



# FAUNA *of* AUSTRALIA



## 9. FAMILY MICROHYLIDAE

Thomas C. Burton



**Pl 1.3.** *Cophixalus ornatus* (Microhylidae): usually found in leaf litter, this tiny frog is endemic to the wet tropics of northern Queensland. [H. Cogger]

## DEFINITION AND GENERAL DESCRIPTION

The Microhylidae is a family of firmisternal frogs, which have broad sacral diapophyses, one or more transverse folds on the surface of the roof of the mouth, and a unique slip to the abdominal musculature, the *m. rectus abdominis pars anteroflecta* (Burton 1980). All but one of the Australian microhylids are small (snout to vent length less than 35 mm), and all have procoelous vertebrae, are toothless and smooth-bodied, with transverse grooves on the tips of their variously expanded digits. The terminal phalanges of fingers and toes of all Australian microhylids are T-shaped or Y-shaped (Pl. 1.3) with transverse grooves.

The Microhylidae consists of eight subfamilies, of which two, the Asterophryinae and Genyophryinae, occur in the Australopapuan region. Only the Genyophryinae occurs in Australia, represented by *Cophixalus* (11 species) and *Sphenophryne* (five species). Two newly discovered species of *Cophixalus* await description (Tyler 1989a). As both genera are also represented in New Guinea, information available from New Guinean species is included in this chapter to remedy deficiencies in knowledge of the Australian fauna.

## HISTORY OF DISCOVERY

The Australian microhylids generally are small, cryptic and tropical, and so it was not until 100 years after European settlement that the first species, *Cophixalus ornatus*, was collected, in 1888 (Fry 1912). As the microhylids are much more prominent and diverse in New Guinea than in Australia, Australian specimens have been referred to New Guinean species from the time of the early descriptions by Fry (1915), whilst revisions by Parker (1934) and Loveridge (1935) minimised the extent of endemism in Australia.

The most important factors in the development of understanding of the nature and extent of the Australian microhylid fauna were an acceleration of faunal surveys of the northern rainforests and the involvement of Dr R.G. Zweifel, who in a series of papers described most of the known species, and explored their relationships, ecology and behaviour (Zweifel 1962, 1965, 1985; Zweifel & Parker 1969, 1977).

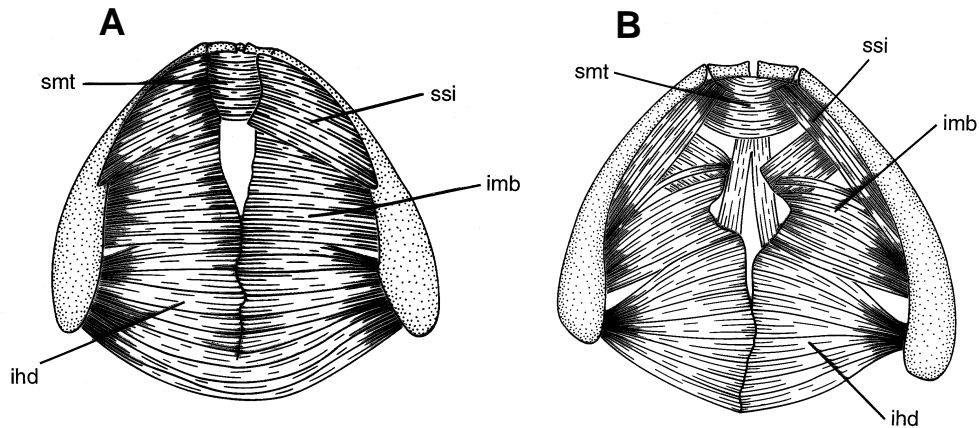
## MORPHOLOGY AND PHYSIOLOGY

### External Characteristics

The main features of the external morphology are listed above. Although with experience it is possible to identify a frog as a microhylid by its general appearance, the only diagnostic external character is the presence of transverse grooves at the tips of the digits. Nor are there any reliable external characters to distinguish microhylid genera, as intrageneric variation outweighs intergeneric variation.

External characters are, however, the basis of a key to the Australian microhylid species prepared by Zweifel (1985). Variation between species occurs in size, breadths of finger and toe discs, proportions of leg length and of the snout, and the size of the thumb in *Sphenophryne*. As specimens, alive or dead, are difficult to measure reliably or consistently, even when the measuring equipment is good and the researcher experienced, there is often a degree of uncertainty in identifications based on proportions. Moreover, two pairs of Australian microhylid species are distinguishable by call alone.





**Figure 9.1** The submandibular musculature of microhylids. **A**, *Cophixalus ornatus*; **B**, *Sphenophryne* sp. **ihd**, *m. interhyoideus*; **imb**, *m. intermandibularis*; **smt**, *m. submentalis*; **ssi**, supplementary slip of the *m. intermandibularis*. (After Burton 1984) [C. Eadie]

Australian species range from reddish brown to grey brown, and sometimes pale yellow in colour dorsally, and are usually marked with darker streaks, W-, or H-shaped blotches, and mottling. The ventral surface may be white, yellow, orange, brown or grey in colour, sometimes with paler or darker flecks. Snout-vent length for all species ranges from 15 to 40 mm.

### Body Wall

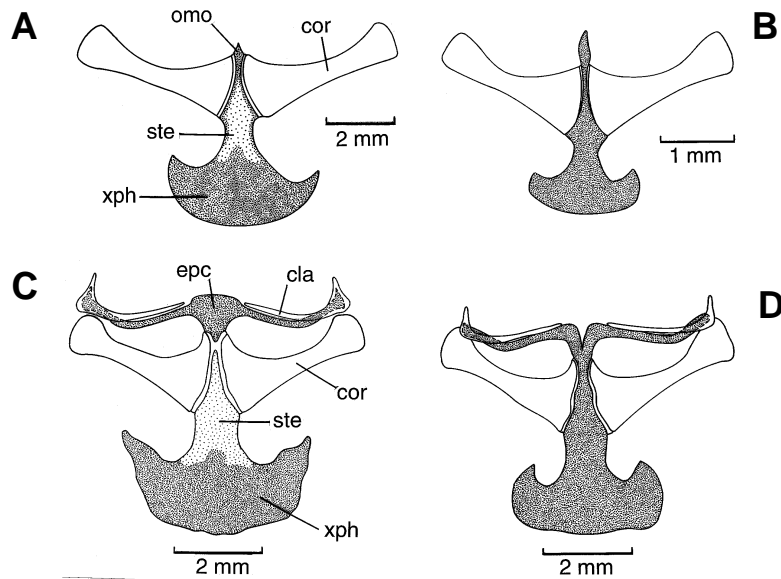
Tyler (1974b) demonstrated the importance of musculature as a source of taxonomically useful variation in Australopapuan microhylids. *Cophixalus* and *Sphenophryne* conform in most important respects to the generalised microhylid pattern exemplified by the New Guinean asterophryine *Phrynomantis stictogaster* (Burton 1983b), except in those features that distinguish the subfamilies Asterophryinae and Genyophryinae. These are the presence of a dorsal slip of the *m. intermandibularis* (Burton 1986) and the origin, in part, of the *m. acromiohumeralis* from the coracoid (Burton 1990) in genyophryines, and overlap in the asterophryines of *m. intermandibularis* and *m. interhyoideus* (Tyler 1979).

The submandibular musculature of the genera differs (Burton 1984). In *Sphenophryne* the supplementary slip of the *m. intermandibularis* is a broad muscle, orientated medially, while in *Cophixalus* the same slip is narrow and orientated parallel to the mandible (Fig. 9.1A, B).

### Skeletal System

In both genera the pectoral girdle is reduced: *Sphenophryne* possesses clavicles and procoracoid cartilages but no presternal elements (Fig. 9.2A, B); *Cophixalus* lacks clavicles and procoracoids (Fig. 9.2C, D).

The skulls of Australian *Cophixalus* and *Sphenophryne* are generally well-developed, toothless, and the maxillae do not meet anteriorly to the premaxillae (the eleutherognathine condition). In both genera there is variation in the degree of ossification of the prootic region and the development of the vomer. Zweifel (1985) believed that paedomorphosis explains much of the evolution of the Australian fauna. He ascribes to paedomorphosis the poor ossification found in some species, for example, *C. hosmeri*, *C. infacetus* and *S. robusta*, and the relative lack of ossification of the extremity of the vomer in *Cophixalus*.



**Figure 9.2** Pectoral girdles of Australian microhylids. **A**, *Sphenophryne fryi*; **B**, *S. pluvialis*; **C**, *Cophixalus hosmeri*; **D**, *C. saxatilis*. Dense stippling indicates cartilage, sparse stippling calcified cartilage, clear areas bone. **cla**, clavicle; **cor**, coracoid; **epc**, epicoracoid cartilages; **omo**, omosternum; **ste**, sternum; **xph**, xiphisternum. (After Zweifel 1985) [C. Eadie]

Paedomorphosis is invoked also to explain the non-imbricate condition of the vertebrae observed in both genera. As Zweifel (1985) points out, variation in the postcranial skeleton has not yet been documented sufficiently in either genus for useful generalisations to be made.

### Locomotion

Australian microhylids are walkers rather than leapers. All *Sphenophryne* and most *Cophixalus* appear to be predominantly leaf-litter dwellers, but some *Cophixalus* are at least partially scansorial, and males of six *Cophixalus* species are known to call from elevated sites (Zweifel 1985). There appears to be a loose correlation between the tendency to climb and the width of finger-discs (but not toe-discs), but too little is known of the habits of most species to generalise (Zweifel 1985).

### Feeding and Digestive System

As far as is known, the Australian microhylids are generalised feeders on leaf-litter invertebrates. No specialisation, such as the earthworm-feeding of *Xenobatrachus* (Blum & Menzies 1988), has been observed. All genyophrynines possess densely muscled tongues which are free posteriorly (Zweifel 1971; Horton 1982; Burton 1986). Captive specimens of *Cophixalus ornatus* and *Sphenophryne fryi* have been observed to flick their tongues long distances, almost to a body length (Burton pers. obs.).

As in other Genyophryninae and Asterophryinae, the Australian microhylids that have been examined possess a denticulate transverse fold on the posterior surface of the roof of the mouth. The function of this fold is not known. It may provide mucus to the tongue before or during feeding, lubricate food, or it may wipe the tongue after feeding. There has been no study of the morphology or physiology of the digestive system of microhylids.

## Reproduction

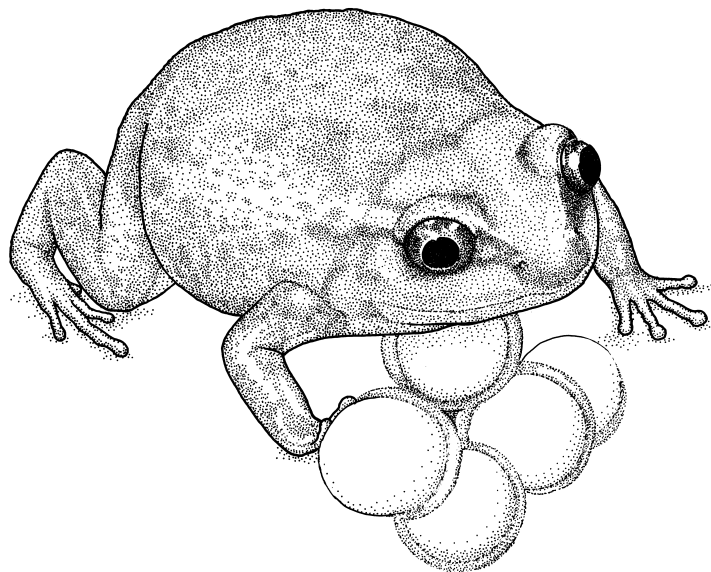
Little is known of the reproduction of the Australopapuan microhylids. A small number of macrolethical (large-yolked) eggs are laid on land, the eggs being held together by a string of jelly so that the egg mass resembles a string of beads.

When egg masses are discovered by accident under leaf-litter, almost always they have been accompanied by an adult male (Fig. 9.3). In New Guinea also it is rare for a female to be collected with an egg mass (Simon 1983). The function of this apparent parental behaviour is unknown. Tyler (1976b) discusses fungal attack of microhylid eggs and suggests similarity to salamanders that sit on eggs and have antibacterial and antifungal agents in ventral skin. Simon (1983) found high mortality among embryos from which the adult was removed, usually due to fungal attack.

Horton (1984) examined the female reproductive tracts of five *Cophixalus* species, including *C. neglectus* and *C. ornatus* from Australia, and one *Sphenophryne*. She found that these species possess reproductive tracts characterised by few convolutions of the oviducts, a small ovarian complement and large egg diameter, few lobes of the ovary, and completely united ovisacs.

## Embryology and Development

All available data suggest that microhylid larvae develop directly, completing metamorphosis within the egg capsule, and a miniature frog ultimately emerges from the egg. The larva lacks adhesive organs, external gills, branchial clefts, internal gills, an operculum, spiracles and keratinous denticles (Parker 1934). Parker noted also that respiration is achieved through a vascular tail which is apposed to the inner surface of the egg capsule (Parker 1934). Simon (1983) found that the time between egg-laying and hatching varied from 85 to 100 days in *Cophixalus parkeri* from New Guinea.



**Figure 9.3** Adult *Sphenophryne fryi* attending egg mass. The eggs are held together by a string of jelly. (After photo by A. Dennis/ANT) [M. Cilento]



Figure 9.4 Adult *Cophixalus parkeri* with hatchlings. (After Simon 1983)  
[M. Cilento]

## NATURAL HISTORY

### Ecology

Of the 16 Australian microhylid species, 13 are restricted to rainforest, and two occur in rainforest in part of their range. *Sphenophryne adelphe* occurs also on the Arnhem Land escarpment, where it is found under spinifex (*Triodia irritans*), and on Melville Island where it has been recorded from lawns and the floors of pine plantations (Tyler, Davies & Watson 1991). *Sphenophryne gracilipes* occurs in open forest (Zweifel 1985), and *Cophixalus saxatilis* is unique among the Australian microhylids in its habitat, as it occurs only in granite boulder country, never in rainforests.

The altitudinal range occupied by a species appears at least in part to be related to temperature tolerance. Zweifel (1985) was unable to keep specimens of the high altitude frog *Cophixalus neglectus* alive whilst transporting them down from Mount Bellenden Ker to Cairns. On the other hand, Brattstrom (1970) found specimens of the low altitude species *Sphenophryne pluvialis* intolerant of temperatures as low as 10°C.

### Behaviour

Most of the Australian microhylids are cryptic by day. All of the rainforest species are found by day under logs or leaf-litter, but *Cophixalus saxatilis* calls during the day from deep in crevices in a jumble of granite boulders (Zweifel 1985). *Sphenophryne adelphe* also calls by day (Tyler *et al.* 1991).

Rainforest species call at night from a variety of sites. All rainforest *Cophixalus* call from elevated positions, such as in shrubs, but seldom at a height much above two metres. Of the five *Sphenophryne* species, only *S. gracilipes* calls from an exposed position (Zweifel 1985).

## BIOGEOGRAPHY AND PHYLOGENY

### Distribution

Only one of the 16 Australian species, *Sphenophryne gracilipes*, occurs in New Guinea (Zweifel 1985). Within Australia, 15 of the 16 species are apparently restricted to northern Queensland, between Mount Elliot, 30 km south of Townsville and the tip of Cape York. The only species recorded in the Northern Territory, *Sphenophryne adelphe*, occurs on the Cobourg Peninsula, in western Arnhem Land and on Marchinbar Island in the Wessel group. Of the north Queensland microhylids, only *Cophixalus saxatilis* occurs exclusively outside of the rainforest areas, in the vicinity of Black Gap, south of Cooktown, in a habitat of granite boulders.

Few species have a widespread distribution, and these tend also to have a wide altitudinal distribution. *Cophixalus ornatus*, found at altitudes of 20 to 1520 m, has a north-south range extending over more than 300 km. The other *Cophixalus* species have restricted distributions and generally occur over a narrow altitudinal range, about half of them above 900 m. All of the *Sphenophryne* species have relatively broad geographic and altitudinal distributions. Czechura (1978) suggested that altitudinal displacement occurs between *S. pluvialis* and *S. robusta* near the headwaters of the Russell River. McDonald (1992) pointed out that these two species are not found sympatrically.

### Affinities with other Groups

There are two issues of the historical biogeography of the Australian Microhylidae to consider: the origins of the Australopapuan fauna as a whole, and the origins of the Australian component of that fauna.

The origins of the Australopapuan microhylids have been canvassed by Savage (1973) and Tyler (1979a), who came to radically different conclusions. Savage saw the microhylids of the Oriental region as Gondwanan frogs which rafted northwards on the then-forested Australia and subsequently invaded Asia via New Guinea and the Indonesian Archipelago. In his view, the present Australian fauna is the product of a Pliocene reinvasion from New Guinea, after extinction of the family in Australia. Tyler, using modern distributional data, saw the reverse, and hypothesised an Asian origin and dispersal through Indonesia, followed by entry into New Guinea after the Miocene collision of the Australian plate with the Sunda Arc.

Only a discovery of appropriate fossils or a phylogenetic analysis of the Microhylidae could determine which of these hypotheses can be rejected. Currently fossil frogs are classified on the basis of the form of the ilium, which appears to be the most durable and taxonomically useful bone in fossils (Tyler 1989a). Unfortunately, the microhylid ilium is variable and not distinctive (Burton 1986), so that a fossilised ilium would be difficult to recognise. It is unlikely that fossils will yield evidence of past microhylid distribution in the foreseeable future.

Evidence of the monophyly of the Australian representatives of the two genera comes from the analysis of calls. Zweifel (1985) pointed out that there is very strong similarity of call structure in both genera of Australian microhylids compared with the congeners in New Guinea, and argued, albeit tentatively, that this indicates the monophyly of the Australian component of each genus. Zweifel allowed that the similarity of call may be due to the retention of primitive calls by the Australian microhylids, but this appears less likely than the derivation of the fauna from single invasions of Australia by one species each of *Cophixalus* and *Sphenophryne*.



The timing of the entry of the microhylids into Australia is open to debate. The Pleistocene (Tyler, Watson & Martin 1981), Pliocene (Savage 1973) or an earlier period (Zweifel 1985) have all been proposed. If the Australian microhylids are monophyletic, the time of entry must have been sufficient for at least some speciation to have occurred before the re-entry into New Guinea of *Sphenophryne gracilipes*, the only species to occur both in Australia and New Guinea.

### Affinities within the Taxon

Zweifel's (1985) hypotheses of the phylogeny of each genus, based on external morphology are tenuous, as he expressed little confidence in assigning polarities to characters. McDonald's (1992) discussion of the prevalence of mountain top endemism suggested that *in situ* speciation of isolated populations may have been important in the evolution of the genera.

Parker (1934) referred the New Guinean species *Copiula fistulans* to *Cophixalus*, on the basis of its lack of a clavicle and procoracoids. Menzies & Tyler (1977) resurrected *Copiula* to accommodate *C. fistulans* and two other morphologically similar species, but the implication that *Copiula* and *Cophixalus* are close relatives persisted, and Zweifel (1985) pointed out the paucity of objective characters to distinguish the genera. Burton (1990) claimed that the unique, broad, transverse supplementary slip to the *m. intermandibularis* shared by *Sphenophryne* and *Copiula* is a more reliable indicator of relationships than the reduction of the pectoral girdle, which has clearly happened many times in the course of microhylid evolution (Jones 1933; Menzies & Tyler 1977). If the affinities of *Sphenophryne* have now been clarified, those of *Cophixalus* remain obscure.