



<http://dx.doi.org/10.11646/zootaxa.3750.5.8>

<http://zoobank.org/urn:lsid:zoobank.org:pub:AF19DE00-5E28-4029-B12D-DB811383D228>

A new species of the genus *Pristimantis* (Amphibia, Craugastoridae) associated with the moderately elevated massifs of French Guiana

ANTOINE FOUQUET^{1,7}, QUENTIN MARTINEZ¹, ELODIE A. COURTOIS¹, MAËL DEWYNTER², KÉVIN PINEAU², PHILIPPE GAUCHER¹, MICHEL BLANC³, CHRISTIAN MARTY⁴ & PHILIPPE J. R. KOK^{5,6}

¹CNRS Guyane USR3456, Immeuble Le Relais, 2 Avenue Gustave Charlery, 97300, Cayenne, French Guiana

²Biotope, Agence Amazonie-Caraïbes, 30 Domaine de Montabo, Lotissement Ribal, 97300, Cayenne, French Guiana

³Pointe Maripa, RN2/PK35, Roura, French Guiana

⁴Impasse Jean Galot, Montjoly, French Guiana

⁵Biology Department, Amphibian Evolution Lab, Vrije Universiteit Brussel, 2 Pleinlaan, B-1050 Brussels, Belgium

⁶Department of Vertebrates, Royal Belgian Institute of Natural Sciences, 29 rue Vautier, B-1000 Brussels, Belgium

⁷Corresponding author. E-mail: fouquet.antoine@gmail.com

Abstract

We describe a new *Pristimantis* from French Guiana, northern South America, which is mainly distinguished from known phenotypically related congeners (*i.e.* species from the polyphyletic *unistrigatus* species group) occurring at low and middle elevations in the Guiana Shield by the combination of a distinct tympanum, a lower ratio of tibia *vs.* hand length, a reddish groin region, and a distinct advertisement call consisting of clusters of generally four short notes. The new species inhabits pristine primary forests on the slopes of isolated massifs reaching more than 400 m elevation, and seems not to occur below *ca.* 200 m above sea level. Such a sharp altitudinal limit suggests a strong influence of thermal variation on the distribution of the species, and therefore a potential sensitivity to climate change. With only nine isolated populations documented so far, the new species should be prioritized for conservation. Historical climate fluctuations during the Quaternary are likely responsible for the distribution pattern of the new species.

Key words: Climate change, Conservation, Endemism, Guiana Shield, Taxonomy, Terrarana.

Introduction

The number of amphibian species described each year is increasing and this trend shows no sign of slowing (Köhler *et al.* 2005; Giam *et al.* 2011). These new species are essentially detected in tropical regions (Giam *et al.* 2011), especially in South America (Jenkins *et al.* 2013), and often from highlands or altitudinal gradients (McDiarmid & Donnelly 2005; Duellman & Lehr 2009; Kok *et al.* 2012). Amphibians are particularly tied to narrow thermal and hygrometric conditions (Buckley & Jetz 2007), and they generally display poor dispersal abilities (Smith & Green 2005). It has been demonstrated that thermal tolerance of tropical ectotherms is overall narrower than for temperate ones (Deutsch *et al.* 2008; Buckley *et al.* 2012). In the context of climate change, these species could be at particular risk of decline (Lips *et al.* 2003; Pounds *et al.* 2006; Whitefield *et al.* 2007). Therefore, an unknown proportion of undescribed species are threatened or may have already gone extinct, especially in the tropical highlands. Using currently recognized ranges of nominal species, Foden *et al.* (2013) suggested that amphibians of western Amazonia and the eastern Guiana Shield are the most exposed and sensitive to climate change. Given that naming species is crucial for species conservation (Angulo & Icochea 2010) it is urgent that species in these areas be described.

Among the South American direct-developing frogs (Terrarana)—and vertebrates in general—the genus *Pristimantis* is the most species-rich, containing more than 450 species to date (Heinicke *et al.* 2007; Hedges *et al.* 2008; Frost 2013), with many species still undescribed, notably from the Guiana Shield highlands (McDiarmid & Donnelly 2005, Kok 2013). A large proportion of the newly described species in the genus occur at very narrow

Acknowledgements

This work has benefited from an “Investissement d’Avenir” grant managed by the Agence Nationale de la Recherche [CEBA (Centre d’Etude de la Biodiversité Amazonienne), ref. ANR-10-LABX-25-01]. We thank Marc Gayot (Office National des Forêts - ONF, Réserve Naturelle de la Trinité), Marguerite Delaval (ONF, Réserve Naturelle des Nouragues), Nicolas Surugue (Parc Amazonien de Guyane - PAG), Dawn Frame (UMR AMAP) and Anthony Cochard for their participation. The Nouragues research station through material and technical support for USR 3456 and AnaEE-S infrastructure (ANR-11-INBS-001), the Direction de l’Environnement de Développement Durable et du Logement de la Guyane, as well as the PAG, made field work in remote localities possible. We also thank Valentine Alt and Elodie Michel for investigating the ecology and natural history of *Pristimantis espedeus* sp. nov. PJRK was granted a postdoctoral fellowship from the Fonds voor Wetenschappelijk Onderzoek Vlaanderen (FWO12A7614N), and thanks Barry Clarke and Colin McCarthy (BMNH) for providing access to comparative museum specimens and working space during his visit. Finally, we thank César Barrio-Amorós and José Padial for constructive comments on a previous version of this manuscript.

Literature cited

- Angulo, A. & Icochea, J. (2010) Cryptic species complexes, widespread species and conservation: lessons from Amazonian frogs of the *Leptodactylus marmoratus* group (Anura: Leptodactylidae). *Systematics and Biodiversity*, 8, 357–370.
<http://dx.doi.org/10.1080/14772000.2010.507264>
- Avila-Pires, T.C.S., Hoogmoed, M.S. & Rocha, W.A. (2010) Notes on the vertebrates of northern Pará, Brazil: a forgotten part of the Guianan Region, I. Herpetofauna. *Boletim do Museu Paraense Emílio Goeldi. Ciências Naturais*, 5 (1), 13–112.
<http://dx.doi.org/10.5123/s1981-81142008000200001>
- Barrio-Amorós, C.L. & Brewer-Carias, C. (2008) Herpetological results of the 2002 expedition to Sarisariñama, a tepui in Venezuelan Guayana, with the description of five new species. *Zootaxa*, 1942, 1–68.
- Boulenger, G.A. (1900) Batrachians. In: Lankester, E.R. (Ed.), Report on a collection made by Messrs. McConnell, F.V. & Quelch J.J. at Mount Roraima in British Guiana. Transactions of the Linnean Society of London, 2nd series. *Zoology*, 8, 55–56.
<http://dx.doi.org/10.1111/j.1096-3642.1900.tb00308.x>
- Boulenger, G.A. (1912) Descriptions of new batrachians from the Andes of South America, preserved in the British Museum. *Annals and Magazine of Natural History*, 10, 185–191.
<http://dx.doi.org/10.1080/00222931208693215>
- Buckley, L.B. & Jetz, W. (2007) Environmental and historical constraints on global patterns of Amphibian richness. *Proceedings of the Royal Society B-Biological Sciences*, 274, 1167–1173.
<http://dx.doi.org/10.1098/rspb.2006.0436>
- Buckley, L.B., Hurlbert, A.H. & Jetz, W. (2012) Broad-scale ecological implications of ectothermy and endothermy in changing environments. *Global Ecology and Biogeography*, 21, 873–885.
<http://dx.doi.org/10.1111/j.1466-8238.2011.00737.x>
- Colinvaux, P.A., De Oliveira, P.E. & Bush, M.B. (2000) Amazonian and Neotropical plant communities on glacial time-scales: the failure of the aridity and refuge hypotheses. *Quaternary Science Reviews*, 19, 141–169.
[http://dx.doi.org/10.1016/s0277-3791\(99\)00059-1](http://dx.doi.org/10.1016/s0277-3791(99)00059-1)
- Deutsch, C.A., Tewksbury, J.J., Huey, R.B., Sheldon, K.S., Ghalambor, C.K., Haak, D.C. & Martin, P.R. (2008) Impacts of climate warming on terrestrial ectotherms across latitude. *Proceedings of the National Academy of Science of the USA*, 105, 6668–6672.
<http://dx.doi.org/10.1073/pnas.0709472105>
- Dewynter, M., Marty, C., Blanc, M., Gaucher, P., Vidal, N., Frétey, T., de Massary, J.-C. & Fouquet, A. (2008) Liste des Amphibiens et des Reptiles de Guyane. Available online: <http://www.chelidae.com/pdf/dewynter2008.pdf/> (accessed 16 August 2013)
- Dias Lima, J. (2008) A herpetofauna do Parque Nacional do Montanhas do Tumucumaque, Amapá, Brasil, Expedições I a V. In: Bernard, E. (Ed.), Inventários Biológicos Rápidos no Parque Nacional Montanhas do Tumucumaque, Amapá, Brasil. *RAP Bulletin of Biological Assessment* 48. Conservation International, Arlington, pp. 38–50.
- Dray, S. & Dufour, A.-B. (2007) The ade4 package: implementing the duality diagram for ecologists. *Journal of Statistical Software*, 22 (4), 1–20.
- Duellman, W.E. (1978) Three new species of *Eleutherodactylus* from Amazonian Peru (Amphibia: Anura: Leptodactylidae). *Herpetologica*, 34, 264–270.
<http://dx.doi.org/10.1655/03-24>
- Duellman, W.E. & Lehr, E. (2009) *Terrestrial-Breeding Frogs (Strabomantidae) in Peru*. Natur und Tier-Verlag, Naturwissenschaft, Münster, 382 pp.

- Duputié, A., Deletre, M., De Granville, J.J. & Mckey, D. (2009) Population genetics of *Manihot esculenta* ssp *flabellifolia* gives insight into past distribution of xeric vegetation in a postulated forest refugium area in northern Amazonia. *Molecular Ecology*, 18, 2897–2907.
<http://dx.doi.org/10.1111/j.1365-294x.2009.04231.x>
- Dwyer, C.M. (1995) A new species of *Eleutherodactylus* from Peru (Anura: Leptodactylidae). *Amphibia-Reptilia*, 16, 245–256.
<http://dx.doi.org/10.1163/156853895x00046>
- Elmer, K.R. & Cannatella, D.C. (2008) Three new species of leaf-litter frogs from the upper Amazon forests: cryptic diversity within *Pristimantis "ockendeni"* (Anura: Strabomantidae) in Ecuador. *Zootaxa*, 1784, 11–38.
- Foden, W.B., Butchart, S.H.M., Stuart, S.N., Vie, J.-C., Akcakaya, H.R., Angulo, A., DeVantier, L.M., Gutsche, A., Turak, E., Cao, L., Donner, S.D., Katariya, V., Bernard, R., Holland, R.A., Hughes, A.F., O'Hanlon, S.E., Garnett, S.T., Sekercioglu, C.H. & Mace, G.M. (2013) Identifying the world's most climate change vulnerable species: A systematic trait-based assessment of all Birds, Amphibians and Corals. *PLoS ONE*, 8 (6), e65427.
<http://dx.doi.org/10.1371/journal.pone.0065427>
- Fouquet, A., Gilles, A., Vences, M., Marty, C., Blanc, M. & Gemmell, N.J. (2007) Underestimation of species richness in Neotropical frogs revealed by mtDNA analyses. *PLoS ONE*, 2 (10), e1109.
<http://dx.doi.org/10.1371/journal.pone.0001109>
- Fouquet A., Noonan, B., Blanc, M. & Dill Orrico, V.G. (2011) Phylogenetic position of *Dendropsophus gaucheri* (Lescure & Marty 2000) highlights the need for an in-depth investigation of the phylogenetic relationships of *Dendropsophus* (Anura: Hylidae). *Zootaxa*, 3035, 59–67.
- Fouquet, A., Noonan, B.P., Rodrigues, M.T., Pech, N., Gilles, A. & Gemmell, N.J. (2012) Multiple quaternary refugia in the eastern Guiana Shield revealed by comparative phylogeography of 12 frog species. *Systematic Biology*, 61, 461–489.
- Frost, D.R. (2013) Amphibian Species of the World: an Online Reference. Version 5.6 (9 January 2013), American Museum of Natural History, New York, USA. Available from: <http://research.amnh.org/herpetology/amphibia/index.html> (accessed 25 August 2013)
- Gonzalez-Voyer, A., Padial, J.M., Castroviejo-Fisher, S., de la Riva, I. & Vila, C. (2011) Correlates of species richness in the largest Neotropical Amphibian radiation. *Journal of Evolutionary Biology*, 24 (5), 931–942.
<http://dx.doi.org/10.1111/j.1420-9101.2011.02243.x>
- Giam, X., Scheffers, B.R., Sodhi, N.S., Wilcove, D.S., Ceballos, G. & Ehrlich, P.R. (2011) Reservoirs of richness: least disturbed tropical forests are centres of undescribed species diversity. *Proceedings of the National Academy of Sciences B*, 279, 67–76.
<http://dx.doi.org/10.1098/rspb.2011.0433>
- Hedges, S.B., Duellman, W.E. & Heinicke, M.P. (2008) New World direct-developing frogs (Anura: Terrarana): Molecular phylogeny, classification, biogeography, and conservation. *Zootaxa*, 1737, 1–182.
- Heinicke, M.P., Duellman, W.E. & Hedges, S.B. (2007) Major Caribbean and Central American frog faunas originated by ancient oceanic dispersal. *Proceedings of the National Academy of Sciences of the USA*, 104, 10092–10097.
<http://dx.doi.org/10.1073/pnas.0611051104>
- Heyer, W.R. & Hardy, L.M. (1991) A new species of frog of the *Eleutherodactylus lacrimosus* assembly from Amazonia, South America (Amphibia: Anura: Leptodactylidae). *Proceedings of the Biological Society of Washington*, 104, 436–447.
- IUCN (2001) IUCN Red List Categories and Criteria. Version 3.1. Available from: <http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria/> (accessed 16 August 2013)
- IUCN (2013) IUCN Red List of Threatened Species. Version 2013.1. Available from: <http://www.iucnredlist.org> (accessed 26 August 2013)
- Jenkins, C.N., Pimm, S.L. & Joppa, L.N. (2013) Global patterns of terrestrial vertebrate diversity and conservation. *Proceedings of the National Academy of Sciences of the USA*, 110 (28), E2602–E2610.
<http://dx.doi.org/10.1073/pnas.1302251110>
- Köhler, J., Vieites, D.R., Bonett, R.M., Garcia, F.H., Glaw, F., Steinke, D. & Vences, M. (2005) New Amphibians and global conservation: A boost in species discoveries in a highly endangered vertebrate group. *Bioscience*, 55, 693–696.
[http://dx.doi.org/10.1641/0006-3568\(2005\)055\[0693:naagca\]2.0.co;2](http://dx.doi.org/10.1641/0006-3568(2005)055[0693:naagca]2.0.co;2)
- Kok, P.J.R. (2010) A new species of *Chironius* Fitzinger, 1826 (Squamata: Colubridae) from the Pantepui region, northeastern South America. *Zootaxa*, 2611, 31–44.
- Kok, P.J.R. (2013) Two new charismatic *Pristimantis* species (Anura: Craugastoridae) from the tepuis of the “Lost World” (Pantepui region, South America). *European Journal of Taxonomy*, 60, 1–24.
<http://dx.doi.org/10.5852/ejt.2013.60>
- Kok, P.J.R. & Kalamandeen, M. (2008) *Introduction to the Taxonomy of the Amphibians of Kaieteur National Park, Guyana, Abc Taxa: A Series of Manual Dedicated to Capacity Building in Taxonomy and Collection Management* [Brussels, Belgium], Belgian Development Corporation, 1–288.
- Kok, P.J.R., Means, D.B. & Bossuyt, F. (2011) A new highland species of *Pristimantis* Jiménez de la Espada, 1871 (Anura: Strabomantidae) from the Pantepui region, northern South America. *Zootaxa*, 2934, 1–19
- Kok, P.J.R., MacCulloch, R.D., Means, D.B., Roelants, K., Van Bocxlaer, I. & Bossuyt, F. (2012) Low genetic diversity in tepui summit vertebrates. *Current Biology*, 22, R589–R590.
<http://dx.doi.org/10.1016/j.cub.2012.06.034>

- Lescure, J. & Marty, C. (2001 "2000") *Atlas des Amphibiens de Guyane*. Patrimoines Naturels. Muséum national d'Histoire Naturelle, Paris, 45, pp. 388.
- Lima, A.P., Magnusson, W.E., Menin, M., Erdtmann, L.K., Rodrigue, D.J., Keller, C. & Hödl, W. (2006) *Guia de sapos da Reserva Adolpho Ducke – Amazônia Central / Guide to the frogs of Reserva Adolpho Ducke – Central Amazonia*. Attema, Manaus, 168 pp.
- Lips, K.R., Reeve, J.D. & Writers, L.R. (2003) Ecological traits predicting Amphibian population declines in Central America. *Conservation Biology*, 17 (4), 1078–1088.
<http://dx.doi.org/10.1046/j.1523-1739.2003.01623.x>
- Lutz, B. & Kloss, G.R. (1952) Anfíbios anuros do alto Solimões e Rio Negro. Apontamento sobre algumas formas e suas vicariantes. *Memórias do Instituto Oswaldo Cruz. Rio de Janeiro*, 50, 625–678.
<http://dx.doi.org/10.1590/s0074-02761952000100020>
- Lynch, J.D. (1968) Two new frogs of the genus *Eleutherodactylus* from eastern Ecuador (Amphibia: Leptodactylidae). *Journal of Herpetology*, 2, 129–135.
- Marty, C. & Gaucher, P. (1999) *Guide sonore des Amphibiens Anoures de Guyane*. CD audio. CEBA, Mens.
- Mayle, F.E., Beerling, D.J., Gosling, W.D. & Bush, M.B. (2004) Responses of Amazonian ecosystems to climatic and atmospheric carbon dioxide changes since the last glacial maximum. *Proceedings of the National Academy of Sciences*, 359, 499–514.
<http://dx.doi.org/10.1098/rstb.2003.1434>
- Means, D.B. & Savage, J.M. (2007) Three new malodorous rainfrogs of the genus *Pristimantis* (Anura: Brachycephalidae) from the Wokomung Massif in west-central Guyana, South America. *Zootaxa*, 1658, 39–55.
- McDiarmid, R.W. & Donnelly, M.A. (2005) The herpetofauna of the Guayana Highlands: Amphibians and Reptiles of the Lost World. In: Donnelly, M.A., Crother, B.I., Guyer, C., Wake, M.H. & White, M.E. (Eds.), *Ecology and Evolution in the Tropics: A Herpetological Perspective*. University of Chicago Press, Chicago, Illinois, pp. 461–560.
- Myers, C.W. & Donnelly, M.A. (1997) A tepui herpetofauna on a granitic mountain (Tamacuari) in the borderland between Venezuela and Brazil: Report from the Phipps Tapirapecó Expedition. *American Museum Novitates*, 3213, 1–71.
- Ouboter, P.E. & Jairam, R. (2012) *Amphibians of Suriname*. Brill Academic Publishers, Leiden, 376 pp.
- Noonan, B.P. & Gaucher, P. (2005) Phylogeography and demography of Guianan harlequin toads (*Atelopus*): Diversification within a refuge. *Molecular Ecology*, 14 (10), 3017–3031.
<http://dx.doi.org/10.1111/j.1365-294x.2005.02624.x>
- Noonan, B.P. & Gaucher, P. (2006) Refugial isolation and secondary contact in the dyeing poison frog *Dendrobates tinctorius*. *Molecular Ecology*, 15 (14), 4425–4435.
<http://dx.doi.org/10.1111/j.1365-294x.2006.03074.x>
- Parker, H.W. (1940) Undescribed anatomical structures and new species of Reptiles and Amphibians. *Annals and Magazine of Natural History*, 5, 257–274.
<http://dx.doi.org/10.1080/00222934008527045>
- Pounds, J.A., Bustamante, M.R., Coloma, L.A., Consuegra, J.A., Fogden, M.P.L., Foster, P.N., La Marca, E., Masters, K.L., Merino-Viteri, A., Puschendorf, R., Ron, S.R., Sánchez-Azofeifa, G.A., Still, C.J. & Young, B.E. (2006) Widespread Amphibian extinctions from epidemic disease driven by global warming. *Nature*, 439, 161–167.
<http://dx.doi.org/10.1038/nature04246>
- Rivero, J.A. (1961) Salientia of Venezuela. *Bulletin of the Museum of Comparative Zoology*, 126, 1–207.
- Schlüter, A. & Rödder, D. (2007) "2006" Three new frogs of the genus *Eleutherodactylus* (Amphibia, Leptodactylidae) from Guaiquinima Table Mountain, Bolivar, Venezuela. *Herpetotropicos*, 3, 88–99.
- Smith, M.A. & Green, D.M. (2005) Dispersal and the metapopulation paradigm in Amphibian ecology and conservation: are all Amphibian populations metapopulations? *Ecography*, 28, 110–128.
<http://dx.doi.org/10.1111/j.0906-7590.2005.04042.x>
- Sueur, J., Aubin, T. & Simonis, C. (2008) Equipment review: Seewave, a free modular tool for sound analysis and synthesis. *Bioacoustics*, 18 (2), 213–226.
<http://dx.doi.org/10.1080/09524622.2008.9753600>
- Whitefield, S.M., Bell, K.E., Philippi, T., Saas, M., Bolanos, F., Chaves, G., Savage, J.M. & Donnelly, M.A. (2007) Amphibian and Reptile declines over 35 years at La Selva, Costa Rica. *Proceedings of the National Academy of Sciences of the USA*, 104 (20), 8352–8356.
<http://dx.doi.org/10.1073/pnas.0611256104>