FROGS OF THE FAMILY RHACOPHORIDAE (ANURA: AMPHIBIA) IN THE NORTHERN HOANG LIEN MOUNTAINS (MOUNT FAN SI PAN, SA PA DISTRICT, LAO CAI PROVINCE), VIETNAM

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Based on the results of own field work as well as data from the literature (Smith, 1924; Abl, 1931; Bourrett, 1937, 1942; Smirnov and Ho, 1983; Nguyen and Ho, 1996; Orlov, 1997; Inger et al., 1999; Orlov and Rybalovsk, 1999; Orlov and Ho. 2000a, 2000b; Ziegler and Weitkug, 1999; Ziegler and Hermann, 2000) and additional museum collections we identified 32 species among 5 genera of the family Rhacophoridae, in Vietnam. This estimate is derived from those species that have been examined by ourselves as well as taking into account the current understanding of rhacophorid taxonomy based on the information available from “Amphibian Species of the World” (Frost, 1985, 1999, 2000; Duellman, 1993). Adopting the higher classifications of S.S. Liem (1970); W.C. Brown and A.C. Alcala (1994) and J. A. Wilkinson and R. C. Drewes (2000) we conclude that the following genera are present in Vietnam: Chiricalus, Polypedates, Philautus, Rhacophorus, and Theloderma.

In the spring of 1999, field work was conducted in the northern Hoang Lien Mountains (Fan Si Pan Mountain, Sa Pa district, Lao Cai Province, Vietnam). We found 8 species of rhacophorids previously not known to occur in Vietnam. We provide detailed descriptions of these and a description of the new species of Rhacophorus. The rhacophorid diversity for the Hoang Lien Mountains included 4 genera and 20 species. Thus the total number of rhacophorid species in Vietnam is increased up to 40 species. Small part of these collections have not been identified and, therefore, are not included in this list. Some material is represented by a single specimen and we refrain from drawing any taxonomic conclusions until additional material becomes available.

Keywords: Amphibia, Anura, Rhacophoridae, Rhacophorus, new species, Polypedates, Vietnam, Hoang Lien Mountains.

INTRODUCTION

The Hoang Lien Mountains (Map 1) are situated on the border between two phytogeographic regions, the Palearctic and Paleotropics (Krivolutsky et al., 1995). This region also includes the highest mountain in Vietnam, Fan Si Pan Mountain (up to 3143 m above sea level). For these reasons, understanding the faunai distribution of this region is complex and intriguing. The geographic position of the Hoang Lien Mountains provides a setting of copenetration of Tibeto-Himalayan Palearctic elements and Paleotropical elements of Malayan-Indonesian fauna. This result is an incredible amount of biodiversity, in particular for amphibians.

The amphibian fauna of the Hoang Lien Mountains shares a significant number of species with the mountainous region of southern and central Yunnan, China. In fact, at various altitudes on Mt. Fan Si Pan we discovered species of Megophryidae, Ranidae, Bufonidae, Rhacophoridae, and Discoglossidae (Bombina microdeladigitora) that are not found in other regions of Vietnam, but are common in the mountains of Yunnan Province in southern China.

The Hoang Lien Mountains represent the southern border of the subtropical forests and the tropical monsoon rain forests are much further south in central and southern part of Vietnam. It is interesting to note that in Northern Vietnam mountain regions of the west from Red River [= Song Hong] (right bank) in many aspects have more herpetofaunal similarities with Northern Annam than with mountainous regions.
to the east of the Red River [= Song Hong] (left bank). A similar biogeographic pattern was found by Vo- Qui (1966) for the bird fauna of Northern Vietnam. The climate of this region is unique and is not duplicated in other regions of Vietnam. At elevations greater than 2400 m it is relatively cold and extremely wet. The rainy season (monthly amount of rain exceeds 100 mm) is 9 months long (from March through November). At elevations less than 2400 m the rainy season is from April through October (Krivolutsky et al., 1995).

Most of our efforts concentrated on elevations between 1200 and 2400 m, which corresponds to the mid-mountainous belt. Here predominant forests at the mid-mountainous belt (1200 – 1800 m) were close evergreen and semideciduous broad-leaved trees of subtropical association and were composed mostly by representatives of Fagaceae (Castanopsis, Lithocarpus, Quercus), Juglandaceae, Magnoliaceae, Lauraceae, Meliaceae, Mimosaceae, Fabaceae, in some places mixing with representative conifers, Fokienia hodginsii. Here vast bamboo undergrowth is present. Altered habitats were usually represented by secondary bamboo and bamboo-broad-leaved forests, and along the river valleys were forest-like aggregations of banana trees.

Between elevations of 1800–2400 m broad-leaved cloud forests are present having a mixture of the following genera: Alnus, Betula, Acer, Carpinus, and in some places coniferous trees. Hydrologically, this mountainous region is very rich and saturated. Given that the slopes at this elevation are invariably steep, these are, as a rule, rapid streams with numerous cascades and waterfalls. With the endless rains these conditions support an incredible diversity of amphibians. In gently sloping valley streams, swampy reservoirs are common along with high grasses and, in particular, thickets of large Araceae. Vast open meadows with numerous reservoirs occur on cut out slopes. The expansive range of elevations and microhabitat diversity provides not only rich species composition, but also an endless reproductive season for amphibians. At any time of the year it is possible to find one species or another breeding. Whereas megophryids breed during the autumn and winter, discoglossids, bufonids and ranids are found breeding in the early spring. Spring and summer breeding is dominated by rhacophorids, however some also have an autumn peak of reproduction as well.

Fieldwork and examination of museum specimens reveals that 20 species of rhacophorids occur in this region, among them 8 are new records for Vietnam. This significantly changes our understanding of southern distribution of the high elevation Yunnan – Sichuan fauna. In cases where this represents a new record for Vietnam we have provided detailed descriptions. These new records include a new species of Rhacophorus. In the species accounts below we have provided an annotated review of members of the family Rhacophoridae that occur in the northern Hoang Lien Mountains. In addition we have compiled a list of rhacophorids found in Vietnam.

**MATERIAL AND METHODS**

For the most part, frogs were observed, photographed in natural situations and collected at night, usually at 18:00 – 24:00. Study sites included three localities of differing elevation on the north side of the Hoang Lien Mountains: Site 1. 1900 m [22°20′58.3″ N. 103°46′15.7″ E]; Site 2. 1200 m [22°18′59″ N. 103°49′16″ E]; Site 3. 1400 m [22°18′56″ N. 103°49′35″ E] (Map 2).

Night excursions from each base camp mostly followed mountain streams, flood-lands swamps, and
Vietnamese Rhacophorids

forest trails that ranged between 1200 - 2400 m. Specimens were euthanized in a solution of one part clove oil and two parts 95% ethanol. Technical photos were taken of the dorsum and venter of representative specimens, followed by the removal of tissue (liver) that was then preserved in 95% ethanol for future molecular studies. Initial preservation of specimens was carried out in 4% formalin for 24 h, and subsequently in 70% ethanol, a concentration in which they are permanently stored. Preserved specimens, their photos and tissue samples have corresponding field number. Selected specimens are stored in the following museums: Royal Ontario Museum (ROM; Toronto, Canada), the Zoological Institute of St. Petersburg (ZISP; St. Petersburg, Russia), and the Institute of Ecology and Biological Resources (IEBR; Hanoi, Vietnam). In addition, earlier collections from the Hoang Liem region housed in IEBR, University of Hanoi, FMNH, and ZISP have been examined. Comparative material was examined from the collections of Chengdu Institute of Biology (CIB; Chengdu, China), Field Museum of Natural History (FMNH; Chicago, USA), and Universität Humboldt, Zoologisches Museum (ZMB; Berlin, Germany).

All measurements were taken with digital calipers to the nearest 0.01 mm and rounded to 0.1 mm. The following abbreviations are used: (SVL) snout-vent length; (IOD) interorbital distance; (HW) head width at the greatest cranial width; (HL) head length from the rear of the lower jaw to the tip of the snout; (FL) foot (tarsus) length; (ED) eye diameter; (TD) tympanum diameter; (T) tibia length; (F) femur length. Webbing formula follows that of Myers and Duellman (1982), in that Roman numbers refer to the digits, and the Arabic number refer to the number of phalanges free of webbing.

Our review of the rhacophorids of Vietnam has been divided into two publications: the first part includes a list of Rhacophoridae of Vietnam and a review of the Hoang Lien Mountain species in the genera Polypedates and Rhacophorus. Following this we review of the species of the genera Chirixalus, Philautus and Thelodema of Hoang Lien Mountains.

LIST OF GENERA AND SPECIES
IN THE FAMILY RHACOPHORIDAE
IN VIETNAM

The greatest diversity in Vietnam corresponds to the mountainous subtropical and tropical forests in the Northern (Tonkin) and Southern (Truong Son

Mountains [= Annam Mountains] and Tay Nguyen Plateau) regions of the country at elevations between 150 - 3000 m.

A list of the 5 genera and 40 species of rhacophorids in Vietnam follows:

**Chirixalus Boulenger, 1893**
- Chirixalus doriae Boulenger, 1893.
- Chirixalus laevis (Smith, 1924).
- Chirixalus nongkorensis (Cochran, 1927).
- Chirixalus palpebralis (Smith, 1924).
- Chirixalus vittatus (Boulenger, 1887).

**Philautus Gistel, 1848**
- Philautus aditus Inger, Orlov et Darevsky, 1999.
- Philautus banaensis Bourret, 1939.
- Philautus carinensis (Boulenger, 1893).
- Philautus gracilipes Bourret, 1937.
- Philautus gryllus Smith, 1924.
- Philautus maosonensis Bourret, 1937.
- Philautus parvulus (Boulenger, 1893).

**Polypedates Tschudi, 1838**
- Polypedates colletti Boulenger, 1890.
- Polypedates dennysi (Blanford, 1881).
- Polypedates dorsoviridis (Bourret, 1937).
- Polypedates dagritei David, 1871.
- Polypedates feae (Boulenger, 1893).
Polypedates leucomystax (Gravenhorst, 1829).
Polypedates megacephalus Hallowell, 1861 “1860”.
Polypedates mutus (Smith, 1940).
Polypedates omeimonis (Stebneger, 1924).

**Rhacophorus Kuhl and van Hasselt, 1822**

Rhacophorus annamensis Smith, 1924.
Rhacophorus appendiculatus (Günther, 1859 “1858”).
Rhacophorus balrogaster Inger, Orlov et Darevsky, 1999.
Rhacophorus bimaculatus (Peters, 1867).
Rhacophorus bipunctatus Ahl, 1927.
Rhacophorus calcaneus Smith, 1924.
Rhacophorus exechopygus Inger, Orlov et Darevsky, 1999.
Rhacophorus sp. nov.
Rhacophorus notater Smith, 1924.
Rhacophorus reinwardti (Schlegel, 1840).
Rhacophorus verrucosus Boulenger, 1893.

**Thelodema Tschudi, 1838**

Thelodema asperum (Boulenger, 1886).
Thelodema bicolor (Bourret, 1937).
Thelodema corticale (Boulenger, 1903).
Thelodema gordoni Taylor, 1962.
Thelodema stellatum Taylor, 1962.

**SPECIES ACCOUNTS. PART I**

**Polypedates Tschudi, 1838**

**Polypedates dugritei David, 1872 “1871”**

[Fig. 1, male (ROM 38652); Fig. 2, female (ROM 38642); Fig. 3, female (ROM 38642) and males (ROM 38652, ROM 38664); Fan Si Pan Mt., 1900 m]


**Type locality.** Mouping (= Baoxing Co.), Sichuan Prov., China. [Fig. 4, Topotypes of Polypedates dugritei, male (CIB 741532) and female (CIB 741533); Fig. 5, Topotypes of Polypedates dugritei, male (CIB 7910113) and female (CIB 7910211)].

**Description.** Polypedates dugritei is a medium-sized member of this genus; males attain a maximum SVL 41.8 mm (mean, n = 23, 37.0 mm), and females reach 53.0 mm (mean, n = 5, 50.1 mm). Measurements are given in Table 1. Head length less than head width, approximately 90% head width. In dorsal view snout rounded in females more acuminate in males, and in lateral view, truncate in females, distinctly sloping in males. Canthus rounded, loreal slightly concave in females, and distinctly concave in males; supratympanic fold present from posterior corner of eye to a level just behind insertion of arm. Tympanum partially obscured by a layer of skin, 52% of eye diameter in males, 56% in females. Vomerine processes variably developed, some with only a weak
Fig. 4. Topotypes of *Polidorana duprasi*, male (smaller specimen, CIB 741532) and female (CIB 741533). (a) dorsal view, (q) ventral view. Scale bar is 10 mm.

Fig. 5. Female *Polidorana duprasi* (KOM 38642) and males (KOM 38692, 386941 from Pan Sla Pan Mountain). (a) dorsal view, (q) ventral view.

Vietnamese Rhacophorids
ridge, others with a distinct ridge and up to 7 odonto-phores on each.

Fingers slender and long; discs moderately large, disc on finger III equal to or greater than tympanum diameter; fingers webbed basally and tapers distally to lateral fringes; nuptial pad in breeding males with microscopic pustules. Forearms without distinct dermal fold, but sometimes with an indistinct row of pustules. Legs relatively short, tibia 44% SVL; heels barely contact when adpressed; tibiotarsal articulation extends to midlevel of eye. Toes slender, discs slightly less than those on fingers; toes moderately webbed, webbing formula I 1½–1½ II 1½–2½ III 2–3 IV 2–2–V, distal webbing is reduced to fringes. Dermal appendages, calcars, absent, small row of tubercles maybe present along tarsus, more common in males than females.

Skin on dorsum smooth, males with or without small tubercles on dorsum, females always with indistinct tubercles evenly distributed on head and back; venter granular.

Sexual dimorphism expressed in size (females approximately 25% larger than males), the shape of snout, and color pattern. Males have a single median external vocal sac that is often darkened, and a nuptial pad on the thumb.

Dorsum light to dark green, reddish brown spots on the dorsum and flanks, the number of spots is extremely variable; some specimens having only a few scattered spots. The number and size of spots vary in females, but in general they have a higher number of reddish brown spots on the dorsum than do males, and in some cases form a dense mosaic on the back. Supratympanic fold and canthal ridges often outlined in this reddish brown color. Axillary region, flanks, anterior and posterior surface of thighs are black with white mottling in both sexes. Belly, chest, throat and ventral surface of limbs cream with variable amounts of mottling: females either spotted with gray (n = 1), spotted with dark brown (n = 3) or so heavily spotted that the belly is almost entirely brown (n = 1). Males are either nearly immaculate or lightly spotted with brown (n = 8), or heavily spotted (n = 15). Iris golden brown, pupil horizontal, black.

**Material examined.** Males, ROM 38641, 38643–38645, 38647; 38649, 38651–38657, 38659–38666, 38668–38669; females, ROM 38640; 38642; 38646; 38648; 38658.

**Distribution.** Southern Sichuan and Yunnan provinces, China (Liu and Hu, 1961; Inger et al., 1990; Yang et al., 1991; Zhao and Adler, 1993; Wu and Zheng, 1994; Zhao and Yang, 1997; Fei, 1999;
TABLE 1. Measurements of Polypedates dugritei

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SVL</th>
<th>IOD</th>
<th>HW</th>
<th>HL</th>
<th>FL</th>
<th>ED</th>
<th>TD</th>
<th>T</th>
<th>Number of spots on dorsum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max.</td>
<td>41.78</td>
<td>8.34</td>
<td>15.69</td>
<td>15.25</td>
<td>17.82</td>
<td>4.94</td>
<td>2.98</td>
<td>18.09</td>
<td>65% few spots</td>
</tr>
<tr>
<td>Min.</td>
<td>31.65</td>
<td>6.20</td>
<td>12.60</td>
<td>11.08</td>
<td>12.98</td>
<td>3.07</td>
<td>1.52</td>
<td>14.36</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>36.98</td>
<td>7.35</td>
<td>13.71</td>
<td>12.63</td>
<td>15.34</td>
<td>4.10</td>
<td>2.11</td>
<td>16.12</td>
<td></td>
</tr>
<tr>
<td>Standard deviation</td>
<td>2.72</td>
<td>0.55</td>
<td>0.96</td>
<td>1.07</td>
<td>1.65</td>
<td>0.45</td>
<td>0.39</td>
<td>1.12</td>
<td></td>
</tr>
</tbody>
</table>

| Max.      | 53.04 | 10.28 | 19.29 | 18.23 | 23.79 | 5.77 | 3.18 | 25.60 | 100% many spots |
| Min.      | 45.86 | 8.87 | 16.23 | 15.54 | 18.88 | 5.22 | 2.86 | 21.77 |                |
| Mean      | 50.13 | 9.60 | 18.64 | 16.89 | 21.20 | 5.40 | 3.01 | 23.47 |                |
| Standard deviation | 2.76 | 0.57 | 1.35 | 0.99 | 1.92 | 0.22 | 0.13 | 1.68 |                |

**Taxonomic notes.** Polypedates dugritei is likely a complex of cryptic species that has yet to be fully resolved. Recently, similar Chinese forms have been described as new species. Based on chromosomal polymorphism in “P. dugritei” a new species, P. zhaojuensis Wu and Zheng, 1994, was described from Emei Mountain, Washan and Zhaojue Mountains in Sichuan Province and in Lichuan of Hubei Province, China [Fig. 7, Holotype of Polypedates zhaojuensis, male (CIB 6883)]. He (1999) undertook a morphological analysis of this complex and described P. puerensis from Banshan, Puer County Yunnan Province, China [22°54' N, 101°21' E]. Both species in China were discovered at elevation between 1600 – 3150 m.

Polypedates puerensis He, 1999 from Banshan (elevation 2000 m) [for photos of holotype see He, 1999, p. 99] is similar to that on Fan Si Pan Mountain at 1900 m. It is possible that they are conspecific. The measurements given in the original description (He, 1999) are comparable to measurements from the Vietnamese material (male P. zhaojuensis from Yunnan. SVL, 35.5 – 41.1 mm [mean 40.5, n = 9]: females 52.0 – 55.2 mm [mean 53.6, n = 2]). The photo of P. puerensis (He, 1999) appears very similar to what we have found in Vietnam. However, the conspecificity of the Sa Pa material and Yunnan P. puerensis cannot be determined until specimens of the latter can be examined. Three males from Fan Si Pan Mountain differ slightly in coloration and body proportions from sympatric P. dugritei [Fig. 8, males Polypedates cf. dugritei, ROM 36639 (30509), 36650 (30507), 36667 (30508)]. The data on these specimens are given below:

**Variation.** SVL measurements of three males 33.4 – 35.2 mm (mean 34.0) (ROM 38639, 38650, 38667), collected on 5 May 1999. All measurements are given in Table 2. Dorsum olive-green with small...
Fig. 6. Habitats of thraupids on Fan Si Pan Mountain. a, b) Site 1; c, d) Site 2.
Vietnamese Rhacophorids

dark spots; the dorsal surfaces of the first and the second toes are green with reddish brown spots, toes I–III distinctly orange-red, IV–V reddish brown; throat and chest are light with a few indistinct dark spots; anterior and posterior surface of thighs are orange-red, the flanks and groin are distinctly mottled black in such a way that it form a narrow spotted line that demarcates the dorsum and venter. Heels of specimens ROM 38639 and 38667 with distinct row of white tubercles. Iris greenish yellow.


Polypedates dorsoviridis (Bourret, 1937)
[Fig. 9, female (ROM 38015, Field No. 30279); Fig. 10, male and female (ROM Field Nos. 30429, 30428); Fan Si Pan Mt., 1900 m]


Type locality. Chapa (= Sa Pa), Tonkin (= North Vietnam); 1500 m.

Description. Polypedates dorsoviridis is a small member of this genus; males attain a maximum SVL 40.0 mm (mean, \( n = 7, 35.5 \) mm), and females reach 42.8 mm (mean, \( n = 4, 42.8 \) mm). Measurements are given in Table 3. Head length nearly equal to head width, width approximately 98% head length. In dorsal view snout sharply rounded, in lateral view, rounded in females, and distinctly sloping in males. Canthus concave and rounded in males, straight and more distinct in female, loreal slightly concave in females, and distinctly concave in males; supratympanic fold present from posterior corner of eye to a level above insertion of arm. Tympanum partially obscured by a layer of skin, 52% of eye diameter in males, 55% in females. Vomerine processes present with 5 – 7 odontophores per ridge.

Fingers long, slender; discs moderately large, disc on finger III equal tympanum diameter in fe-
### TABLE 2. Measurements of *Polypedates cf. dugritei*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SVL</th>
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<th>HW</th>
<th>HL</th>
<th>FL</th>
<th>Eye diameter</th>
<th>Tympanum diameter</th>
<th>Tibia</th>
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<td>Max.</td>
<td>35.16</td>
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<td>12.59</td>
<td>12.79</td>
<td>15.48</td>
<td>4.36</td>
<td>2.65</td>
<td>16.05</td>
<td>100% many spots</td>
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<tr>
<td>Min.</td>
<td>33.39</td>
<td>6.18</td>
<td>11.81</td>
<td>10.24</td>
<td>15.00</td>
<td>3.12</td>
<td>1.86</td>
<td>14.57</td>
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<tr>
<td>Mean</td>
<td>0.34</td>
<td>6.61</td>
<td>12.25</td>
<td>11.31</td>
<td>15.29</td>
<td>0.04</td>
<td>0.02</td>
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<tr>
<td>Standard deviation</td>
<td>0.01</td>
<td>0.00</td>
<td>0.00</td>
<td>0.01</td>
<td>0.00</td>
<td>0.01</td>
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### TABLE 3. Measurements of *Polypedates dorsovirdis*

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<th>TD</th>
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#### 9 males

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<td>Max.</td>
<td>42.43</td>
<td>9.05</td>
<td>15.29</td>
<td>15.71</td>
<td>17.43</td>
<td>4.66</td>
<td>3.15</td>
<td>19.12</td>
<td>100% few spots</td>
</tr>
<tr>
<td>Min.</td>
<td>31.31</td>
<td>6.88</td>
<td>11.05</td>
<td>11.24</td>
<td>12.65</td>
<td>3.40</td>
<td>1.69</td>
<td>10.85</td>
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<tr>
<td>Mean</td>
<td>37.18</td>
<td>7.67</td>
<td>13.51</td>
<td>13.22</td>
<td>15.41</td>
<td>4.05</td>
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<tr>
<td>Standard deviation</td>
<td>3.91</td>
<td>0.80</td>
<td>1.53</td>
<td>1.51</td>
<td>1.83</td>
<td>0.42</td>
<td>0.51</td>
<td>2.66</td>
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#### 2 females

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<th>The number of spots on dorsum</th>
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<td>Max.</td>
<td>42.83</td>
<td>9.58</td>
<td>15.06</td>
<td>14.14</td>
<td>19.53</td>
<td>4.64</td>
<td>2.40</td>
<td>17.96</td>
<td>100% few spots</td>
</tr>
<tr>
<td>Min.</td>
<td>37.91</td>
<td>8.80</td>
<td>14.53</td>
<td>12.51</td>
<td>17.20</td>
<td>3.90</td>
<td>2.37</td>
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<tr>
<td>Mean</td>
<td>40.19</td>
<td>9.16</td>
<td>14.78</td>
<td>13.13</td>
<td>18.34</td>
<td>4.27</td>
<td>2.39</td>
<td>15.83</td>
<td></td>
</tr>
<tr>
<td>Standard deviation</td>
<td>3.73</td>
<td>1.46</td>
<td>1.22</td>
<td>1.20</td>
<td>1.68</td>
<td>0.52</td>
<td>0.20</td>
<td>3.00</td>
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</table>

Fig. 8. Males *Polypedates cf. dugritei* (ROM 38650, 38667, 38639), from Fan Si Pan Mountain; a) dorsal view, b) ventral view. Scale bar is 10 mm.
males, and smaller than tympanum in males; fingers moderately webbed, webbing formula, I 2 ± 2½ II 2–3 III 2–2 V, lateral fringes present distally; nuptial pad absent. Forearms without distinct dermal fold, but sometimes with an indistinct row of pustules. Legs relatively short, tibia 40–42% SVL; heels overlap slightly when adpressed; tibiotarsal articulation extends to posterior margin of eye. Toes slender, discs slightly less than those on fingers; toes moderately webbed, webbing formula I 1–2 II 1–2½ III 1–3 IV 2–1½ V, distal webbing is reduced to fringes. Dermal appendages, calcars, absent, faint glandular ridge along tarsus and toe V.

Skin on dorsum smooth, venter granular.

Sexual dimorphism expressed in size (females approximately 20% larger than males), snout shape, and color pattern. Males have a single median vocal sac that is not distended, obviously darkened in one specimen (ROM 380111).

Dorsum bright green with very small light green or white spots. Flanks white with variable black spotting. Venter without spots, white in females, yellow in males. Fingers I–III, disc of finger IV, toes I–III and disc of toe IV and V, dorsomedial surface of tibia and tarsus orange-red, anterior and posterior surface
of flanks also orange red, the posterior surface and occasionally the dorsomedial surface of tibiotarsus with large black spots. Iris brilliant orange above, and less subdued hue below, pupil horizontal, black.

Material examined. Males, ROM 38009–38011, 38014–38016, 38018; females, ROM 38006–38008, 38017.

Distribution. Inhabits northern parts of Hoang Lien Mountains in Vietnam (Bourret, 1937; 1942) and, probably, adjacent regions in China (see taxonomic comments).

Habitat and ecological notes in Vietnam. We observed this species in the vicinity of Site 1, approximately 1900 m (Map 2, Fig. 6a, b). It occupies similar microhabitats as P. dugritei, although often keeping lower to the ground than P. dugritei. Often it was found on broad-leaf vegetation of the Araceae family, in particular, on the leaves of Anturium sp., and plants of the family Gingeracae. During our observations (May–April), this species was most active on relatively warm (+14°C) foggy-rainy nights.

Taxonomic notes. The descriptions of P. nigropunctatus (Liu, Hu et Yang, 1962) [Liu et al., 1962; Yang et al., 1991] suggest that it is closely allied with P. dorsoviridis (Fig. 11). The former is known from western Guizhou and western Yunnan, China (Frost, 1985; Yang et al., 1991; Zhao and Adler, 1993; Fei, 1999). The type locality for P. nigropunctatus is Long-chu, Weining Co., western Guizhou Province, 2134 m. Because no attention given to the name P. dorsoviridis in any of these descriptions it is unclear if the authors were aware of this species when P. nigropunctatus was described. The SVL measurements given in Yang et al. (1991) for male P. nigropunctatus indicate that it is a smaller species than Vietnamese P. dorosoviridis (P. nigropunctatus: 28.0 – 32.0 mm; mean 29.7). However, these values are based on four males only.

If Polypedates dorsoviridis and P. nigropunctatus are conspecific, because the former has priority, P. nigropunctatus should be considered a junior synonym of P. dorsoviridis. However, we refrain from making any taxonomic decisions regarding the Chinese species until additional material from Guizhou or Yunnan can be examined.

Polypedates omeimontis Stejneger, 1924
[Figs. 12, 13, male and female, Fan Si Pan Mountain; Fig. 14, male and female (ROM 38775, 38759, Field Nos. 30358, 30357); Fig. 15, topotypes of *Polypedates omeimontis*, females (CIB 561066, 561068); Fig. 16, topotypes of *Polypedates omeimontis*, male (CIB 55.V.19) and females (CIB 55.V.05)].


**Type locality.** Shin-Kai-Si (= Xin-Kai Si), Omei Mountain, Szechwan (= Sichuan Prov.), China.

**Description.** *Polypedates omeimontis* is a medium-sized species of *Polypedates*; males attain a maximum SVL 67.2 mm (mean, n = 27, 59.1 mm), and females reach 73.6 mm (mean, n = 2, 72.6 mm). Measurements are given in Table 4. Head width nearly equal to head length, average width 97% of the length. In dorsal view snout obliquely rounded in females, more acuminate in males, in lateral view, weakly sloped in females, and distinctly sloped in males. Canthus rounded, loreal region concave; supratympanic fold present from posterior corner of eye to a level above and behind insertion of arm. Tympanum partially obscured by a layer of skin, 70% of eye diameter in males, 83% in females. Vomerine processes present with 12 or more odontophores per ridge.

Fingers long; discs large, disc on finger III equal tympanum diameter in females, and smaller than in males; fingers moderately webbed, webbing formula, I 2¾–2½ II 1½–2¾ III 2½–2 V, lateral fringes present distally; nuptual pad on thumb and base of first finger, composed of microscopic pustules. Forearms without distinct dermal fold. Legs robust, tibia 49% SVL in males, 54% in females; heels overlap slightly in males, more so in females when ad pressed; tibiotarsal articulation extends between eye and nostril in males, and to nostril in females. Toes long, discs slightly less than those on fingers; toes extensively webbed, webbing formula I–1–1 II 1–1 + III 1–2 IV 2–1 V, distal webbing reduced to slight lateral fringes on toe III. Dermal appendages, calcars, absent.

Skin on dorsum smooth to shagreen; venter granular.

Sexual dimorphism is evident in size, snout shape, and coloration.

The dorsum of males is bright-green (in preservative bluish-gray or bluish-green), large brown spots on the dorsum and limbs, number of spots on males is
Fig. 14. Male (smaller specimen) and female *Polypedates omeinomus* (ROM 38775, 387599). a) dorsal view, b) ventral view. Scale bar is 10 mm.

Fig. 15. Topotypes of *Polypedates omeinomus*, females (CIB 561066, 501088). a) dorsal view, b) ventral view. Scale bar is 10 mm.
TABLE 4. Measurements of *Polypedates omeimontis*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SVL</th>
<th>IOD</th>
<th>HW</th>
<th>HL</th>
<th>FL</th>
<th>ED</th>
<th>TD</th>
<th>T</th>
<th>The number of spots on back</th>
<th>Distance nostril to tip of snout</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max.</td>
<td>67.20</td>
<td>13.00</td>
<td>21.71</td>
<td>21.81</td>
<td>31.81</td>
<td>7.80</td>
<td>5.75</td>
<td>31.28</td>
<td>70% lots</td>
</tr>
<tr>
<td></td>
<td>Min.</td>
<td>53.13</td>
<td>10.41</td>
<td>17.85</td>
<td>18.62</td>
<td>25.74</td>
<td>5.33</td>
<td>3.68</td>
<td>26.63</td>
<td>3.88</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>59.05</td>
<td>11.73</td>
<td>19.70</td>
<td>20.36</td>
<td>27.88</td>
<td>6.70</td>
<td>4.64</td>
<td>29.16</td>
<td>4.86</td>
</tr>
<tr>
<td></td>
<td>Standard deviation</td>
<td>3.25</td>
<td>0.57</td>
<td>0.90</td>
<td>0.87</td>
<td>1.50</td>
<td>0.65</td>
<td>0.51</td>
<td>1.33</td>
<td>0.72</td>
</tr>
<tr>
<td></td>
<td>Max.</td>
<td>73.57</td>
<td>15.17</td>
<td>26.22</td>
<td>24.16</td>
<td>35.70</td>
<td>7.18</td>
<td>6.00</td>
<td>40.39</td>
<td>100% lots</td>
</tr>
<tr>
<td></td>
<td>Min.</td>
<td>71.67</td>
<td>15.02</td>
<td>26.07</td>
<td>23.10</td>
<td>33.71</td>
<td>6.98</td>
<td>5.74</td>
<td>38.27</td>
<td>5.11</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>72.62</td>
<td>15.10</td>
<td>26.15</td>
<td>23.63</td>
<td>34.71</td>
<td>7.08</td>
<td>5.87</td>
<td>39.33</td>
<td>5.85</td>
</tr>
<tr>
<td></td>
<td>Standard deviation</td>
<td>1.34</td>
<td>0.11</td>
<td>0.11</td>
<td>0.75</td>
<td>1.41</td>
<td>0.14</td>
<td>0.18</td>
<td>1.50</td>
<td>1.05</td>
</tr>
</tbody>
</table>

Considerably less than that of females. Canthus and supratympanic ridge outlined in brown. In both sexes, the dorsum and limbs are covered with small white spots, which are much more abundant on females. Venter is creamy white and lighter in males than females (tan in preservative), both sexes with light spotting of gray or brown, or immaculate (ROM 38779, 38761, 38772, 38769); throat on males is gray (brown in preservative) with light brown spotting on some, throat of females either light gray (ROM 38762) or very dark gray with white spotting (ROM 38759).

**Material examined.** Males, ROM 38758, 38760, 38761, 38763 - 38786; females, ROM 38759, 38762.

Habitat and ecological notes in Vietnam. P. omeimontis was discovered in the Hoang Lien Mountains at elevations between 1200 – 2100 m. They were observed mostly at an elevation of 1900 m near Site 1, and one example was found on the Site 2 (Fig. 6; Map 2). This species inhabits forest trails that are in close proximity to streams and swampy flood-plain. They occupy mostly dense vegetation on bushes and trees at the height of 150 – 400 cm. Vocalizing males were found sitting on thick branches high off the ground, their cryptic color pattern making them difficult to find. Silent females were even more difficult to be recorded. As in other rhabdophoriids, they are mostly active in relatively warm (more than 14°C) foggy rainy nights. Nests are constructed at the approximate height of 100 – 400 cm, and consist of large leaves from distal parts of branches wrapped around a foamy ball surrounding a clutch of eggs. Sometimes nests are constructed in bamboo thickets. Nests on ferns are also noted. As a rule, trees with nests are directly above stagnant pools amidst the flood-plains of streams. A pair in amplexus was found on a tree at ~300 cm off the ground and approximately 5 m from the stream.

Taxonomic notes. The Vietnamese material identified as P. omeimontis is very similar in body proportions to the specimens from southern China. Zhao and Yang (1997) provide measurements for P. omeimontis from Hengduan Mountain Region, Qinghai – Xizang Plateau (China), that are within the range of the material from Hoang Lien Mountains. SVL of males from China 52.0 – 65.5 mm (mean 59.0, n = 18); females — 70.0 – 79.5 mm (mean 75.7, n = 7). Similar data are given by Inger et al. (1990) for Sichuan Province: SVL males 54 – 67 mm (mean 59.5, n = 13).


Polypedates feae (Boulenger, 1893)

[Fig. 17, 18, physiological variants in coloration of P. feae from Fan Si Pan Mountain]


Type locality. Thao, northern Burma (= Myanmar).

Description. Polypedates feae is an extremely large species of Polypedates: two females have SVL of 119.2 mm (ROM 38139) and 118.8 mm (ROM 38138). The following description is based on these two animals. Head length slightly less than head width, 96 – 97% width. In dorsal view snout rounded, in lateral view, weakly sloped. Canthus distinct, loreal region concave; supratympanic fold present from posterior corner of eye to a level behind insertion of arm. Tympanum partially obscured by a layer of skin, 60 – 61% of eye diameter. Vomerine processes present with 8 – 12 odontophores per ridge.

Fingers long, robust, discs large, disc on finger III slightly larger than tympanum diameter, smaller than eye diameter; fingers extensively webbed, webbing formula, I 1½ – 2 II 1–2 III 1 ± 1 V, weak lateral fringe on finger III. Forearms with a weak dermal fold that extends to tip of finger IV. Legs robust, tibia 32 – 34% SVL; heels overlap slightly when addpressed; tibiotarsal articulation extends to the nostril. Toes long, robust, discs approximately 75% of those on fingers; toes extensively webbed, webbing formula 1 1–1 11 1–1 11 1–1 IV 1–1 V. Dermal appendages, calcar. absent, thin glandular fold extends from heel to tip of toe V.

Skin on dorsum smooth, belly and ventral surface of thighs granular, throat, chest, and ventral surface of arms smooth.

The dorsum and dorsal surfaces of limbs, discs, and flanks uniformly bright-green (in preservative bluish-gray), webbing between fingers III – IV and toes IV – V green (in preservative, light brown with some blue-gray); webbing between fingers I – III, toes I – IV creamy white; glandular fold from heel to toe V, white; canthus, lateral extremities of upper eyelid and supratympanic fold highlighted golden brown. Lower lip cream colored, throat greenish white (gray in preservative) chest tan, belly and ventral surface of thigh also tan but spotted with brown, spotting is
more concentrated on the thighs. While held captive the two female specimens underwent color shifts from bright green to brown. This could be a result of what they were encased in, because they were agitated, or maybe temperature dependent (Figs. 17, 18).

**Distribution.** Myanmar; northern Thailand; northern Laos; Vietnam; Yunnan (Southern China). [Ahl, 1931; Wolf, 1936; Bourret, 1942; Liu and Hu, 1961; Yang et al., 1991; Frost, 1985, 1999, 2000; Zhao and Adler, 1993; Orlov and Ho, 2000 a.]

**Habitat and ecological notes in Vietnam.** Inhabits mountainous regions of the provinces Lao Cai and Lai Chau on Fan Si Pan Mountain and Phoung Chang Mountain in Hoang Lien Mountains; elevation 1200 – 1800 m (Maps 1, 2; Fig. 6c). A male *Polypedates feae* (Figs. 19, 20) from Ngoc Linh Mountain, Kon Tum Province, Southern Vietnam (ZISP 21419) was revealed also in the provinces Kon Tum on a Ngoc Linh Mountain, southern Vietnam, at elevation 1500 – 2000 m. This marks the southernmost distribution of this species (Map 1). This major range extension suggest a much broader distribution of the species in Vietnam and Laos. This species prefers rare secondary forest tract with bushes, bamboo thickets and numerous stagnant pools situated, as a rule, not far from mountain rivers (Fig. 21).

The two females (ROM 38139, 28381) were found on a robust branch approximately 2.5 m above a swiftly moving stream. Both specimens were captured within 2 m of each other, over a period of 3 hours. When startled, they escaped by jumping into the fastest part of the stream, and surfaced about 50 m downstream. Once apprehended the females produced a very loud and shocking distress call that sounded like a screaming baby.

Nests are constructed on the soil or not far off the ground, approximately half a m above ground they are found on vegetation near stagnant pools. As a rule these pools are situated in the vicinity of swift montain rivers.

On occasion they are found in banana and bamboo thickets in the swampy places of secondary forests. In this condition, found mainly in southern Vietnam, they were noted together with *Polypedates leucomystax*.

**Taxonomic notes.** *P. feae* together with *P. dennysii* (Blanford, 1881) are the largest anuran in mass and SVL for Vietnam and, probably, for all of
Rhacophoridae. At one locality, Tam Dao (Vinh Phu and Bac Thai Provinces, Vietnam), we have conducted many years of observations of *P. dennysii*, where the largest known specimens of this species occur (max SVL males, 128 mm; max SVL females, 132 mm). Previous collections estimate the maximum SVL of *P. feae* from Sa Pa [SVL male, 106 mm (FMNH 213928); SVL female, 114 mm (FMNH 213930)] less than our latest data (see description of *P. feae*).

*Polypedates feae* and *P. dennysii* are very similar in both appearance and biology. In Vietnam *P. feae* can be found west and south of the Red River in the mountains of Tonkin and Annam. The distribution of *P. dennysii* is limited to the left bank of Red River east to the mountains and foothills of Tonkin. At this time we do not know the zones of sympatry.

Vietnamese Rhacophorids


**Polypedates leucomystax** (Gravenhorst, 1829)


**Type locality.** Java (Indonesia).

**Distribution.** Traditionally it is accepted that *Polypedates leucomystax* (sensu lato) inhabits vast regions in East and Southeast Asia from eastern India and southern China (including Taiwan and Hainan) through Indochina to the Philippines and Indonesia (Sumatra, Java, Borneo); introduced on Okinawa Island, Japan [Okada, 1931; Bourret, 1942; Inger, 1954; Taylor, 1962; Inger, 1966; Frost, 1985, 1999, 2000; Matsui et al., 1986; Yang, at al., 1991, Zhao and Adler, 1993; Zhao and Yang, 1997; Inger et al., 1999; Orlov and Ho, 2000a.]

**Habitat and ecological notes in Vietnam.** It is common throughout Vietnam, and does exceptionally well in disturbed habitats.

**Taxonomic notes.** At present no agreement has been reached regarding the distribution, relationships, and taxonomic status of the forms belonging to the difficult complex of “*Polypedates leucomystax*”: *Polypedates leucomystax leucomystax* (Gravenhorst, 1829); *Polypedates leucomystax sexvirgatus* (Gravenhorst, 1829); *Polypedates leucomystax terraiensis* Dubois, 1987; *Polypedates longinatus* (Ahl, 1931); *Polypedates macrotis* (Boulenger, 1891); *Polypedates megacephalus* Hallowell, 1861; *Polypedates mutus* (Smith, 1940). Ongoing investigations into this group demonstrate that the number of species the *P. leucomystax* complex cannot be determined based solely on descriptions. In Vietnam we noted no less than five forms that clearly differ in coloration, size, relative length of extremities, relative size of eyes, vocalization, elevational distribution, microhabitat preference, nest construction, and cellular and DNA content. In some regions we noted the sympatry of three forms, each with clearly different microhabitat preferences (in mountainous regions of Tonkin and in southern Vietnam on Tay-Nguen Plateau). Some differences noted in the *P. leucomystax* complex in southern Vietnam are discussed in Inger et al. (1999).

Using acoustic and karyotypes Matsui et al. (1986) identified characteristics that distinguish Taiwan, Borneo, and mainland China forms. Zhao and Adler (1993) have records of two species of this complex,

![Fig. 21. Habitat of Polypedates feae in Ngoc Linh Mountain, 1500 m elevation.](image)

*P. mutus* and *P. megacephalus*, in China, northeast India, and northern Myanmar. These two forms are also known from northern Vietnam, in particular, the northern part of Hoang Lien Mountains (Trepanier et al., 1999).

**Polypedates megacephalus** Hallowell, 1861 “1860”


**Type locality.** Hong Kong, China.

**Distribution.** Southern China including Taiwan, Hong Kong and Hainan, west to Xizang (= Tibet), north to Gansu; north-eastern India; northern Vietnam (Zhao and Adler, 1993; Zhao and Yang, 1997; Frost, 1999, 2000).

**Habitat and ecological notes in Vietnam.** This species inhabits the mountains and foothills in Northern Vietnam. It has been observed sympatrically with smaller *P. leucomystax*, in Hai Duong, Cao Bang, and Vinh Phu Provinces.


**Polypedates mutus** (Smith, 1940)

*Polypedates mutus* M. A. Smith, 1940, Rec. Indian Mus., Calcutta, 42, 473.

**Type locality.** N’Chang Yang, northern Burma (= Myanmar).

**Distribution.** Northern Myanmar; Yunnan, Guizhou, Guangxi, and Hainan Island, China; northern Laos; northern Vietnam (Liu and Hu, 1961; Yang et al., 1991; Zhao and Adler, 1993; Zhao and Yang, 1997; Frost, 1999, 2000).

**Habitat and ecological notes in Vietnam.** Found throughout all of northern Vietnam from the border of southern China to northern reaches of the Annam mountain in Nghe An Province.


**Polypedates cf. hungfuensis** (Liu and Hu, 1961)

[Fig. 22, 23, male P. cf. hungfuensis from Fan Si Pan Mt., ROM 37996 (30568)]


**Type locality.** Mt. Hong (= Hongfoshan), Guan Co. (= Duijiangian Shi), Sichuan Prov., China.

**Description.** This specimen, a single male collected on 1999: Site 1 (Map 2) in the vicinity of 1900 m in elevation, most closely approximates *P. hungfuensis* as described by Liu and Hu (1961) in body shape and proportions. It is a small *Polypedates*, SVL 39.2 mm. Additional measurements of this specimen (ROM 37996): IOD 7.8; HW 14.0; HL 13.9; FL 18.5; ED 4.2; TD 3.3; T 18.4. Head length equal to head width; in dorsal view snout sharply rounded, and in lateral view sloping. Canthus rounded, loreal weakly concave; supratympanic fold present from posterior corner of eye to a level just above insertion of arm. Tympanum partially obscured by a layer of skin. 79% of eye diameter. Vomerine processes obliquely aligned with 5 odontophores on each ridge.

Fingers long, slender with medium-sized discs, disc on finger III slightly larger than tympanum diameter; fingers webbed basally, webbing formula 12½–2½ II 2–3–III 2½–2½ IV and tapers distally to lateral fringes on fingers II–IV; nuptial pad on thumb and base of finger I composed of microscopic pustules. Forearms without distinct dermal fold or row of pustules. Legs relatively short, tibia 47% SVL; heels barely contact when addressed; tibiotarsal articulation extends to anterior margin of eye. Toes slender, discs slightly less than those on fingers, toe disc IV equal to finger disc IV; toes moderately webbed, webbing formula 12–2 II 1½–3 III 2–3 IV 2–2 V, distal webbing reduced to lateral fringes on toe IV and V. Dermal appendages, calcares, absent, small row of tubercles along tarsus absent.

Skin on dorsum granular with microscopic wrinkles, venter weakly granular.

Dorsum in life (and preservative) dark, almost black, with indistinct light brown spots on flank and groin. Supratympanic fold and canthal ridge same color as dorsum. Belly and throat flesh colored (creamy white in preservative) with microscopic brown flecks more concentrated on the thighs below the anus. Axillary region, flanks, anterior and posterior surface of thighs are black with white mottling in both sexes. Dorsal surfaces of Toes I–IV, Finger I–III, and anterior and posterior surfaces of thighs orange-red. Iris dark brown.


**Type locality.** Mt. Hong (= Hongfoshan), Guan Co. (= Duijiangian Shi), Sichuan Prov., China.

**Description.** This specimen, a single male collected on 1999: Site 1 (Map 2) in the vicinity of 1900 m in elevation, most closely approximates *P. hungfuensis* as described by Liu and Hu (1961) in body shape and proportions. It is a small *Polypedates*, SVL 39.2 mm. Additional measurements of this specimen (ROM 37996): IOD 7.8; HW 14.0; HL 13.9; FL 18.5; ED 4.2; TD 3.3; T 18.4. Head length equal to head width; in dorsal view snout sharply rounded, and in lateral view sloping. Canthus rounded, loreal weakly concave; supratympanic fold present from posterior corner of eye to a level just above insertion of arm. Tympanum partially obscured by a layer of skin. 79% of eye diameter. Vomerine processes obliquely aligned with 5 odontophores on each ridge.

Fingers long, slender with medium-sized discs, disc on finger III slightly larger than tympanum diameter; fingers webbed basally, webbing formula 12½–2½ II 2–3–III 2½–2½ IV and tapers distally to lateral fringes on fingers II–IV; nuptial pad on thumb and base of finger I composed of microscopic pustules. Forearms without distinct dermal fold or row of pustules. Legs relatively short, tibia 47% SVL; heels barely contact when addressed; tibiotarsal articulation extends to anterior margin of eye. Toes slender, discs slightly less than those on fingers, toe disc IV equal to finger disc IV; toes moderately webbed, webbing formula 12–2 II 1½–3 III 2–3 IV 2–2 V, distal webbing reduced to lateral fringes on toe IV and V. Dermal appendages, calcares, absent, small row of tubercles along tarsus absent.

Skin on dorsum granular with microscopic wrinkles, venter weakly granular.

Dorsum in life (and preservative) dark, almost black, with indistinct light brown spots on flank and groin. Supratympanic fold and canthal ridge same color as dorsum. Belly and throat flesh colored (creamy white in preservative) with microscopic brown flecks more concentrated on the thighs below the anus. Axillary region, flanks, anterior and posterior surface of thighs are black with white mottling in both sexes. Dorsal surfaces of Toes I–IV, Finger I–III, and anterior and posterior surfaces of thighs orange-red. Iris dark brown.
Distribution. Sichuan and Guangxi Provinces, China (Dubois, 1987, Jiang et al., 1987; Frost, 1985, 1999, 2000; Zhao and Adler, 1993; Ye et al., 1993; Fei, 1999); presumably northwestern Vietnam.

Habitat and ecological notes in Vietnam. One male was found at the elevation of 1900 m in the region of Site 1 in the same microhabitat as Polypedates dorsoviridis (Map 2, Fig. 6a).

Taxonomic notes. The single specimen, a male, appears to share the greatest similarity, with P. hungfirensis [Fig. 24, holotype of Rhacophorus hungfirensis, male (CIB 1957.3/V, 570960)].

In appearance it is similar to P. dorsoviridis, but differs in that it has more granulated skin, dark colored dorsum, flanks dark, iris dark brown, no glandular ridge along tarsus and foot and a tympanum that is relatively larger with respect to the eye. Obviously, for more precise conclusions we will need examine additional material. The maximum SVL of male P. hungfirensis is 36.8 mm, and that for females is 45.5 mm (Liu and Hu, 1961). According to Fei (1999) SVL of male can reach 35 mm and SVL of female 45 mm.
Rhacophorus Kuhl and van Hasselt, 1822

Rhacophorus reinwardtii (Schlegel, 1840) (Fig. 25)


Type locality. Java and Sumatra, Indonesia.

Distribution. Sumatra and Java (Indonesia); Malay Peninsula (Malaysia; Thailand and South Myanmar); Yunnan and Guangxi, China; Laos and Vietnam (Liu and Hu, 1961; Inger, 1966; Berry, 1975; Yang, 1991; Zhao and Adler, 1993; Ye et al., 1993; Inger et al., 1999; Frost, 1985, 1999, 2000; Orlov and Ho, 2000b).

Habitat and ecological notes in Vietnam. Widely inhabits mountainous and foothills regions of Vietnam between 200 – 1800 m. (Bourret, 1942; Inger et al., 1999; Orlov and Ho, 2000b).

Taxonomic notes (see Table 5). Coloration is fairly consistent across its entire range, however there are differences in intensity and number of white spots on the back, the intensity of yellow coloration on the sides, belly and throat. Further details distinguishing R. reinwardtii from other large species of green Rhacophorus were given in Inger et al. (1999). R. reinwardtii has formula of subarticular tubercles for fingers is 1–2–3–2 and for toes is 1–1–1–2–3–2 and vornemine processes with 9 odonto-phores per ridge.

The extreme similarity between R. reinwardtii and R. nigropalmatus Boulenger, 1895, often causes confusion and as a result does not allow for the possibility to interpret the precise distribution of R. nigropalmatus based on the literature. Nguyen and Ho (1996) report R. nigropalmatus in Vietnam. However, vouchers of Vietnamese R. nigropalmatus are unknown to us, and whether it occurs in the eastern part of Indochina has still not been confirmed. Most likely that all records for R. nigropunctatus in Vietnam are actually misidentified R. reinwardtii.

Rhacophorus verrucosus Boulenger, 1893  
[Figs. 26, 27, female Rhacophorus verrucosus from Fan Si Pan Mountain].

Rhacophorus verrucosus G. A. Boulenger, 1893,  

Type locality. Thao, Burma (= Myanmar).

Distribution. Arunachal Pradesh, India; Myanmar; Laos; Thailand and Vietnam (Bourret, 1942; Dubois, 1987 “1986”; Duellman, 1993; Inger et al., 1999; Frost, 1999; Orlov and Ho, 2000). The distribution of the species is wider and, mostly likely, includes southern China, Hainan and Taiwan islands. Currently there is a significant problem deciphering this group of closely related forms (see taxonomic comments), thus making it impossible to accurately estimate its distribution.

Habitat and ecological notes in Vietnam. This species occurs in the Annam mountains in the south and the Tonkin Mountains in the north at elevations from 150 m (Ha Tinh Prov.) to 2000 m (Lao Cai Prov.). R. verrucosus is present within these elevations in all mountain systems from northern Annam north to the Chinese border.

Taxonomic notes. Inger et al., (1999) discuss problems of similarity and distribution of the species group Rhacophorus verrucosus, which includes R. appendiculatus (Günther, 1858), R. bisacculus Taylor, 1962, and R. microtympanum (Günther, 1859 “1858”) [= R. cavirostris (Günther, 1858) in Lue, Lai, and Chen, 1994; or Philautus cavirostris in Jiang, Hu and, and Zhao, 1987; Zhao and Adler, 1993]. It is necessary to note that in Vietnam there have been found two species of this group: R. verrucosus in mountain forests of Tonkin and Northern Annam and R. appendiculatus in southern part of Annam mountains and Tay-Nguyen Plateau.

Determining what species is present in northern Vietnam is more difficult because of a complex of similar forms that have been reported from northern

<table>
<thead>
<tr>
<th>Distribution range</th>
<th>Males</th>
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<th>Females</th>
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<td>SVL, mm</td>
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<td>Northern Vietnam</td>
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<td>Lao Cai Province</td>
<td>67.3–69.5</td>
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<td>91.2</td>
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<td>Vinh Phu Prov.</td>
<td>65.2–70.5</td>
<td>11</td>
<td>80.5–93.2</td>
<td>8</td>
<td>coll. ZISP</td>
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<td>Gia Lai Province, southern Vietnam</td>
<td>65.6–69.7</td>
<td>3</td>
<td>81.8–92.7</td>
<td>8</td>
<td>Inger et al., 1999</td>
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<tr>
<td>Yunnan, China</td>
<td>66.0–72.0</td>
<td>10</td>
<td>74.0–95.0</td>
<td>5</td>
<td>Yang et al., 1991</td>
</tr>
<tr>
<td>Java, Indonesia</td>
<td>46.4–54.6</td>
<td>2</td>
<td>56.2–65.7</td>
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<td>Inger et al., 1999</td>
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Vietnam and adjacent China. In northern Vietnam there are records for *Rhacophorus appendiculatus* [Philautus appendiculatus in Ye, Fei, and Hu, 1993] and in southern China *R. microtymanum* (= *R. cavirostris*); *R. naso* Annandale, 1912 [in Zhao and Adler, 1993; Fei, 1999] or *Polypedates naso* in Ye, Fei, and Hu, 1993; Frost, 1999, and *Philautus odontotarsus* Ye and Fei, 1993 [in Zhao and Adler, 1993; Ye, Fei, and Hu, 1993; Fei, 1999; Frost, 1999]. We refrain from making any taxonomic motions at this time. However, a thorough investigation into this species complex may reveal that these forms from northern Vietnam and southern China are conspecific.

Vietnamese Rhacophorids


Rhacophorus hoanglienensis sp. nov.

[Figs. 28 – 30]

Holotype. ROM 37997 (Field No. ROM 28290), an adult male collected at Fan Si Pan Mountain, northern part of Hoang Lien Mountains, Sa Pa district, Lao Cai Province; 1400 m elevation; [22°18'59" N, 103°49'35" E], 30 May 1999 by Amy Lathrop, Tom Mason, Robert W. Murphy, Ho Thu Cuc, Nikolai Orlov, and Rafael de Sa (Fig. 6; Maps 1, 2, Site 3).

Etymology. The species is named after the Hoang Lien mountain range in northern Vietnam where it was found.

Diagnosis. A medium-sized Rhacophorus (male, SVL 43.2 mm) distinguished from all other members of Asian rhacophorids by a combination of the following characters: canthus rostralis very distinct; loreal region dark, in sharp contrast with top of head and snout; tympanum small, indistinct; posterior flank and groin white with black marbling; weak dermal flaps on forearm; calcar on heels; skin smooth; webbing on hands moderate; dorsum brown.

Description. Rhacophorus hoanglienensis is a medium-sized rhacophorid; the single male specimen having SVL 43.2 mm. Head width greater than length, length 75% head width. In dorsal view snout acuminate, in lateral view truncate. Canthus distinct, loreal concave; lips flared; supratympanic fold present from posterior corner of eye to a level above and behind insertion of arm. Tympanum partially obscured by a layer of skin, 46% of eye diameter. Vomeronine processes present, with 5 odontophores on each.

Fingers robust and long; discs moderately large, disc on finger III a little greater than tympanum diameter; fingers webbed basally and tapers distally to lateral fringes, webbing formula: I 2–2 II 2⁺–2½ III 2–1½ IV; nuptial pad is present (Fig. 30a). Formula of subarticular tubercles for fingers 1–2–3–3. Forearms with a small, distinct dermal flap from elbow to wrist. Legs relatively short, tibia 47% SVL; heels strongly overlap when ad pressed; tibiotarsal articulation extends more than the midpoint of eye. Toes robust, discs less than those on fingers (Fig. 30b); toes moderately webbed, webbing formula I 1–1½ II 1½–2⅔ III 1⅓, 2 IV 2–1V, distal webbing is reduced to fringes. Formula of subarticular tubercles for toes: 2–2–3–3–3. Lateral edge of tarsus and toe V with weak dermal ridge; calcar present on heels.

Skin on dorsum smooth, venter granular.

Dorsum brown with diffuse darker brown pattern on sacral, scapular and head region; black spot above each sacral diapophysis and a few at the distal end of the coccyx. A darkened interorbital bar present. Supratympanic fold highlighted below by a thin dark brown line; side of head including snout, loreal region and temporal region a darker shade of brown. From above, light pattern on top of head comes to an apex at the tip of the snout. Flanks gray with some diffuse dark mottling in axillary region; groin white with black mottling and a few randomly placed oceli on groin and flanks. The dorsal surface of hindlimb has alternating wide and narrow transverse dark stripes (on femur, 6; tibia, 6; tarsus, 4). Forearm with 4 thick transverse bands. Ventral surfaces of the body are creamy white, covered by small dark spots that merge in distal parts of the fore and hind limbs creating a completely dark background. The distal part of the first and second finger remain light; throat is dark gray; a proximal part of the ventral surface of the hind limbs is covered by additional large, dark spots.
Fig. 30. Rhacophorus hoanglienensis sp. nov.: a) fingers, b) toes.

Along the anterior and posterior surface of the thighs are black with white. Iris golden brown.

**Measurements of holotype, mm.** SVL of specimen (ROM 37997, male), 43.2; IOD, 8.5; HW, 12.6; HL, 13.3; FL, 17.9; eye diameter, 4.6; tympanum diameter, 2.1; Tibia 22.0; femur, 20.9.

**Comparisons.** There are several Southeast Asian species of Rhacophorus that possess dermal flaps on the forearms [R. exechopygus Inger et al., 1999; R. annamensis Smith, 1924; R. nigropalmatus Boulenger, 1895; R. reinwardtii (Schlegel, 1840); R. calcaneus Smith, 1924; R. prominanus Smith, 1924; R. maximus Gunther, 1859; R. robinsoni Boulenger, 1903; R. pardalis Gunther, 1858; R. "verrucosus - appendiculatus," complex]. Incomplete webbing in R. hoanglienensis distinguishes it from R. exechopygus, R. annamensis, R. maximus, R. nigropalmatus, R. pardinus, R. bipunctatus, R. prominanus, R. reinwardtii, R. robinsoni. Smooth skin on the dorsum further distinguishes it from R. verrucosus Boulenger, 1893; R. appendiculatus (Gunther, 1859 "1858") and R. bisacculus Taylor, 1962. Brown dorsum and SVL of 43.2 mm distinguishes it from the much larger species, R. maximus, R. nigropalmatus, R. reinwardtii, and R. annamensis; the vomerine teeth, and no white spot below eye separates it from R. bimaculatus that lack vomerine teeth (Brown and Alcala, 1994). R. hoanglienensis can be distinguished from R. bimaculatus and R. cyanopunctatus by the absence of a light spot in the temporal region. It differs from R. bipunctatus by light gray coloration of finger and toe discs (red-yellow or red in R. bipunctatus); from R. baliogaster Inger et al., 1999 by gray coloration of of belly with small spots (R. baliogaster has white belly with large dark spots), in addition to other characters the snout of the males of R. baliogaster is more rounded.
It is most important to underline the differences of new species from Indochina and southern chinese medium-sized species of *Rhacophorus* with brown coloration: *Rhacophorus bimaculatus* (Peters, 1867); *R. calcaneus* Smith, 1924; *R. cyanopunctatus* Manthey et Steiof, 1998; *R. translineatus* Wu, 1977; *R. bipunctatus* Ahl, 1927, and *R. rhodopus* Lui et Hu, 1959 [*R. rhodopus* appears to be conspecific with *R. bipunctatus* (Frost, 1999, 2000)]. In addition, we record the following differences: *R. bimaculatus* (type, ZMB 5681) [Brown and Alcala, 1994; Manthey and Steiof, 1998] differs from new species by formula of subarticular tubercles for forehands 1–1–2–2 and for legs 1–1–2–3–2; *R. calcaneus* differs by sharply pointed snout, the vomerine processes with 4 odontophores per ridge and formulas of subarticular tubercles 1–2–3–2 and 2–1–2–3–2, respectively: *R. cyanopunctatus* (holotype, ZMB 57895) by formulas 2–2–3–3 and 1–1–2–3–2, respectively; *R. translineatus* differs by very extendetd and sharply pointed snout and clear transverse bands along the body: *R. bipunctatus* differs by vomerine processes with 3 odontophores per ridges and the formulas of subarticular tubercles 1–1–2–2 and 2–1–2–3–2, respectively.

**Habitat and ecological notes in Vietnam.** Males of this species were invariably heard calling high in the forest canopy in primary or old secondary forests. They could be heard adjacent to mountain streams or in the forest more than 500 m from the nearest stream. The call, approximately 5 sec in duration, was composed of a series of short, loud knocks that were produced at an ever-increasing rate. The call frequency was about 1 call every 3 – 5 min.

The holotype was heard near the top of a large deciduous tree on the bank of a swift-flowing river. We did not see the frog until we fell the branch of the tree where we suspected it was perched. Once down, the frog made no attempt to escape.


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