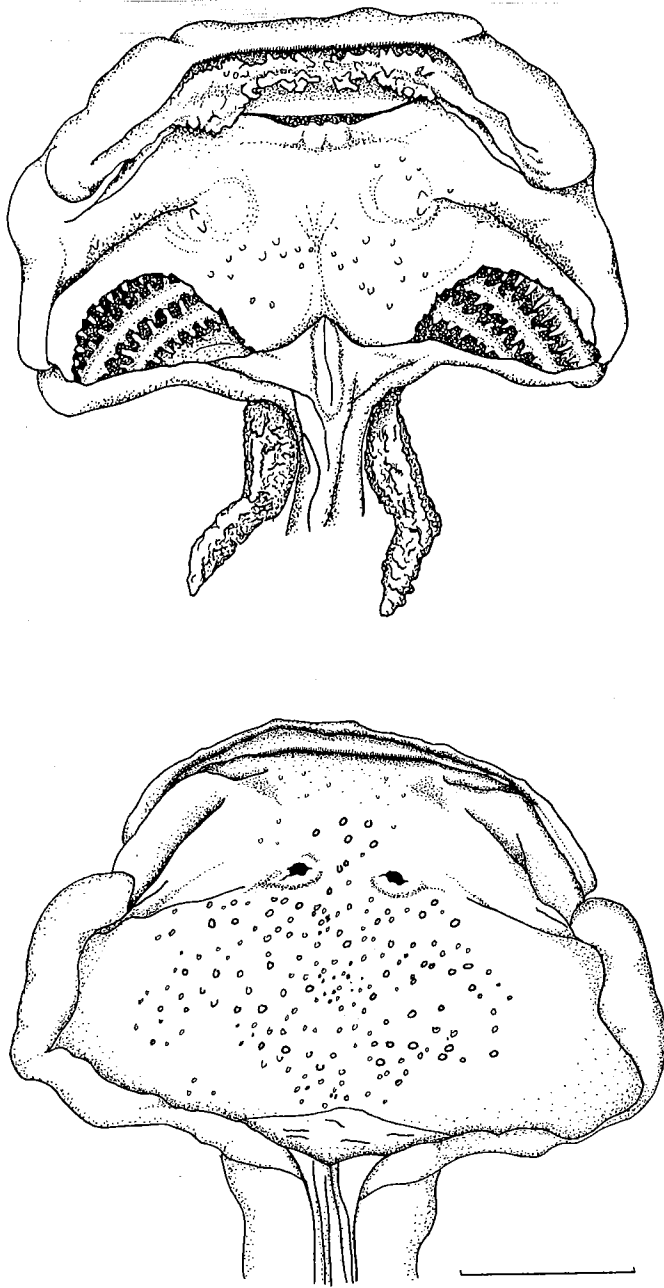


FIGURE 17.—Camera lucida drawings of floor (above) and roof (below) of oral cavity of *Lepidobatrachus laevis*; scale line = 5 mm.

3 times as wide as long; oriented 20° from transverse plane; perforation data unobtainable from specimen. Free velar surface of average length; well supported by spicules; bow-shaped edge with 3 distinct peaks on each side over 2nd, 3rd, and 4th filter plates respectively; broad, distinct, median notch bounded on each side by rounded cusp; no additional sculpturing on edge; secretory pits along margin and cusps.

Pharyngeal Cavity: Branchial baskets as long as wide, long axis anterolateral to posteromedial; each branchial basket

about 50% remaining buccal floor area; branchial baskets about as deep as wide. Second filter cavity about 25% larger than 3rd, about 45° orientation from midline. Second filter plate with relatively straight dorsal edge, 3rd filter plate with slightly upward curving dorsal edge; 1st, 2nd, and 4th filter plates 30% longer than tall, 3rd filter plate as long as tall; 3rd filter plate almost lying on side, other filter plates tipped at 45°; cb 1 with 8 filter rows, cb 2 with 11, cb 3 with 12, cb 4 with 8. Filter mesh relatively dense; quaternary folds on larger filter rows; filter rows relatively wide and of uniform thickness; filter rows separated but almost abutting; filter canals narrow, <50% width of largest rows, 50% or more canopied. Branchial food traps present, well developed, with narrow, even secretory ridges (Figure 57c), more medial food trap descending well into front of 3rd filter cavity. Glottis distinct, fully exposed, open, with average-sized lips; broad, round and distinct laryngeal disk. Esophageal funnel narrow; esophageal diameter broad.

DORSAL ASPECT.—Buccal Cavity: Roof of mouth distorted in preparation; nares 25% distance from front of mouth to esophagus; median ridge 40% distance from front of mouth to esophagus. Prenarial arena with transverse ridge with single anteroposterior cusp on each side of midline (cusps not visible in Figure 16). Nares of average size; internarial distance 50% length of naris; nares at 45° from midline; anterior narial wall with knobby anteromedial edge and single, small, posteriorly directed, prenasal papilla along lateral third; posterior narial wall a thin flap with no distinct narial-valve projection. Several small conical papillae posterior to nares defining the postnarial arena; pustulations scattered within arena (actual pattern of structures cannot be determined because of distortion of specimen during SEM preparation). Median-ridge and lateral-ridge papillae destroyed in dissection. BRA an elongate "U" defined by 15–20 simple, conical, slightly medially and anteriorly curved papillae on each side. Two or three small, lateral-roof papillae; pustulate ridge running from lateral-roof papillae posteromedially to BRA; more than 100 pustulations scattered about roof of BRA. Glandular zone distinct, of uniform width; secretory pits fairly dense. Dorsal velum relatively large, almost continuous across midline, with moderately papillate medial ridge on each side.

Pharyngeal Cavity: Pressure cushions and ciliary groove destroyed in dissection.

Lepidobatrachus laevis Budgett

FIGURE 17

MATERIAL.—USNM 241344 (one specimen dissected, stage 38, SVL 31.2 mm). Adults collected from Filadelfia, Boqueron, Paraguay; larvae raised in laboratory of Rudolfo Ruibal.

REFERENCE.—Ceï (1968) described and figured the external morphology of *Lepidobatrachus asper* and *llanensis*. The larva of *laevis* is very similar to the larvae of *asper* and *llanensis*.

GENERAL REMARKS.—Very large fields of filamentous gills. Lungs small, about $\frac{3}{4}$ length of buccal floor; uninflated.

VENTRAL ASPECT.—Buccal Cavity: Floor of mouth extremely broad, especially anteriorly, almost rectangular, 25% wider than long. Floor of mouth lacking many features found on other tadpoles. Infralabial region poorly defined. Irregular collection of pustules immediately posterior to denticle tooth row; immediately behind pustules a transversely oriented low ridge running width of mouth but interrupted medially; near midline and posterior to ridge, 2 short, knobby, conical papillae with very broad bases. Tongue anlage very small, 3 tiny lingual papillae and a pustulation in a transverse row. BFA not defined. No pre-pocket papillae. Only distinct papilla isolated just posterior to medial end of buccal pockets; some pustulations scattered in pre-pocket area and many in posterior $\frac{1}{2}$ of buccal floor. Buccal pockets very long, curved, 8 times as wide as long; deep; oriented 40% from transverse plane; perforations not visible under light microscopy. Almost no free velar surface, area of free velar surface less than 3% rest of buccal floor; velum divided, middle $\frac{1}{3}$ of velum absent; spicules absent; free velar margin on each side a single arch with slightly irregular jagged margin; secretory pits absent.

Pharyngeal Cavity: Branchial baskets isosceles triangle-shaped with transverse base, 20% wider than long; area of both branchial baskets equalling about 25% area of remainder of buccal floor. No filter cavities. No filter plates; small projections on dorsal surface of some gill bars probably vestiges of filter rows; cb 1 with 9 filter row vestiges, cb 2 with 8, cb 3 with 7, cb 4 with 6; gill filaments visible through gill bars. No filter mesh. Branchial food traps absent. Glottis fully exposed, large, dorsally directed; lips well developed; glottis on triangular laryngeal disk; esophageal funnel narrow, esophagus diameter large.

DORSAL ASPECT.—Buccal Cavity: Roof of mouth very broad, particularly anteriorly; nares about 30% distance from front of mouth to esophagus. No median ridge. Roof of mouth lacking many features found in other tadpoles. Small, distinct, randomly distributed pustulations of uneven size scattered about entire buccal roof. Nares small transverse ovals, internarial distance $\frac{1}{4}$ width of buccal roof; flap arising from posteromedial margin of internal nares covering less than $\frac{1}{2}$ of narial orifice and as such incompetent as a valve. BRA not defined. No glandular zone. No dorsal velum.

Pharyngeal Cavity: No pressure cushions. No ciliary groove.

Leptodactylus chaquensis Cei

FIGURE 18

MATERIAL.—USNM 241322 (one specimen dissected, stage 37, SVL 18.1 mm). Collected from a pond in the city of Embarcación, Salta, Argentina, 31 December 1971.

REFERENCE.—The external morphology of the *L. chaquensis* larva has been reported and illustrated by Cei (1980:351, fig. 148).

VENTRAL ASPECT.—Buccal Cavity: Floor of mouth triangu-

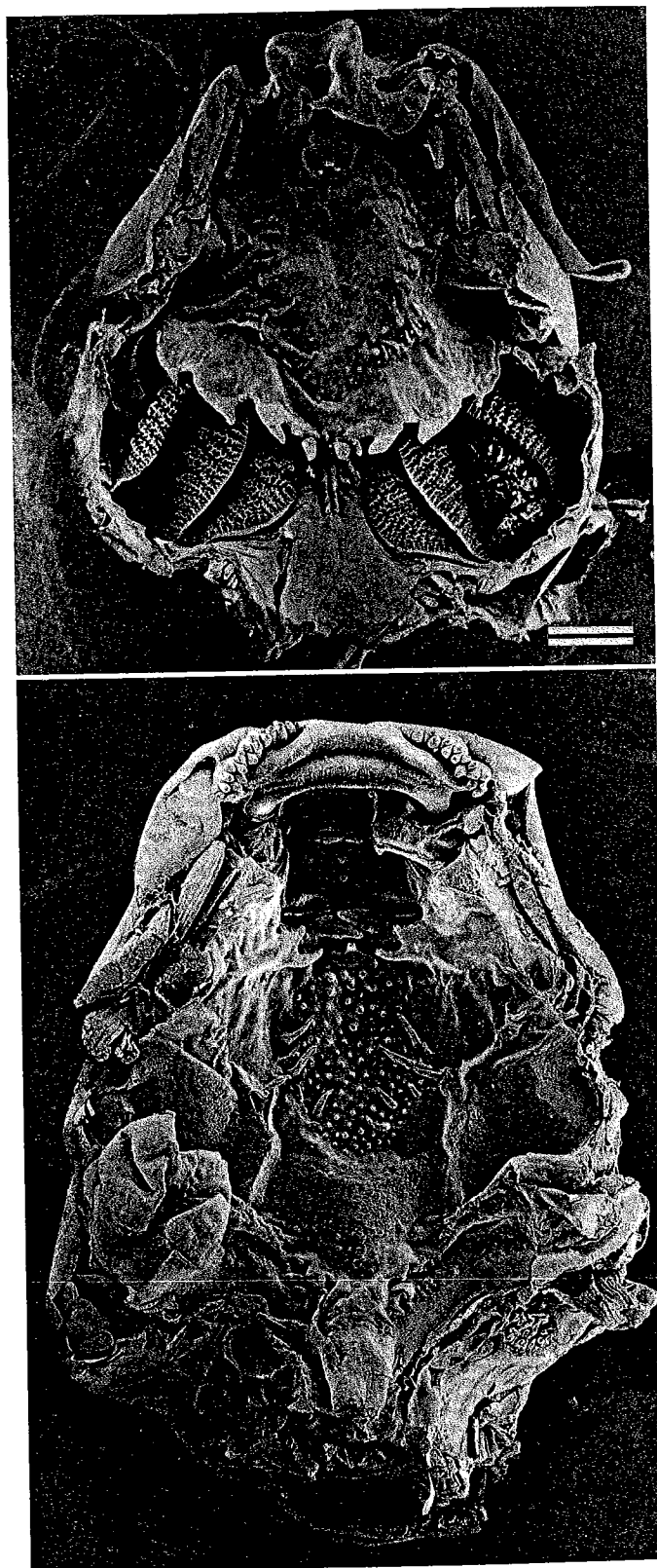


FIGURE 18.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Leptodactylus chaquensis*; scale line = 1 mm.

lar, length about equal width. Two infralabial papillae on each side, 1 pair near midline, much larger pair directly lateral to medial pair; papillae with rough knobby margins; 2 or 3 pustulations anterior to infralabial papillae. Three anteriorly to posteriorly flattened lingual papillae; large one on midline, bifurcated at tip, smaller two lingual papillae posterolateral to larger median one. BFA broadest anteriorly, narrowing gradually posteriorly, then abruptly near posterior limit; 10–15 BFA papillae on each side; largest BFA papillae medial to buccal pockets; most thin and conical, some with bifurcated tips. No pre-pocket papillae. Five or six papillae lateral to BFA just posterior to medial edge of pockets. Buccal pockets large; transverse; not perforated. Free velar surface of slightly longer than average length; spicular support obvious through epithelium of buccal floor; spicules long, thin, and stiff; posterior edge of ventral velum with 3 long, distinct, posteromedially directed, marginal projections on each side directly above the tops of the 2nd, 3rd, and 4th filter plates and 2 short papillae on either side of median notch; median notch large; very conspicuous secretory pits densely distributed on margin and marginal projections of velum.

Pharyngeal Cavity: Branchial baskets oval, almost round, with long axis from anterolateral to posteromedial; area of both branchial baskets about equal to rest of buccal floor area; branchial baskets deep; filter cavities about same size, 2nd less than 25% larger than 1st and 3rd. Two medial filter plates with gently upwardly curved dorsal edges; more lateral filter plates with straight dorsal margins; filter plate length about equal to height; slightly imbricate; cb 1 with 12 filter rows, cb 2 with 12, cb 3 with 12, cb 4 with 9. Filter mesh dense; extensively branched with conspicuous tertiary folds. Filter rows wide, abutting. Filter canals not as wide as rows, fully canopied. Branchial food traps of average size with conspicuous secretory ridges. Glottis entirely exposed when viewed from above, small with tall, thin lips; no laryngeal disc. Esophageal funnel narrow, but esophagus relatively large.

DORSAL ASPECT.—Buccal Cavity: Mouth relatively narrow, roof 20% longer than wide; long pre-narial area, nares about 25% distance from front of mouth to esophagus; median ridge located about 40% distance from front of mouth to esophagus. Prenarial arena with 5 or 6 random pustulations plus a transverse median ridge with a gently curved, biconcave margin and a medial cleft. Nares of moderate size, transversely oriented; anterior narial wall thick, not exceptionally high, ending medially with a medially directed papilla; narial valves thin, 5 times as long as tall, no distinctive projection. Postnarial arena with few pustulations and 1 irregular, short, pustulate papilla on each side. Median ridge triangular, ending in 1 truncate papilla; anterior surface pustulate. Lateral-ridge papillae complex, large, elkhorn-shaped, far lateral and slightly anterior to median ridge. One to four small lateral-roof papillae. BRA triangular, relatively narrow; 5 attenuate, simple BRA papillae on 1 side, 8 on other; 30–40 pustulations scattered evenly about BRA. Glandular zone with distinct anterior

margin of secretory pits; zone of uniform anterior to posterior dimension, about $\frac{1}{10}$ length of roof of mouth. Free medial $\frac{1}{2}$ of dorsal velum pustulate and papillate, larger and more medial papillae pointing posteriorly; dorsal velum narrowly interrupted on midline.

Pharyngeal Cavity: Pressure cushions distinct; lateral cushions irregular in shape, more medial cushion oriented in anteromedial to posterolateral plane; medial cushion large, vaguely pyramid in shape. Ciliary groove shallow and wide.

Leptodactylus fuscus (Schneider)

FIGURE 19

MATERIAL.—USNM 241294 (one specimen dissected, stage 37, SVL 15.3 mm). Collected from a 3 by 10 m pond in an open situation near Teresópolis, Rio de Janeiro, Brazil, 4 December 1977.

REFERENCE.—Lescure (1972) described and illustrated the external larval morphology.

GENERAL REMARKS.—Only those features that differ from *L. chaquensis* are described. Lungs large, about length of floor of mouth. Dense mesh of gill filaments.

VENTRAL ASPECT.—Buccal Cavity: Three infralabial papillae in a transverse row, all relatively small, blunt, stubby; medial papilla with deeply bifurcate apex. Four lingual papillae, subequal in size in an approximately transverse row; simple and attenuate. BFA more an open, simple “U” than in *L. chaquensis*; few BFA papillae with jagged tips. One or two very small, pre-pocket papillae. Two or three papillae lateral to BFA just posterior to medial edge of pockets.

Pharyngeal Cavity: Three most medial filter plates with upwardly curved dorsal margins; cb 1 with 10 filter rows, cb 2 with 11, cb 3 with 10, cb 4 with 7 or 8. Filter canals 90%–100% canopied. Glottis lying mostly under ventral velum, 80% exposed through median notch proper.

DORSAL ASPECT.—Buccal Cavity: Fewer pre-narial pustulations, median ridge not deeply cleft. Anterior narial wall rugose, lacking papillae. Postnarial arena with 4 papillae; larger pair more anterior and medial, smaller pair more posterior and lateral. Median ridge with serrate apex (Figure 61a). Lateral-ridge papillae not as branched as in *L. chaquensis*. BRA U-shaped, 4 or 5 BRA papillae on each side.

Pharyngeal Cavity: Medial pressure cushion oval-shaped.

Leptodactylus gracilis (Duméril and Bibron)

FIGURE 20

MATERIAL.—USNM 241234 (one specimen dissected, stage 38, SVL 14.1 mm). Collected from a small temporary pond in a vacant lot in Santo Amaro da Imperatriz, Santa Catarina, Brazil, 19 November 1979.

REFERENCE.—Fernandez and Fernandez (1921) described and figured the external larval morphology.

GENERAL REMARKS.—Only those features that differ from

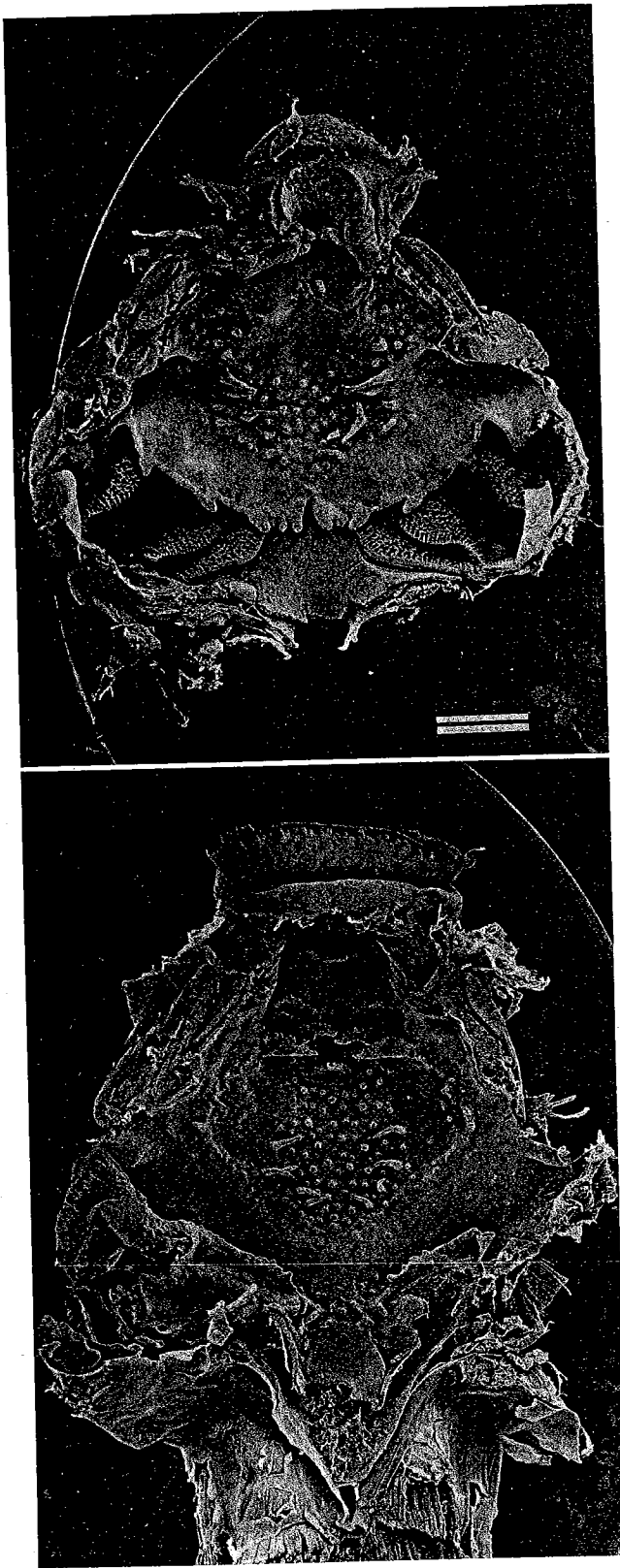


FIGURE 19.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Leptodactylus fuscus*; scale line = 1 mm.

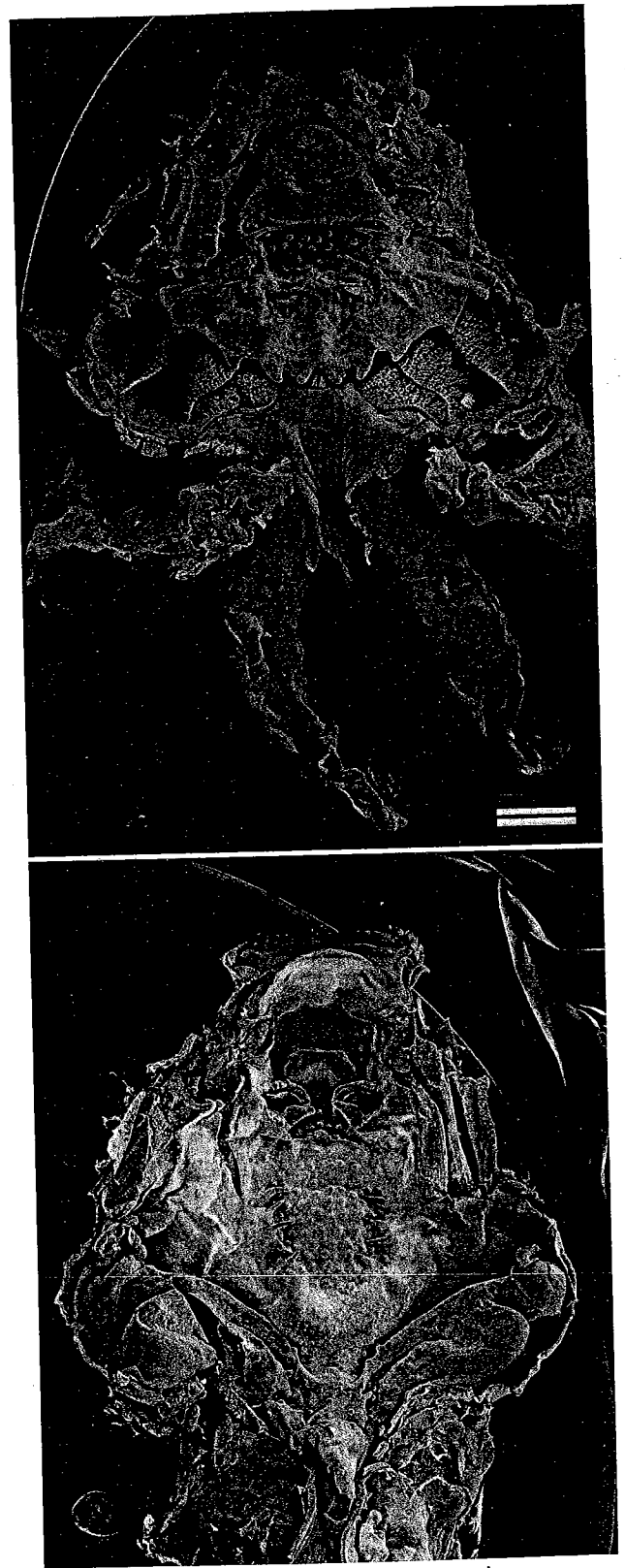


FIGURE 20.—SEM micrographs of floor (above) and roof (below) of oral cavity of *Leptodactylus gracilis*; scale line = 1 mm.