

New records and geographic distribution map of *Adenomera heyeri* Boistel, de Massary and Angulo, 2006 (Anura: Leptodactylidae)

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ABSTRACT: Here we report new distributional data for *Adenomera heyeri*, a recently described species of the lowlands of the Guiana Shield. We compiled available and new occurrence data as well as the absence of records from field surveys that were undertaken in the Guiana Shield in order to evaluate the actual range of the species. We confirm that *A. heyeri* is potentially distributed over most forested part of the northern Guiana Shield lowlands. The pattern of distribution also reveals valuable information on the ecology of the species.

Species of the genus *Adenomera* (*Leptodactylus marmoratus* species group *sensu* Frost *et al.* 2006; but see Fouquet *et al.* 2007a; Kwet *et al.* 2009) are small terrestrial dull-colored frogs distributed in tropical South America across Amazonia, Cerrado and Atlantic forest. Two species, *A. andreae* and *A. hylaedactyla* are known to be widely distributed across Amazonia, the latter being also present in the Cerrado and the extreme North of the Brazilian Atlantic Forest (Heyer 1973). The remaining 13 nominal species are believed to display much more restricted ranges. The mode of reproduction in *Adenomera* is unique. Males are territorial during the breeding season and reproduction takes place in a flask-shaped chamber excavated by the male and located away from standing bodies of water. A small clutch is deposited in a foam nest that is attended by the male during embryonic development. The lecithotrophic tadpoles complete their entire development within these nests in most species (Heyer 1974; but see De la Riva 1995; Almeida and Angulo 2006).

Adenomera heyeri has only recently been described (Boistel *et al.* 2006) from two localities in French Guiana. The species inhabits the leaf-litter of the primary forest and appears to be relatively uncommon throughout its range. Since its description, Fouquet *et al.* (2007a) collected and analyzed molecular data of specimens from two additional localities in French Guiana (Montagne des Singes and Piton Baron). Avila-Pires *et al.* (2010) reported its presence at the border between state of Pará (Brazil) and Guyana, extending considerably the originally known distribution. Avila-Pires *et al.* (2010) also mention 13 unpublished records from Suriname (including Brownsberg Nature Park) and French Guiana, mainly based on M. Hoogmoed's personal observations. In their report for IUCN, Angulo

and Hoogmoed (2008) based on Hoogmoed's unpublished personal observations also mentioned the presence of the species in Parque Nacional Montanhas do Tumucumaque (PNMT, Amapá, Brazil) and in the Central Suriname Nature Reserve, and thus classified the species under the "least concern" category. Additional surveys undertaken in Guyana and Brazil (Kok 2000; Donnelly *et al.* 2005; Ernst *et al.* 2005; Dias Lima 2008; Kok and Kalamandeen 2008) provide potential records of presence and absence for the species.

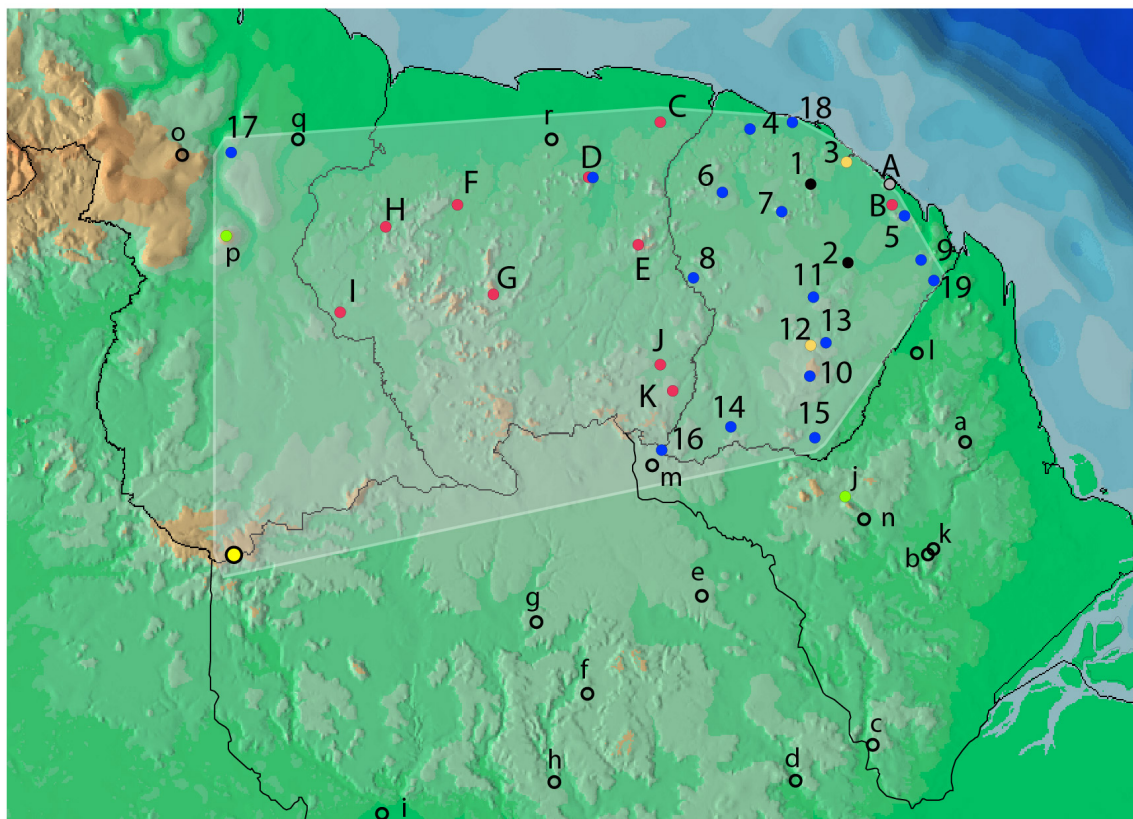
During several field surveys in the Guiana Shield we collected data on the presence and in some cases abundance of this species in 14 new localities including central Guyana and additional localities over French Guiana (Figure 1) and confirmed the presence of the species at Brownsberg Nature Park, Suriname. Absence of records of the species in localities close to the documented range of the species was also compiled. Newly collected specimens were deposited in several collections (Table 1).

The new records showed that the species has a much broader distribution than previously assumed. The actual range potentially includes almost all forested parts of French Guiana, Suriname and the Guyana lowlands. The occurrence of the species at Mabura Forest Reserve, Guyana, is particularly noteworthy as it extends widely the known range of the species toward northwest and is very close from the eastern edge of the Guiana Highlands where another *Adenomera* species occurs, *Adenomera lutzi* (*e.g.* Kok *et al.* 2007).

Adenomera heyeri (Figure 2) is found from nearly sea level (Montagne des Singes) to up to 800 m (Mont Itoupé). Such a wide altitudinal range and the quasi absence of land over 800 m asl in the eastern Guiana shield suggests that the species could be distributed continuously over a most

eastern Guiana Shield. Moreover, the proximity of Mabura Forest Reserve with the known range of *A. lutzi*, which has been reported to occur between 430 and 1,400 m asl. in the Guyana Highlands (Kok *et al.* 2007) suggests that the two species may be in contact and undergo replacement along the slope of the Guyana Highlands. Such contact zone would be worth studying. Nevertheless, despite being found at low altitude nearly sea level in French Guiana, *A. heyeri* is always associated to an altitudinal gradient (authors pers. obs.), which is suggestive of specific thermal and humidity requirements. Such requirement probably structures the overall range and population's connectivity at a local scale, which would be worth further investigation for example using ecological niche modeling.

Adenomera heyeri probably occurs also in part of Amapá and Pará adjacent to the documented range. Nevertheless, we did not encounter the species in several localities visited in Guyana (Bamboo landing), Suriname (Road to Apura) and Amapá (Lourenço, Serra do Navio and Laranjal do Jari) neither did Avila-Pires *et al.* (2010) in the other sites visited in state of Pará nor Kok and Kalamandeen (2008) in Kaieteur National Park in Guyana (a thoroughly studied area where only *Adenomera lutzi* occurs). Even if the absence of the species is virtually impossible to verify, these distributional gaps lie outside the documented occurrence patch (Figure 1) and suggest that the species may not occur south and east of the PNMT. Other frog species may display a similar pattern such as



Published and available data

- Data from original description
- 1 St Eugène
- 2 Nouragues
- Data from Avila-Pires *et al.* 2010
- ESEC Grão-Pará North
- Fouquet *et al.* 2007
- 3 Montagne des singes
- 12 Piton Baron

New data

- 4 Angoulême
- 5 Patamaca
- 6 Lucifer
- 7 Trinité
- 8 Mont Kotika
- 9 DZ5
- 10 Mont Itoupé
- 13 Pic Coudreau
- 14 Haute Wanapi
- 15 Mont Saint Marcel
- 17 Mabura hill forest reserve
- 18 Iracoubo Counamama
- 19 St Georges
- 11 Pic Matecho
- 16 Mitarka

Hoogmoed's pers. obs. in Avila-Pires

- B Mont La Gabrielle
- C Patamaca
- D Brownsberg
- E Lely Mountains
- F Mozes Creek
- G Tafelberg
- H Kabalebo
- I 20 km N Lucie River
- J Oelemari
- K Loë Creek

Dubious data

- A Mont Mahury/
Dégrad des Cannes

Negative data

- a Lourenço
- b Serra do Navio
- c Laranjal do Jari
- q Bamboo landing
- r Road to Apura
- d FLOTA Paru
- e REBIO Maicuru
- f Grão-Pará South
- g Grão-Pará Centre
- h FLOTA Trombetas
- i FLOTA Faro
- j Rio Anacuí ●
- k Rio Mutum
- l Rio Anotaie
- m Rio Mapaoni
- n Rio Amapari
- Kok and Kalamandeen 2008 ●
- Donnelly *et al.* 2005 p Iwokrama ●

FIGURE 1. Map of the distribution records of *Adenomera heyeri*. Black dots stand for distribution records from the original description of the species; Large yellow dot stands for the published occurrence data from Avila-Pires *et al.* (2010) and small yellow dots stand for published data from Fouquet *et al.* (2007). New data are indicated with blue dots and data from Hoogmoed personal observations with red dots. The record considered dubious is indicated in gray. Surveys that took place in the Guiana Shield and did not record *A. heyeri* are indicated with circles; two of them (indicated in green) may have actually encountered the species.

Anomaloglossus degranvillei and *Allobates granti*. Along with *A. heyeri*, these species were described from French Guiana and are only known to occur in French Guiana and adjacent areas of Suriname (A.F., M.B., C.M. pers. obs.) as well as reported from PNMT (Dias Lima 2008). Conversely, other species display a mirrored geographic limit in their range. *Ameerega pulchripecta* (Silverstone 1976; A.F. pers. obs.), *Adelophryne* cf. *gutturosa* (Reynolds et al. 2004; Lescure and Marty 2000) and *Bolitoglossa* cf. *parensis* (Dias Lima 2008) have been recorded in the state of Amapá but never in French Guiana despite relative extensive field surveys. Given its strong association with primary forest and altitudinal gradient *A. heyeri* is also probably absent from white sand forest, littoral forest and large flood plain forests as suggested by the absence of records in these habitats in Guyana and Suriname (Figure 1).

Conversely, due to the species recent description and to its frequent misidentification some surveys may have actually collected *Adenomera heyeri* (Figure 2) but identified it as *Adenomera* sp. or *Adenomera andreae* / *A.*

hylaedactyla as it has been respectively the case for Ernst et al. (2005; 2006). Another possible new locality is the record from central Guyana reported by Donnelly et al. (2005) who reported the presence of *Adenomera andreae* and “*Adenomera* sp.” from Iwokrama. Similarly, though no explicit mention of *A. heyeri* from PNMT was made by Dias Lima (2008), we suspect that it was collected and either named under one of the three *Leptodactylus* spp. (locality V: Rio Anacuí) or under one of the two collected *Adenomera* spp. It would be worth checking the identity of the specimens collected. The mention by Kok (2000) from “Montagne Belvédère” of an *Adenomera* sp. corresponds however unambiguously to *A. heyeri* as well as the incorrectly identified *A. andreae* record from DZ5 in French Guiana from Marty and Gaucher (1999).

As a result of being misidentified as *Adenomera andreae* some important information about the species deserves to be highlighted. Previous data on the distribution and occurrence of *A. heyeri* suggested that the species is comparatively rare and its presence confined to primary

TABLE 1. List of material. MNHN (Muséum National d'Histoire Naturelle-Paris); CN (Museu Goeldi); BYU (Brigham Young University); CM (Christian Marty field number); AF (Antoine Fouquet field number); SMNS (Staatliches Museum für Naturkunde Stuttgart); PG (Philippe Gaucher field number); T (Université de Montpellier-François Catzeflis); AG and BM (Michel Blanc Field number), EU (GenBank accession number)

LOCALITY	VOUCHER	COUNTRY	LAT	LON
Angouleme	AF203, AF211, MNHN 2011.0101-2	French Guiana	05°23'00" N	53°39'00" W
Mont Kaw	BPN1361; BYU48915	French Guiana	04°43'00" N	52°08'00" W
Brownsberg	AF126-7; MNHN 2010.0191-2	Suriname	04°43'00" N	56°13'00" W
ESEC Grão-Pará North	CN1226; CN1236; CN1275	Brazil PA	01°17'07" N	58°41'45" W
Mabura hill forest reserve	SMNS11963-7	Guyana	05°09'19" N	58°41'59" W
Lucifer	CM369, CM400; MNHN 2011.0103-4	French Guiana	04°46'00" N	53°55'00" W
Mitaraka	30PG; MNHN 2001.0354	French Guiana	02°16'00" N	54°31'00" W
Mont Kotika	PG469; MNHN 2011.0105	French Guiana	03°56'05" N	54°12'17" W
Pic Matecho	T2529	French Guiana	03°45'00" N	53°02'00" W
Piton Baron	PG46; MNHN 2001.0815; EU201050	French Guiana	03°17'00" N	53°04'00" W
St Eugene	MNHN 1999.8331	French Guiana	04°51'00" N	53°04'00" W
Trinité	AG307; MNHN 2011.0107	French Guiana	04°35'00" N	53°21'00" W
DZ5	Track #53 in CD Marty and Gaucher 1999	French Guiana	04°03'00" N	52°01'00" W
Nouragues	PG648; MNHN 1999.8302-8304	French Guiana	04°05'00" N	52°41'00" W
Mont Saint Marcel	PG90; MNHN 2011.0106	French Guiana	02°23'09" N	53°00'68" W
Montagne des singes	CM221, EU201051	French Guiana	05°04'00" N	52°43'00" W
20 km N. Lucie River	Hoogmoed unpubl	Suriname	03°36'27" N	57°38'16" W
Airstrip Tafelberg	Hoogmoed unpubl	Suriname	03°47'00" N	56°09'00" W
Dégrad des Cannes	Hoogmoed unpubl	Suriname	04°51'18" N	52°16'19" W
Brownsberg	Hoogmoed unpubl	Suriname	04°43'00" N	56°13'00" W
Kabalebo	Hoogmoed unpubl	Suriname	04°26'21" N	57°11'14" W
Lely Mountains,	Hoogmoed unpubl	Suriname	04°16'00" N	54°44'00" W
Loë Creek	Hoogmoed unpubl	Suriname	02°50'52" N	54°24'17" W
Mont La Gabrielle	Hoogmoed unpubl	Suriname	04°39'08" N	52°15'59" W
Mont Mahury	Hoogmoed unpubl	Suriname	04°52'24" N	52°15'53" W
Mozes Creek	Hoogmoed unpubl	Suriname	04°39'22" N	56°29'36" W
Oelemari	Hoogmoed unpubl	Suriname	03°06'00" N	54°31'60" W
Patamaca	Hoogmoed unpubl	Suriname	05°27'28" N	54°31'26" W
Pic Coudreau	NA	French Guiana	03°18'02" N	52°56'77" W
HauteWanapi	NA	French Guiana	02°30'57" N	53°49'56" W
Itoupé	NA	French Guiana	03°38'30" N	53°34'42" W
St Georges	NA	French Guiana	03°52'00" N	51°48'00" W
Iracoubo	NA	French Guiana	05°26'53" N	53°08'52" W

forest. However, Ernst *et al.* (2005; 2006) reported that the species can be locally very abundant with relative densities of 9.5 individuals recorded per standardized transect survey hour (Ind/Th) in a lowland rainforest site of central Guyana. In the same study, the species was even recorded in previously logged forest sites, however, with much lower densities (0.94 Ind/Th as compared to 8.6 Ind/Th in primary forest). This suggests that even though locally abundant, the species could nonetheless be threatened regionally due to its restricted range and it may face severe population declines due to anthropogenic disturbances, such as logging.

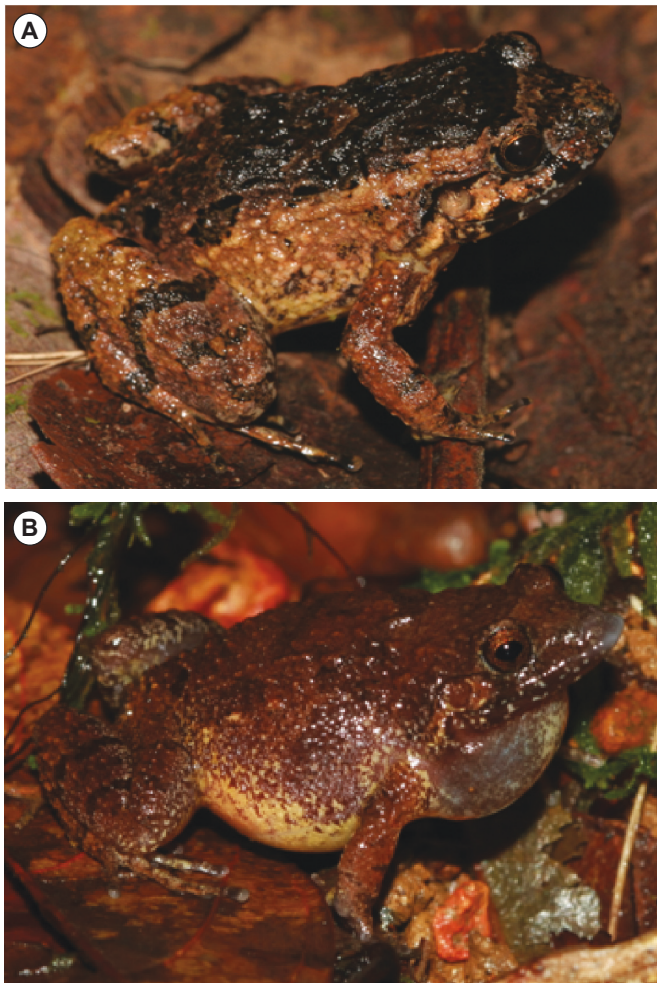


FIGURE 2. Two photographed specimens (Maël Dewynter) of *Adenomera heyeri* from Lucifer (A) and Itoupé (B) in French Guiana.

Avila-Pires *et al.* (2010) mentioned, again from Hoogmoed's personal observations, the presence of the species on two localities on the Cayenne peninsula, Mt Mahury and Dégrad des Cannes. However, the species has never been found there despite the first area is easily accessible to prospection and that extensive forested portion of the Mt Mahury remained relatively undisturbed. Half of it is already under a conservation program (undertaken by the « Conservatoire régional des espaces naturels » and the « Conseil Général de Guyane française »). Actually, we never found the species on none of the forest remnants of the Cayenne peninsula. We therefore assume that *A. heyeri* is absent from these localities. This could be due to the extinction of the population due to human modifications of the habitat since Hoogmoed's observation

or confusion with another *Adenomera* species occurring there. Interestingly, *Allobates granti*, and *Anomalloglossus degranvillei*, the other species that are also restricted from the eastern Guiana Shield and so far not documented in Amapá and Pará, are also absent from the Cayenne peninsula.

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