A new, large species of *Chiasmocleis* Méhély 1904 (Anura: Microhylidae) from the Iquitos region, Amazonian Peru

W. CHRIS FUNK1,3 & DAVID C. CANNATELLA1,2

1Department of Biology, Colorado State University, Fort Collins, CO 80523-1878, USA. E-mail: Chris.Funk@colostate.edu.
2Texas Natural Science Center, University of Texas, Austin, TX 78712, USA. E-mail: cafish@mail.utexas.edu.
3Corresponding author

Abstract

We describe a new species of *Chiasmocleis* (Anura: Microhylidae) from lowland rainforests in the western Amazon basin of Peru (near Iquitos, Departamento de Loreto). The species differs from congeners in the Amazon basin by its large size (it is the largest known *Chiasmocleis* species), bright yellow iris, a grey dorsum with reddish blotches posteriorly and on limbs, and a creamy white venter with bold dark mottling with pale centers. The new species also differs from two other sympatric *Chiasmocleis* species at 12S–16S mitochondrial DNA (6.1% and 11.9% sequence divergence between the new species and *C. ventrimaculata* and *C. bassleri*, respectively). A comparison of the new species with other microhylids found in the western Amazon basin is provided.

Key words: Anura; new species; terrestrial frog; Peru; mitochondrial DNA; Microhylidae; *Chiasmocleis devriesi*

Introduction

The 62 recognized species of New World microhylids are predominantly terrestrial (fossorial and semifossorial) inhabitants of lowland rainforest (AmphibiaWeb 2009). Eighteen microhylid species in 9 genera are found in the western Amazon basin (IUCN *et al.* 2008, Frost 2009). Relative to some frog families such as Hylidae, Leptodactylidae, and Strabomantidae, microhylids are fairly depauperate in the western Amazon. A few to several microhylid species are typically found at a single site in lowland Amazonia compared to a dozen or more from each of these other three families (Duellman 1978, 2005, Rodríguez & Duellman 1994). However, new microhylid species continue to be discovered in this region (Wild 1995, Duellman & Mendelson 1995, Campbell & Clarke 1998, Lehr *et al.* 2002, Lehr & Trueb 2007, Moravec & Köhler 2007, Peloso & Sturaro 2008), suggesting that the diversity of the group is currently underestimated.
Chiasmocleis Méhely, 1904 is the most diverse genus of microhylids in the western Amazon and in South America with 23 described species (IUCN et al. 2008, Frost 2009). One new Chiasmocleis species was recently described from the Iquitos region of northeastern Peru (Moravec & Köhler 2007), another was described from Amazonian rainforests south of the Amazon River (Peloso & Sturaro 2008), and several new Chiasmocleis have been described in the last decade from non-Amazonian regions in South America (Caramaschi & Cruz 1997, Cruz et al. 1997, 1999, 2007a,b, Caramaschi & Pimenta 2003, Canedo et al. 2004). In the course of research on Physalaemus petersi at the Amazon Conservatory for Tropical Studies (ACTS) near Iquitos in the Departamento de Loreto, Peru (Boul et al. 2007, Funk et al. 2007, 2008, 2009), we discovered a large, undescribed Chiasmocleis species which we describe here.

Materials and methods

We examined alcohol-preserved specimens from herpetological collections at the Smithsonian Institution National Museum of Natural History (USNM), Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima, Peru (MHNSM), and Texas Natural Science Center, Texas Natural History Collection (TNHC). The specimens examined in addition to the new species are shown in Appendix 1. If specimens were not available for direct examination, we relied on the literature. Observations of osteological characters of the holotype were made from a three dimensional Computed Tomography (CT) scan. Terminology of morphological characters generally follows that of Duellman (1970), Zweifel (1986), and Lynch and Duellman (1997). Morphological measurements were taken with digital calipers to the nearest 0.1 mm, as follows: (1) snout-vent length (SVL) = distance from tip of snout to posterior margin of vent; (2) head length (HL) = distance from tip of snout to posterior angle of jaw articulation; (3) head width (HW) = width of head measured at level of jaw articulation; (4) internarial distance (IN) = distance between nostrils; (5) eye nostril distance (EN) = distance from posterior margin of nostril to anterior margin of eye; (6) eye diameter (ED) = distance between anterior and posterior borders of eyes; (7) interorbital distance (IOD) = distance between upper eyelids; (8) thigh length (ThL) = distance from flexed knee to vent; (9) tibia length (TiL) = length of flexed leg from knee to heel; and (10) foot length (FL) = distance from proximal margin of outer metatarsal tubercle to tip of Toe IV.

We also estimated sequence divergence between the new species and two sympatric Chiasmocleis species (C. ventrimaculata and C. bassleri). We analyzed 2253 bases of mitochondrial DNA genes 12S rRNA, valine-tRNA, and 16S rRNA for the holotype of the new species and one individual each of C. ventrimaculata and C. bassleri found at the same site as the holotype. Methods for DNA extraction, amplification, and sequencing follow the protocol of Pauly et al. (2004). Methods for sequence alignment and estimation of sequence divergence follow Funk et al. (2007). Briefly, initial alignment of DNA sequences was completed in ClustalX (Thompson et al. 1997). Manual adjustments were then made in MacClade 4.06 (Maddison & Maddison 2000) so as to minimize the number of changes required across taxa. Uncorrected sequence divergence was then estimated in PAUP* 4.0b10 (Swofford 2000).

Species description

Chiasmocleis devriesi Funk & Cannatella, new species
Figs. 1, 2

Holotype. MHNSM 21540, adult female, collected at the Amazon Conservatory for Tropical Studies (ACTS) Field Station, Departamento de Loreto, Peru, 65 km NE of Iquitos, 1 km N of the Río Napo, and 1.3 km SSE of the ACTS Field Station (3°15′34″ S, 72°54′10″ W, 102 m elevation), 30 May 2004 by W. Chris Funk and Claudia P. Torres-Gastello.
FIGURE 1. Dorsal (above) and ventral (below) views of the holotype of *Chiasmocleis devriesi* in life (MHNSM 21540, adult female; SVL = 42.2 mm). Photos by W. Chris Funk.
<table>
<thead>
<tr>
<th>Species</th>
<th>Range</th>
<th>$\sigma$ SVL</th>
<th>$\varphi$ SVL</th>
<th>Head shape</th>
<th>Foot webbing</th>
<th>Occip. fold</th>
<th>Tym. No.</th>
<th>No. toes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adelastes hylonomos</td>
<td>State of Amazonas in southern Venezuela</td>
<td>25-29</td>
<td></td>
<td>Rounded</td>
<td>None</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Alligius alios</td>
<td>Departamento de Madre de Dios in southeastern Peru and northeastern Bolivia</td>
<td>49.5</td>
<td>?</td>
<td>Rounded</td>
<td>Extensive</td>
<td>+</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Chiasmocleis anatipes</td>
<td>Eastern Ecuador, northeastern Peru</td>
<td>18–20</td>
<td>25–30</td>
<td>Rounded</td>
<td>Extensive</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>C. avilapiresae</td>
<td>Amazonian Brazil south of Amazon River</td>
<td>22–27</td>
<td>24–38</td>
<td>Triangular</td>
<td>Extensive - in males; basal in females</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>C. bassleri Dunn</td>
<td>Amazonian Ecuador, Peru, Bolivia, and adjacent Brazil and Colombia</td>
<td>17–22</td>
<td>20–28</td>
<td>Rounded</td>
<td>None</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>C. devriesi sp. nov.</td>
<td>Near Iquitos, Departamento de Loreto, northeastern Peru</td>
<td>?</td>
<td>42</td>
<td>Moderately pointed</td>
<td>Basal in females</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>C. shudikarensis Dunn</td>
<td>Guyana, Surinam, French Guiana, and Amazonian Brazil</td>
<td>25*</td>
<td>25*</td>
<td>Truncate</td>
<td>Extensive - in males; basal in females</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>C. ventrimaculata (Andersson)</td>
<td>Amazonian Ecuador, Peru, Bolivia, and southeastern Colombia, and far western Brazil</td>
<td>20–23</td>
<td>21–34</td>
<td>Rounded</td>
<td>Basal</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Ctenophryne geayi</td>
<td>Amazonian Venezuela, Colombia, Ecuador, Peru, Brazil, and all of Guyana, Suriname, and French Guiana</td>
<td>32–43</td>
<td>42–55</td>
<td>Truncate</td>
<td>Extensive</td>
<td>+</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Elachistocleis ovalis</td>
<td>Panama and Colombia southward, east of the Andes, to Argentina; Trinidad</td>
<td>24–33</td>
<td>33–44</td>
<td>Acutely rounded</td>
<td>Basal</td>
<td>+</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Hamptonophryne boliviana (Parker)</td>
<td>Northern and western sides of the Amazon basin: State of Bolivar (Venezuela), French Guiana, Guyana, Brazil, Ecuador, Peru, Bolivia, and Colombia</td>
<td>34–39</td>
<td>39–44</td>
<td>Rounded</td>
<td>None</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Otophyne pyburni Campbell &amp; Clarke</td>
<td>Vaupés and Amazonas, Colombia, across Venezuelan lowlands through Guianan region to Amapás, Brazil</td>
<td>46–55</td>
<td>52–61</td>
<td>Pointed</td>
<td>Basal</td>
<td>-</td>
<td>+</td>
<td>5</td>
</tr>
<tr>
<td>Synapturanus mirandaribeiroi Nelson &amp; Lescure</td>
<td>Northern Brazil, eastern Colombia, and the Guianas</td>
<td>27–32</td>
<td>25–35</td>
<td>Pointed</td>
<td>None</td>
<td>+</td>
<td>+</td>
<td>5</td>
</tr>
<tr>
<td>S. radus Pyburn</td>
<td>SE Vaupés, Colombia, adj. Ecuador</td>
<td>16–17</td>
<td>18–19</td>
<td>Pointed</td>
<td>None</td>
<td>+</td>
<td>+</td>
<td>5</td>
</tr>
<tr>
<td>S. salseri Pyburn</td>
<td>Vaupés, Colombia, Amazonas, Venezuela, Manaus, Brazil</td>
<td>24–26</td>
<td>?</td>
<td>Pointed</td>
<td>None</td>
<td>+</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Syncope antenori Walker</td>
<td>Amazonian Ecuador and Peru</td>
<td>11–12</td>
<td>13–14</td>
<td>Truncate</td>
<td>None</td>
<td>-</td>
<td>+</td>
<td>4</td>
</tr>
<tr>
<td>S. carvalhoi Nelson</td>
<td>Loreto, Peru, adj. southern Amazonian Colombia</td>
<td>9–10</td>
<td>10–11</td>
<td>Truncate</td>
<td>None</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>S. tridactyla (Duellman &amp; Mendelsohn)</td>
<td>Loreto, Peru, western Brazil</td>
<td>?</td>
<td>12</td>
<td>Truncate</td>
<td>None</td>
<td>-</td>
<td>+</td>
<td>4</td>
</tr>
</tbody>
</table>

* = sex of measured holotype was not specified in the original description of *Chiasmocleis shudikarensis* (Dunn 1949).
FIGURE 2. Computed Tomography (CT) scan of the holotype of *Chiasmocleis devriesi* (MHNSM 21540, adult female; SVL = 42.2 mm), showing dorsal (above) and ventral (below) views.

**Diagnosis.** A member of *Chiasmocleis* based on: (1) no occipital fold; (2) clavicles reduced, not reaching the glenoid region; (3) quadratojugal and maxilla separate; (4) alary process of premaxilla tilted only slightly forward; shelf of premaxilla with moderately sized notch; (5) neopalatine not distinguishable (Parker 1934, Carvalho 1954, Zweifel 1986).

The largest known species of *Chiasmocleis* distinguished from all other members in the genus by the following combination of characters: (1) large size, SVL 42.2 mm in female, body ovoid; (2) snout moderately pointed in dorsal view, rounded and projecting in lateral view; (3) canthus rostralis rounded; loreal
region flat, sloping smoothly to upper jaw; (4) skin on dorsum irregularly textured, almost smooth; (5) fingers IV and II the same length; fingers basally webbed, fringes present, lacking discs; finger tips rounded; (6) all toes with lateral fringes, basally webbed in females (males unknown); tips rounded, no discs; (7) subarticular tubercles prominent; inner metatarsal tubercle distinct, oval; (8) small pigmented eggs; (9) in life, dorsal surfaces dark gray with rusty red blotches posteriorly and on limbs; creamy mid-dorsal stripe from the level of the eyes to the vent; snout and eyelids silver-gray; (10) in life, ventral surfaces creamy white with large grayish brown blotches; blotches are largest on belly and chest, becoming smaller and more dense on throat and hindlimbs; blotches with light centers, particularly on belly and chest; (11) iris bright golden yellow in life.

**Comparisons.** *Chiasmocleis devriesi* is distinguished from other genera of microhylids in the western Amazon basin by a combination of no occipital fold, no visible tympanum, and five toes (Table 1). These character states are also found in *Adelastes hylonomos* and *Hamptophryne boliviana*, but *A. hylonomos* has a rounded head in dorsal view (moderately pointed in *C. devriesi*), no webbing on feet (basal webbing in *C. devriesi*), dark brown dorsal coloration (gray with reddish splotches on limbs and posteriorly in *C. devriesi*), and venter light brown with no color pattern (creamy white with bold dark mottling with pale centers in *C. devriesi*; Zweifel 1986). *Hamptophryne boliviana* has a rounded head, no webbing, a black inguinal spot extending onto dorsum (no such marking in *C. devriesi*), and a distinct demarcation between a tan or gray dorsum and dark brown or black flanks (no distinct demarcation between dorsal and flank color in *C. devriesi*; Parker 1927, Duellman 1978, 2005, Rodríguez & Duellman 1994).

*Chiasmocleis devriesi* is substantially larger than all other known *Chiasmocleis* species found in the Amazon basin (female SVL 42 mm in *C. devriesi* compared to female SVL 17–18 mm in *C. magnova*; 20 mm in *C. hudsoni*; 21–23 mm in *C. jimi*; 25 mm in *C. shudikarensis*; 20–28 mm in *C. bassleri*; 25–30 mm in *C. anatipes*; 21–34 mm in *C. ventrimaculata*; and 24–38 mm in *C. avilapiresae*; Table 1). Of these *Chiasmocleis* species, *C. devriesi* is most likely to be confused with *C. ventrimaculata* (Fig. 3; Andersson 1945, Duellman 1978, Rodríguez & Duellman 1994) and *C. avilapiresae* (Peloso & Sturaro 2008). However, *C. ventrimaculata* has a rounded head (moderately pointed in *C. devriesi*), a reddish brown iris (bright yellow in *C. devriesi*), white spicules present lateral and ventral to vent (spicules not present in *C. devriesi*), no reddish coloration on posterior surface of dorsum (reddish color present on posterior surface of dorsum in *C. devriesi*), and small black blotches or mottling on venter (larger black mottling with pale centers in *C. devriesi*). *Chiasmocleis avilapiresae* has dermal spines on dorsum and toes (no dermal spines in *C. devriesi*), a light horizontal line on the posterior surface of thighs which is always present (no such line in *C. devriesi*), venter varying from light with almost no dark markings, small scattered brown or black spots, a few large spots, or a reticulated pattern (creamy white venter with large black mottling with pale centers in *C. devriesi*), and a bronze iris according to Fig. 1 in Peloso & Sturaro (2008; iris bright golden yellow in *C. devriesi*). *Chiasmocleis devriesi* also differs from *C. anatipes* by basal webbing on feet (extensive webbing in *C. anatipes*; Walker & Duellman 1974); from *C. bassleri* by a gray dorsum with reddish coloration on limbs and a cream venter with large dark mottling with pale centers (cream canthal and postorbital stripe, black inguinal spot extending onto dorsum, and bluish white belly with large black spots in *C. bassleri*; Dunn 1949, Rodríguez & Duellman 1994); from *C. hudsoni* by a moderately pointed head, basal webbing, and a gray dorsum with reddish coloration posteriorly and on limbs (rounded head, no webbing on feet, and a brown dorsum with lighter stippling in *C. hudsoni*; Parker 1940); from *C. jimi* by a moderately pointed head, basal webbing, and a gray dorsum with reddish coloration posteriorly and on limbs (rounded head, no webbing on feet, and a brown dorsum with irregular white dots in *C. jimi*; Caramaschi & Cruz 2001); from *C. magnova* by normal finger and toe length (reduced fingers I and IV and reduced toe I in *C. magnova*; Moravec & Köhler 2007); and from *C. shudikarensis* by a moderately pointed head and a gray dorsum with reddish coloration on limbs (truncate head, gray dorsum with light flecking, and black inguinal spot extending onto dorsum in *C. shudikarensis*; Dunn 1949).
FIGURE 3. Dorsal (above) and ventral (below) views of Chiasmocleis ventrimaculata in life from the same site where C. devriesi was found, the Amazon Conservatory for Tropical Studies (ACTS) Field Station (MHNSM 21539, adult female; SVL = 34.4 mm). Photos by W. Chris Funk.
TABLE 2. Morphological measurements of *Chiasmocleis devriesi* and *C. ventrimaculata* from the Amazon Conservatory for Tropical Studies (ACTS), Departamento de Loreto, Peru. All measurements are in mm.

<table>
<thead>
<tr>
<th>Species</th>
<th>MHNSM no.</th>
<th>Sex</th>
<th>SVL</th>
<th>HL</th>
<th>HW</th>
<th>IN</th>
<th>EN</th>
<th>ED</th>
<th>IOD</th>
<th>ThL</th>
<th>TIL</th>
<th>FL</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Chiasmocleis devriesi</em></td>
<td>21540</td>
<td>F</td>
<td>42.2</td>
<td>10.9</td>
<td>12.5</td>
<td>2.8</td>
<td>2.9</td>
<td>2.8</td>
<td>4.2</td>
<td>15.7</td>
<td>15.4</td>
<td>14.8</td>
</tr>
<tr>
<td><em>C. ventrimaculata</em></td>
<td>21539</td>
<td>F</td>
<td>34.4</td>
<td>8.7</td>
<td>9.4</td>
<td>2.4</td>
<td>2.6</td>
<td>2.1</td>
<td>3.8</td>
<td>13.4</td>
<td>13.7</td>
<td>13.8</td>
</tr>
<tr>
<td><em>C. ventrimaculata</em></td>
<td>15697</td>
<td>F</td>
<td>27.8</td>
<td>8.1</td>
<td>8.4</td>
<td>2.2</td>
<td>2.4</td>
<td>2.4</td>
<td>2.9</td>
<td>11.4</td>
<td>11.3</td>
<td>11.2</td>
</tr>
<tr>
<td><em>C. ventrimaculata</em></td>
<td>15775</td>
<td>F</td>
<td>26.9</td>
<td>7.3</td>
<td>7.5</td>
<td>2.0</td>
<td>2.3</td>
<td>2.0</td>
<td>3.1</td>
<td>10.2</td>
<td>10.3</td>
<td>10.5</td>
</tr>
<tr>
<td><em>C. ventrimaculata</em></td>
<td>15698</td>
<td>F</td>
<td>26.3</td>
<td>7.6</td>
<td>7.4</td>
<td>2.1</td>
<td>2.6</td>
<td>2.2</td>
<td>2.9</td>
<td>10.6</td>
<td>10.1</td>
<td>10.7</td>
</tr>
<tr>
<td><em>C. ventrimaculata</em></td>
<td>15700</td>
<td>F</td>
<td>23.2</td>
<td>6.3</td>
<td>6.3</td>
<td>1.9</td>
<td>2.2</td>
<td>2.2</td>
<td>2.8</td>
<td>8.9</td>
<td>9.7</td>
<td>10.2</td>
</tr>
<tr>
<td><em>C. ventrimaculata</em></td>
<td>21538</td>
<td>M</td>
<td>23.2</td>
<td>7.6</td>
<td>6.9</td>
<td>1.9</td>
<td>2.0</td>
<td>1.6</td>
<td>2.8</td>
<td>10.2</td>
<td>10.1</td>
<td>9.7</td>
</tr>
<tr>
<td><em>C. ventrimaculata</em></td>
<td>15702</td>
<td>M (subad)</td>
<td>17.1</td>
<td>5.7</td>
<td>5.7</td>
<td>1.7</td>
<td>1.6</td>
<td>1.7</td>
<td>2.3</td>
<td>7.5</td>
<td>7.9</td>
<td>7.5</td>
</tr>
<tr>
<td><em>C. ventrimaculata</em></td>
<td>15701</td>
<td>M (subad)</td>
<td>16.5</td>
<td>5.1</td>
<td>5.6</td>
<td>1.4</td>
<td>1.6</td>
<td>1.8</td>
<td>2.1</td>
<td>6.6</td>
<td>6.9</td>
<td>6.9</td>
</tr>
</tbody>
</table>

The remaining 15 non-Amazonian *Chiasmocleis* species are also substantially smaller than *C. devriesi*, have different color patterns, and in some species, extensively webbed feet and dermal spines (Boettger 1885, Boulenger 1888, Dunn et al. 1948, Dunn 1949, Bokermann 1952, Caramaschi & Cruz 1997, Cruz et al. 1997, 1999, 2007a,b, Caramaschi & Pimenta 2003, Canedo et al. 2004).

**Description of holotype.** Skin above irregularly textured, almost smooth; skin below smooth. Occipital fold absent. Head narrower than body. Snout moderately pointed in dorsal view, most similar to *Chiasmocleis panamensis* (Fig. 7C of Zweifel 1986); rounded and projecting in lateral view; nostrils positioned laterally and directed laterally, at level of tip of lower jaw. Loreal region flat, sloping smoothly to upper jaw. Canthus rostralis rounded. Eyes small. Tympanum not apparent externally; supratympanic fold well developed, extending from posterior corner of eye to insertion of forearm. Skin beneath supratympanic fold bulging laterally. Suprascapula and associated musculature bulging dorsolaterally behind head. Relative length of fingers 3 > 4 = 2 > 1, tips rounded, not flattened or expanded, circumferential grooves absent; all fingers with lateral fringes, most developed on finger 3, webbing basal between all fingers; subarticular tubercles prominent, round to oval, raised; inner metacarpal tubercle oval, raised, one-half size of outer metacarpal tubercle; outer metacarpal tubercle oval, prominent, raised. Ulnar fold absent. Relative lengths of toes 4 > 3 > 5 > 2 > 1, tips rounded, not flattened or expanded, lacking circumferential grooves; lateral fringe present on all toes, most prominent on toes 3 and 4; toes webbed basally; subarticular tubercles prominent, round to oval, raised, more prominent proximally than distally; inner metatarsal tubercle distinct, oval; outer metatarsal tubercle barely visible. Tarsal fold suggested by pale line on outer surface of tarsus. Vent opening directed posteriorly, with moderate dorsal fold; crease present from vent opening to venter.

**Osteology of holotype.** Dorsal and ventral views of the skeleton of the holotype are shown in the Computed Tomography (CT) scan (Fig. 2). Maxillary arch incomplete, maxilla and quadratojugal not in contact; alary process of premaxilla narrow, long, tilted slightly forward; palatal shelf of premaxilla with moderately sized notch; premaxilla, maxilla, and mandible lacking teeth. Anterior vomer narrow and long, in contact with sphenethmoid; neopalatine not distinguishable. Posteromedial processes of hyoid ossified, straight, and expanded posteriorly. Pectoral girdle with thin clavicle reaching approximately two-thirds length of coracoids, not reaching glenoid region; large medial gap between anterior ends of clavicles; clavicles curved away from midline. Eight presacral vertebrae; sacral vertebra articulating with the coccyx; sacral diapophyses broadly expanded, the width of the lateral margin being approximately 3 times the width of the base. Pelvic girdle broadly U-shaped. Phalangeal formula of hand 2-2-3-3 with slightly expanded terminal phalanges; formula of foot 2-2-3-4-3. Humerus with anterior flange and a short, rounded posterior process on proximal half.

**Coloration of holotype.** In life (Fig. 1), dorsal and lateral surfaces dark gray with rusty red blotches posteriorly and on limbs; thin cream mid-dorsal stripe from level of the eyes to the vent; snout and eyelids
silver-gray. Line of several raised, white spots extending from posterior margin of eye to above insertion of arm. White flecks on dorsal surfaces of limbs, increasing distally. Hidden surfaces of limbs brown with white blotches. Ventral surfaces creamy white with large grayish brown blotches; blotches are largest on belly and chest, becoming smaller and more dense on throat and hindlimbs; blotches with light centers, particularly on belly and chest. Iris bright golden yellow.

In preservative, dorsum of body gray with reddish brown tinge posteriorly; limbs similar, but with prominent mottling dorsally on forelimbs and slightly weaker motting dorsally on hindlimbs; thin cream middorsal line extending from behind eyes to venter; on flanks, dorsal coloration blending smoothly into ventral coloration; venter pale creamy yellow with bold black-brown blotches with pale centers; motting denser and finer on throat and ventral surfaces of limbs; anterior concealed surfaces of thighs with finer reticulate pattern; posterior concealed surfaces of thighs almost uniformly brown-gray; palmar and plantar surfaces uniformly gray.

Measurements of holotype (in mm). SVL 42.2; HL 10.9; HW 12.5; IN 2.8; EN 2.9; ED 2.8; IOD 4.2; ThL 15.7; TiL 15.4; FL 14.8. Measurements of the holotype and sympatric Chiasmocleis ventrimaculata are shown for comparison in Table 2.

Etymology. The specific name is a noun in the genitive case and a patronym for Philip J. DeVries, one of the most influential researchers in tropical ecology and the person responsible for introducing WCF to tropical biology and the Amazon basin. Appropriately, DeVries’ long-term studies of Amazonian butterfly diversity (e.g., DeVries et al. 1999, 2008, DeVries & Walla 2001) have highlighted the ubiquity and importance of rare species, such as Chiasmocleis devriesi, in lowland Amazonian rainforests.

FIGURE 4. Map showing the known distribution of Chiasmocleis devriesi at the Amazon Conservatory for Tropical Studies (ACTS) Field Station (indicated by star). Color shows elevation (white = below 200 m; light gray = 200–500 m; dark gray = above 500 m).
**Distribution and natural history.** *Chiasmocleis devriesi* is only known from the holotype, found at the Amazon Conservatory for Tropical Studies (ACTS) Field Station, 65 km NE of Iquitos, Departamento de Loreto, Peru (Fig. 4). The holotype was collected in unflooded (terra firme) primary rainforest approximately 1.3 km SSE of the ACTS Field Station at 102 m elevation. It was found at 21:25 hrs on the ground in a “lindero”, a linear clearing of forest (approximately 5–10 m wide) demarcating a boundary between properties. WCF and C. Torres-Gastello searched the forests surrounding ACTS for several hours each day and night for three weeks, but only found this single representative of *C. devriesi*; the species is thus apparently rare at this site. The female had many small (approximately 1 mm diameter) mature, pigmented eggs. No typical microhylid breeding sites, such as ponds, swamps, or lakes, were in the immediate vicinity. Some small (approximately 2–5 m diameter), empty indentations, however, were observed on the forest floor which may fill in the rainy season, potentially serving as breeding sites. Other microhylids found at the ACTS Field Station were *Chiasmocleis ventrimaculata*, *C. bassleri*, *Syncope antenori*, and *S. carvalhoi*.

**Sequence divergence.** Uncorrected sequence divergence between *C. devriesi* and *C. ventrimaculata* was 6.1% and between *C. devriesi* and *C. bassleri* was 11.9% at 12S-16S mtDNA genes. This level of sequence divergence is higher than that seen (in the same genes) between recognized species that are well differentiated by call and morphological characteristics, providing additional evidence that these are distinct species. For example, mean corrected sequence divergence at 12S-16S genes between *Physalaemus petersi* and *P. freibergi* is 4.6% (Funk et al. 2007). Molecular markers have been useful in delineation of other cryptic Amazonian frog species as well (Fouquet et al. 2007).

**Discussion**

An obvious limitation of our description of *C. devriesi* is that it is based on a single female. Thus it is not possible to describe morphological variation within the species, including morphological differences between males and females. For example, some characters such as ventral coloration and size can be highly variable in *Chiasmocleis* and the observed differences in these characters between *C. devriesi* and similar species (such as *C. ventrimaculata* and *C. avilapiresae*) could represent opposite sides of a continuous distribution. Nonetheless, the high sequence divergence between *C. devriesi* and sympatric *Chiasmocleis* (*C. ventrimaculata* and *C. bassleri*) and a unique combination of morphological traits demonstrates that *C. devriesi* is a new, previously undescribed species.

The recent discovery of *C. devriesi* and other new microhylids from the western Amazon basin (*Altigius alios*, Wild 1995; *Syncope tridactyla*, Duellman & Mendelson 1995; *Otophryne pyburni*, Campbell & Clarke 1998; *Melanophryne carpish*, Lehr et al. 2002; *M. barbatula*, Lehr & Trueb 2007; *C. magnova*, Moravec & Köhler 2007) highlights our incomplete knowledge of microhylid diversity in the region. The small number of individuals found for these descriptions (median = 3 per species) suggests that many remaining undescribed species are rare and/or inadequately sampled. In addition to the rarity of some microhylids, their fossorial nature makes them difficult to find. As with the forest canopy (Guayasamin et al. 2006), fossorial habitats are often overlooked by herpetologists and other field biologists. Even some of the best herpetologists neglect this poorly surveyed microhabitat of tropical forests. As stated in Lynch and Duellman (1997; pp. 117–18), “Lynch is guilty of spending too much time gazing at vegetation in quest of dainty centrolenids and small *Eleutherodactylus* and will always be thankful to Thomas J. Berger for showing him large toadlike frogs on the ground along the stream where he had just passed; search images sometimes are so powerful that a frog weighing a half kilogram somehow is not seen.” Future amphibian surveys of tropical forests should make a special effort to thoroughly survey fossorial and terrestrial habitats. Pitfall traps may be a particularly effective means of sampling microhylids.
Acknowledgements

We thank C. Torres-Gastello for her assistance in the field; P. Jenson and S. Madigosky (Amazon Conservatory for Tropical Studies, Explorama Lodges) for providing accommodations in the field; K. Ramirez (Peruvian Instituto Nacional de Recursos Naturales [INRENA]) and J. Cordova (MHNMSM) for assisting with permits; C. Aguilar and J. Cordova (MHNMSM), R. Heyer and R. McDaid (USNM), and T. LaDuc (TNHC) for curatorial assistance; B. Caudle (UT Austin) for sequencing; R. Symula for checking specimens; and A. Angulo and two anonymous reviewers for providing comments on the manuscript. INRENA provided research and export permit numbers 032-2004-INRENA-FFS-DCB and 003886-AG-INRENA. We acknowledge the National Science Foundation for funding from the IRCEB Grant 0078150 to DCC. This is publication number 201 of the Yanayacu Natural History Research Group. This paper is dedicated to the inspiration provided by Hannah Wilcox Handy who passed away during the field excursion in which Chiasmocleis devriesi was discovered.

References


DeVries, P.J., Austin, G.T. & Martin, N.H. (2008) Diet activity and reproductive isolation in a diverse assemblage of
Neotropical skippers (Lepidoptera: Hesperiidae). *Biological Journal of the Linnean Society*, 94, 723–736.


NEW SPECIES OF CHIASMOCLEIS

*Zootaxa* 2247 © 2009 Magnolia Press - 49
APPENDIX 1. Specimens examined


APPENDIX 2. GenBank accession numbers for 12S-16S mtDNA sequences

<table>
<thead>
<tr>
<th>Species</th>
<th>Museum number</th>
<th>GenBank accession no.</th>
<th>Locality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiasmocleis devriesi</td>
<td>MHNSM 21540</td>
<td>GQ891750</td>
<td>Peru: Loreto: ACTS</td>
</tr>
<tr>
<td>C. ventrimaculata</td>
<td>MHNSM 21539</td>
<td>GQ891751</td>
<td>Peru: Loreto: ACTS</td>
</tr>
<tr>
<td>C. bassleri</td>
<td>MHNSM 21576</td>
<td>GQ891752</td>
<td>Peru: Loreto: ACTS</td>
</tr>
</tbody>
</table>