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Description and Relationships of a New Species of Microhylid Frog (Genus *Barygenys*) from Papua New Guinea[1]

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ABSTRACT: *Barygenys parvula*, the seventh species of its genus, is described from the Adelbert Mountains. The genus is endemic to Papua New Guinea, and the new species is the first of its genus known from the north coast of New Guinea. Interspecific relationships among *Barygenys* are discussed, and a revised key to the species is presented.

THE GENUS *Barygenys*, endemic to Papua New Guinea, exemplifies the incompleteness of our knowledge of the frog fauna of New Guinea. Although the genus was revised recently (Zweifel 1972), one new species was subsequently added to the five previously known (Menzies and Tyler 1977), and another has now been collected. The purposes of this paper are to describe the new species, speculate on intrageneric relationships, and provide a revised key to the genus.

METHODS

Measurements are given in millimeters and are standardized to conform with those in Zweifel (1972). They were made by ocular micrometer in a binocular dissecting microscope or with vernier calipers: length from snout to vent (S–V); head width (HW), at level of tympana; orbit length (Eye), from anterior to posterior corner; eye–naris distance (E–N), from anterior edge of eye opening to center of external naris; internarial distance (IN), from center to center of external nares; tibia length (TL), from fold of skin on knee to heel (Zweifel 1972: fig. 1).

Barygenys parvula, sp. nov.

Figure 1

FIGURE 1. Dorsal view of holotype of *Barygenys parvula*, BPBM 5689, adult ♂, ×3.

TYPE MATERIAL: Holotype: BPBM 5689, adult male, collected on 14 March 1974 by G. B. Opit, 14 km north-northwest of Wanuma, Adelbert Mountains, elevation about 1500 m, Madang Province, Papua New Guinea. Paratype: BPBM 5692, a male with the same data as the holotype, but collected on 18 March 1974.

DIAGNOSIS: *Barygenys parvula* is distinguished from the other six species of the genus in its combination of small body size (less than 20 mm S–V in two specimens) and toes with slightly expanded digital disks. Two other species of similarly small size (20–26 mm), *B. nana* and *B. flavigularis*, lack toe disks, as does one of the larger species, *B. cheesmanae* (S–V to 40 mm). The three

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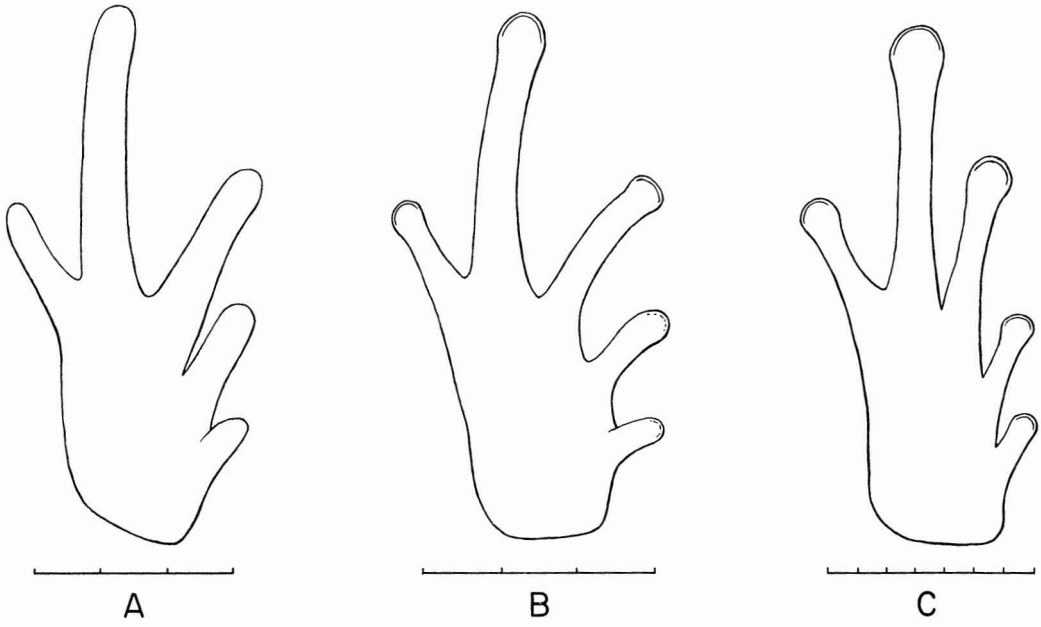

FIGURE 2. Right feet of *Barygenys* in plantar view. *A, flavigularis*; *B, parvula*; *C, atra*. Drawings are semidiagrammatic, but soles are virtually featureless. Scale lines marked in millimeters.

remaining species, *B. atra*, *B. exsul*, and *B. maculata*, are much larger than the new form, reaching at least 39 mm S–V.

DESCRIPTION OF HOLOTYPE: General body form robust, with broad head (HW/S–V is 0.392), relatively short legs (TL/S–V is 0.301), and small eyes (Eye/S–V is 0.094). Snout subacute with three moderately conspicuous vertical ridges and faint traces of ridges lateral to these. Loreal region oblique, flat; canthal region rounded; external nares slightly closer to tip of snout than to eye. Interocular space about two times width of an eyelid. Tympanum inconspicuous, about as large as eye. Fingers short, with bluntly pointed tips, relative lengths $3 > 4 = 2 > 1$, no webbing or subarticular or palmar tubercles. Toes also without webbing or tubercles, relative lengths $4 > 3 > 5 > 2 > 1$; small, rounded, grooved terminal disks present, slightly but distinctly broader than penultimate phalanges on third and fourth toes (Figure 2). Skin somewhat warty, especially on dorsal posterior surface of body and on dorsal surfaces of hind limbs; no skin folds or ridges present; ventral surfaces smooth. Dorsum brown; indistinct darker marks on canthal region, on upper lips below eyes, and dorsally near hind leg insertions; a diagonal row of dark spots passing posteriorly from posterior corner of eye; all ventral surfaces finely mottled in dark and light brown.

The paratype agrees with the holotype in all pertinent ways.

Measurements (paratype in parentheses): S–V 17.6 (18.7); TL 5.3 (5.6); HW 6.9 (6.8); Eye 1.65 (1.80); E–N 1.05 (1.15); IN 1.65 (1.75).

COMPARISONS WITH OTHER SPECIES: The characteristics cited in the diagnosis should suffice to distinguish *Barygenys parvula* from the other species, but these are not the only differences. In comparison with its two congeners of similar size, *parvula* apparently has relatively longer legs: TL/S–V is 0.30 in *parvula*, compared with maxima of 0.29 in 24 *nana* and 0.27 in seven *flavigularis*. Ventral color patterns also differ: yellow throat and contrasting dark chest and abdomen of *flavigularis*; finely mottled venter of *nana* (almost uniform to the unaided eye); more coarsely mottled venter of *parvula*. The

eyes are larger in *parvula*: Eye/S–V is 0.094 and 0.096 in two *parvula*, compared with maxima of 0.089 in seven *flavigularis* and 0.087 in 24 *nana*.

Each of the four larger species of *Barygenys* differs from *B. parvula* in ways additional to size. All have eyes that are relatively much smaller, with the maximum Eye/S–V of 0.06 (*cheesmanae*) greatly removed from the ratio of about 0.09 seen in *parvula*. Relative leg lengths in the large species collectively cover a range from much shorter than seen in *parvula* to much longer (Zweifel 1972: table 4; Menzies and Tyler 1977), but the TL/S–V for *parvula* falls within the known range of only the largest species, *maculata*.

I have examined no juvenile specimens of the large species of *Barygenys*. Probably relative eye sizes in such juveniles would be larger, so this characteristic might be of less use in distinguishing these species from *parvula*. However, the lack of toe disks in *cheesmanae* and the distinctive color patterns of the other three species should suffice: boldly maculated ventral pattern in *maculata*, dark lateral surfaces set off from lighter dorsal area in *atra*, virtually uniformly dark ventral surfaces in *exsul*.

With only two specimens of this tiny new frog at hand, I was reluctant to undertake examination of the skeleton. However, the external morphology is sufficient to establish the species as a member of the genus *Barygenys*. The vertical ridges on the snout and the short, tapering fingers are unique to this genus.

CALL: In a note on the field tag, the collector characterized the call as "a series of rapid, high-pitched peeps." Menzies and Tyler (1977) published the first useful information on the calls of *Barygenys*, with audiospectrograms of calls of five of the six species then known. A second-hand verbal description of the call of the remaining species, *B. cheesmanae*, is in Zweifel (1972).

Of the calls Menzies and Tyler (1977) illustrate, that of *Barygenys nana* is closest to the verbal description of *parvula* in that it consists of repeated short notes with substantial high-frequency components. However, without more objective information on the call of *parvula*, about all that can be concluded is that its call is distinctively different from those of all species except *nana*, and perhaps is of the same general character as that of *nana*.

DISTRIBUTION AND HABITAT: *Barygenys parvula* is known only from the type locality (Figure 3), where the specimens were found in primary forest on the ground at night at an elevation of about 1500 m (collector's notes). The Adelbert Mountains, one of the low, isolated north coast ranges of New Guinea, rise to slightly more than 1600 m and are bounded by the narrow coastal plain on the northeast and by lowlands of the Ramu and Gogol river systems on the southwest.

ETYMOLOGY: The specific epithet is from the Latin adjective meaning small.

NOTES ON *Barygenys flavigularis* AND *B. exsul*

I described *Barygenys flavigularis* on the basis of only three specimens, noting its close resemblance to *B. nana*. Since then, I have examined four more specimens (BPBM 6244, Mt. Kaindi, 4 km southwest of Wau, Morobe Prov., 2300 m; BPBM 6322–6324, Bulldog Road, about 8 km south-southwest of Wau, Morobe Prov., about 2400 m, all collected by Allen Allison). These agree with the type series in color, pattern, and proportions, but do not extend the geographic distribution.[3] More important is Menzies and Tyler's (1977) demonstration of different mating calls of *nana* and *flavigularis*, which supports their specific distinction.

Menzies and Tyler (1977) illustrate the call of *Barygenys exsul* recorded at Alotau, Milne Bay Province, and Menzies has informed me (in litt.) that a specimen was collected there. The species previously had

[3] Menzies (in litt.) reports that *flavigularis* occurs on Mt. Missim, about 21 km northeast of Mt. Kaindi—a slight range extension and probably a disjunct population.

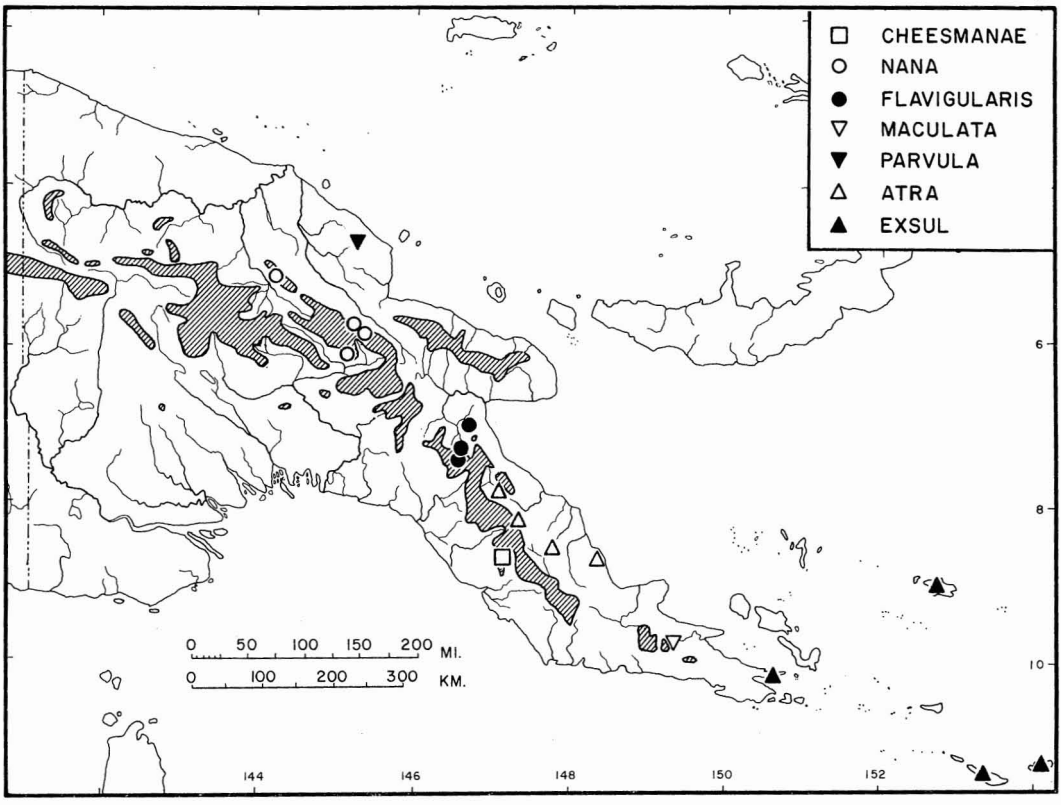

FIGURE 3. Distribution of the genus *Barygenys* in Papua New Guinea. Shaded area is above the 1800-m contour.

been known only from Rossel and Sudest islands, some 300–400 km east-southeast of Milne Bay. Another new record is provided by MCZ 97243, collected by Angus Hutton on Woodlark Island, Milne Bay Province. Thus, *B. exsul* has a wider distribution on the southeastern islands of Papua New Guinea than had been realized, and also occurs on the mainland, at least at the extreme east (Figure 3).

INTRASPECIFIC RELATIONSHIPS

The ways in which the species of *Barygenys* differ from one another include maximum size, relative size of eyes, relative length of legs, degree of development of toe disks, development of snout ridges, color pattern, and call. We may now inquire whether these features can be used to assess interspecific relationships.

Among species of *Barygenys*, the known maximum sizes are as follows: 19 mm (*parvula*); 26 mm (*nana*); 27 mm (*flavigularis*); 39 mm (*exsul*); 40 mm (*cheesmanae*); 41 mm (*atra*); 50 mm (*maculata*). Maximum sizes attained by the 40 species of asterophryine frogs range from less than 20 mm to about 100 mm. Only four other asterophryines are within the size range of *parvula*, *nana*, and *flavigularis*, so frogs of this size are decidedly in the minority. I am inclined to regard small size as a derived condition in *Barygenys* (and, independently, in other genera as well). Whether the relatively large size of *B. maculata* is derived with respect to the more moderate sizes of *atra*, *cheesmanae*,

and *exsul* is even less certain, but I am tentatively considering it that way.

Small eye size, associated with burrowing habits, is characteristic of *Barygenys*, but it is questionable whether the distinct difference of relative eye size among species of *Barygenys* should be attributed significance in inferring relationships. The smallest species have relatively the largest eyes and might thus be considered the most primitive. But a comparison of mean relative eye size (Eye/S–V) with maximum size attained by a species shows a close negative correlation between eye size and body size ($r = -0.957$). Relative eye size can be viewed as an allometric function of body size, comparable to what occurs in the ontogeny of an individual. If species of similar body size could be shown to have distinctly different eye sizes, or if different ontogenetic trends among species could be documented, eye size might be a useful character. As it stands, no significance seems warranted.

Short hind legs are typical of burrowing frogs, and in five of the seven species of *Barygenys* the TL/S–V is within the range 0.22–0.31. *Barygenys exsul* stands out slightly from this group, with a mean ratio of 0.34, and *B. atra* has conspicuously longer legs, 0.38–0.41. If *Barygenys* derives from nonburrowing ancestors [see Zweifel (1972) for speculation on intergeneric relationships], then longer legs may be the more primitive condition within *Barygenys*.

I have speculated elsewhere (Zweifel 1972) that the condition of well-developed digital disks is primitive within the Asterophryinae. All *Barygenys* lack disks on the fingers, and three species—*cheesmanae*, *flavigularis*, and *nana*—lack them on the toes as well. The remaining species have small disks, at least on the three longest toes. There may be differences among the species in the degree of expansion of the disks, but the material I have examined is not adequate to demonstrate this.

A unique characteristic of *Barygenys* is the presence of vertical ridges on the snout. These are relatively inconspicuous in *B. atra* (presumably the primitive condition) compared to their development in *B. nana*. The other species seem to stand somewhere in between, but an objective measurement of this feature is not possible.

Although the color patterns of the several species of *Barygenys* are distinctive, I see no basis for considering any one more primitive than the others. The bright-yellow throat of *B. flavigularis* may be derived relative to the colors of the other species, for bright colors are decidedly rare among asterophryine and sphenophrynine microhylids.

Calls of *Barygenys* are diverse, ranging from single notes almost 0.2 sec in length, through slowly repeated notes of that length, to rapidly repeated notes much less than 0.1 sec long (Menzies and Tyler 1977). The calls may be ordered in a series based on note length and repetition rate, but I know of no basis for considering any type of call more primitive than another.

So, of the features that serve to distinguish among the species of *Barygenys*, only four seem to offer some utility in assessing relationships: body size, leg length, snout ridges, and toe disk development. In all respects, *Barygenys atra* qualifies as the most primitive of the seven known species. Its moderate size, long legs, possession of toe disks, and weak snout ridges are all presumably primitive characters.

One of many possible interpretations of relationships among the species of *Barygenys* is diagrammed in Figure 4. The principal features of this arrangement are a progressive shortening of relative leg length in the more derived species and the loss of toe disks in the most derived forms. Small body size must be considered to have evolved twice. An alternate arrangement that clustered the three small species would be less parsimonious, as two of the small species (*nana* and *flavigularis*) differ in leg length and toe disks from the third (*parvula*).

Habitat and geography together divide the species into two groups (Figure 3). One, including *cheesmanae*, *flavigularis*, and *nana*, comprises species living at high elevations in the central mountain chain. Two of these species are known only from elevations of about 2000–2600 m, whereas the third (*nana*) ranges from 1830 to 3540 m. Species

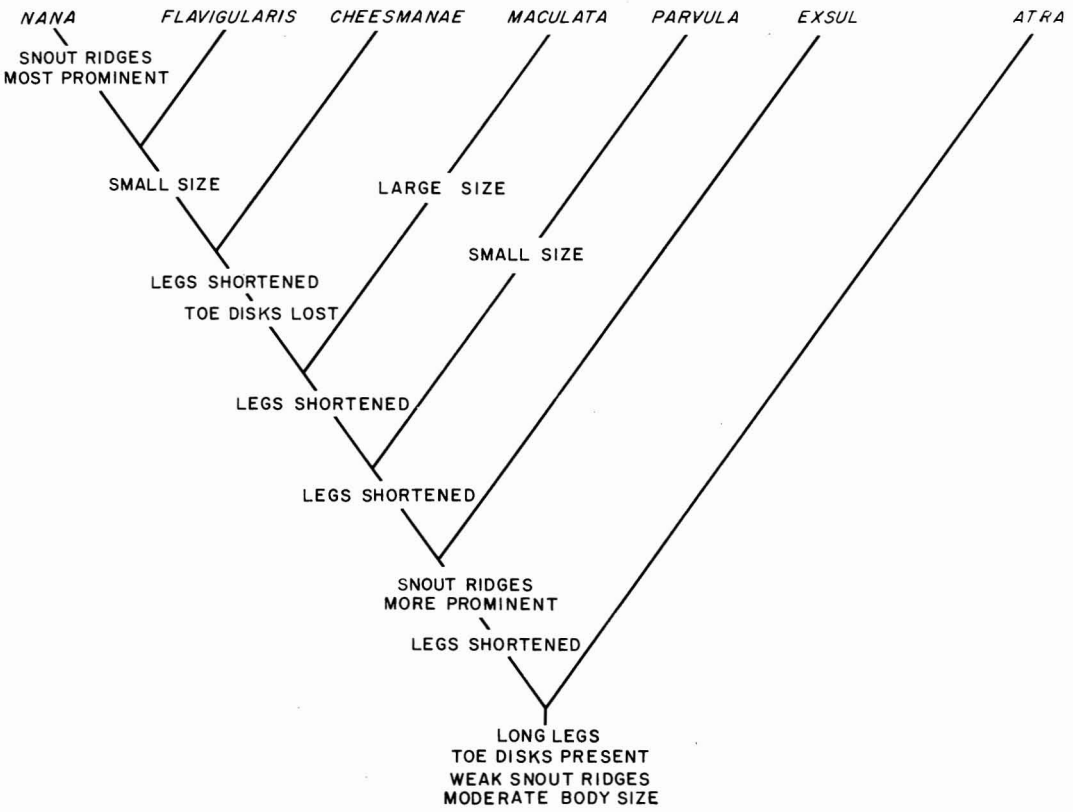

FIGURE 4. Hypothetical relationships among the species of *Barygenys*. The four primitive characters listed at the base of the cladogram all persist in *atra* and in other species except where the corresponding derived character is given. The repeated appearance of "legs shortened" indicates a progressive shortening of relative leg length.

of the second group occur at low to moderate elevations, from virtually sea level up to about 1500 m.[4] The montane species cluster as the most derived on the cladogram (Figure 4), whereas the forms of lower elevations are somewhat more loosely grouped. One inference that can be drawn is that *Barygenys* is primitively a genus of lowland habitats. Other than to direct attention to the isolation of *B. parvula* from its lowland relatives, there is little that can be said about the relationship between geography and cladistics in the lowland group. The most primitive of the montane species, *cheesmanae*, occurs in the same general region as *atra*, the most primitive of all *Barygenys*. The progressively more derived montane species, *flavigularis* and *nana*, range allopatrically in that order to the northwest of the range of *cheesmanae*.

I am well aware of both the paucity of characters used in assessing relationships and of the possibly questionable inferences of primitive versus derived states. Perhaps if sufficient specimens become available, my tentative conclusions may be tested with additional characters—of the skeletal system, for example. We can also hope for increased knowledge of the distribution of the several species. With more than half of the species known from only one or two localities, much remains to be learned.

[4] A record for *B. atra* at Albert Edward Ranges (6000 ft, 1830 m) may be erroneously high; see Zweifel (1979:16) for a discussion of this locality.

KEY TO THE SPECIES OF *Barygenys*

1. Some toes with at least slightly expanded disks bearing terminal grooves (Figure 2*B*, *C*). 2
1. Toes without disks (Figure 2*A*) 5
2. Size small, known specimens less than 20 mm S–V; eyes relatively large, Eye/ S–V greater than 0.09; ventral surfaces with small dark markings, some coalescing, on light background . . . . . *parvula*
2. Size large, adults over 30 mm S–V; eyes smaller, Eye/S–V less than 0.07; ventral surfaces not as described 3
3. Ventral surfaces pale, with large, irregular dark markings . . . . . *maculata*
3. Ventral surfaces uniform brown or dark, with irregular light markings 4
4. Dorsal and lateral surfaces of body dark gray in preservative, not differing in pattern . . . . . *exsul*
4. Lateral band of dark pigment low on sides, rest of dorsum paler . . . . . *atra*
5. Maximum length about 26 mm S–V; Eye/S–V of 0.07 or greater 6
5. Maximum length about 40 mm S–V; Eye/S–V about 0.06 or less . . . . . *cheesmanae*
6. Throat yellow (white in preservative), abruptly differentiated from gray of chest; snout ridges weak . . . . . *flavigularis*
6. Throat not sharply differentiated in color and pattern from rest of ventral surfaces; snout ridges strong . . . . . *nana*

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