The distribution and local density of the critically endangered frog *Conraua derooi* Hulselmans, 1972 in Togo, West Africa

GABRIEL HOINSOUDÉ SÉGNIAGBETO^{1*}, DELAGNON ASSOU¹, DANIELE DENDI^{2,5}, MARK-OLIVER RÖDEL³, ANNEMARIE OHLER⁴, ALAIN DUBOIS⁴ & LUCA LUISELLI^{2,5}

¹Département de Zoologie et Biologie animale, Faculté des Sciences, Université de Lomé, BP 1515, Lomé, Togo

²IDECC – Institute for Development, Ecology, Conservation and Cooperation, via G. Tomasi di Lampedusa 33, I-00144 Rome, Italy

³Museum für Naturkunde, Berlin, Leibniz Institute for Evolution and Biodiversity Science, Invalidenstr. 43, 10115 Berlin, Germany

⁴Institut de Systématique, Évolution, Biodiversité, ISYEB – UMR 7205 – CNRS, MNHN, UPMC, EPHE, Muséum national d'Histoire naturelle, Sorbonne Universités, 57 rue Cuvier, CP 30, F-75005, Paris, France ⁵Department of Applied & Environmental Biology, Rivers State University of Science & Technology,

P.M.B 5080, Port Harcourt, Rivers State, Nigeria

Corresponding author Email: h_segniagbeto@yahoo.fr

ABSTRACT - *Conraua derooi* is a Critically Endangered frog, endemic to the hilly forest region between Ghana and Togo, West Africa. Field surveys were conducted in the Togolese areas, considered to be potentially suitable for *C. derooi* in November 2015 and November 2016. The species was not encountered in several potentially suitable sites. However, *C. derooi* was recorded in two areas, Missahohe and Danyi Yikpa, including two new sites, one rediscovered site, and three confirmed sites within these areas. In total we recorded 522 adult individuals. The number of observed frogs ranged from 14 to 150 individuals × km⁻¹. Due to heavy habitat alteration the known populations are isolated. Some conservation considerations are presented.

INTRODUCTION

Ogo slippery frog, Conraua derooi (Fig. 1) was described from the forest around Missahohe in south-western Togo (Hulselmans, 1972). In 1980, a further small population of the species was discovered north of the type locality in the Danyi Yikpa area (Bourgat et al., 1996). Records of C. derooi from Togo and Ghana, identified as Conraua alleni (a species-complex which occurs from western Ghana to Sierra Leone and Guinea; Mark-Oliver Rödel et al., unpubl. data), prior to the description of C. derooi, were published by Schiøtz (1964) and Lamotte & Perret (1968). Surveys conducted from 2000 to 2005 on the Ghanaian part of the Ghana-Togo highlands failed to detect the species (Rödel & Agyei, 2003; Leaché et al., 2006). Segniagbeto et al. (2007) summarised the known sites from Togo but they did not find any new sites. Finally Kouamé et al. (2007) presented new records from the Atewa Range in Ghana; Hillers et al. (2009) confirmed the persistence of C. derooi at several known sites along the Togo-Ghana border. Preliminary results indicate, however, that the Atewa records may represent an undescribed species (Rödel, unpubl. data). In summary, C. derooi has a very restricted distribution, with all known Togolese populations found along the Camalo torrent in the forests of Missahohe and Yikpa (Segniagbeto et al., 2007, 2013).

Typical habitats of the species are torrents in hilly forested landscapes. Previous studies (Rödel & Agyei, 2003; Hillers et al., 2009 and Segniagbeto et al., 2013) have shown that available habitat for this species is highly fragmented and



Figure 1. Adult C. derooi from Camalo I, south-western Togo.

degraded, as natural forest ecosystems being transformed into coffee and cocoa plantations. As a result and because of its Extent of Occurrence, *C. derooi* has been assessed as Critically Endangered, Criteria B2ab(iii), by IUCN (Rödel & Schiøtz, 2004). In addition, the species should be considered a priority for conservation on the basis of its evolutionary distinctiveness and global endangerment (Isaac et al., 2012). In order to obtain up-to-date scientific data on the distribution and conservation status of the *C. derooi* populations in Togo, we conducted field surveys in November 2015 and November 2016 in areas considered, based on habitat, as potentially suitable for the species. In this paper, we present data on the number of observed individuals and some hitherto unknown sites.



Figure 2. Map of Togo, showing the two study areas with presences of *C. derooi*. The new localities discovered during the present surveys are presented in red colour. Locality 1 was rediscovered after it was firstly discovered in 1980.

STUDY AREA

The study area was within the forest zone in south-western Togo (Figure 2; ecological zone IV according to Ern, 1979). In this area, different sites were surveyed, these included the forest of Assoukoko, the forest of "les Deux Béna", the forest of Assimé, Yikpa, Missahohe and Mount Agou (Table 1). Overall, this comprises hilly area with altitudes of up to 972 m asl. Localities in these areas usually have very steep slopes (Addra et al., 1994). The climate is transitional subequatorial (Papadakis, 1966; Trochain, 1980), being characterised by a prolonged rainy season from March to October, with decreasing amounts of rainfall in August or September. The survey periods were selected on the basis of logistical opportunities, in order to avoid periods of heavy rains that would have caused difficulties in exploration of some sites in remote areas of the forest. It is the wettest area in Togo, with an average annual rainfall amounting to 1,300–1,500 mm. This area is characterised by the presence of several rivers spread over three water-sheds, with the basin River Volta source being the most important in terms of size. The main water-courses are: Assoukoko and its tributaries Yégué and Koflo; Wawa and its tributaries Kpon (also called Gbanhou), Obéka, Ové and Gonobe; Danyi and its tributaries Tonon, Iwé, Sassa and Agoumatsa. The vegetation varied between the sites investigated (see Table 1 for site names). Geographic coordinates of the various presence sites are not provided for conservation reasons (Lindenmayer & Scheele,

2017), but are available on request from the authors.

Djiguégué consists of a mosaic of semi-deciduous, more or less degraded, dense forests, a few small gallery forests, savannas, fallow land and crops (see Figure 2 for its location within Togo).

Assoukoko is similar to Djiguégué in that the site is a mosaic of semi-deciduous forests, dry dense forests, wooded savannas, fallow land and crops. In accessible parts of the semi-deciduous forests, coffee and cocoa is cultivated. The forests in this area gradually shift from semi-deciduous on valley floors, to dense dry forests on upper slopes, and finally transition into wooded savannas at the top.

The area of Akloa (Badou) includes patches of heavily degraded forest, dominated by cash crops (mainly coffee and cocoa), growing under forest canopy. Fruit such as *Persea americana*, *Citrus* spp., *Musa sapitum* and *Musa paradisiaca* is also cultivated in these agroforestry systems. Atigba (Danyi) comprises agroforestry systems (mainly coffee), some narrow gallery forests and wooded savanna.

The vegetation in Dany Yikpa resembles that in the Assoukoko area, i.e. comprising a mosaic of semideciduous forests, dense dry forests and wooded savannas; the undergrowth of accessible semi-deciduous forests is cultivated with coffee and cocoa.

The Missahohé forest comprises a mosaic of mesophilic or semi-deciduous forests (Akpagana, 1989) and savannas. It is heavily impacted because of human settlements and the cultivation of both, cash crops and food crops.

MATERIALS AND METHODS

Two field surveys, on 1-11 November 2015 and 8-13 November 2016, were carried out in the localities mentioned above. Each study site was visited twice. Prior to field work we conducted interviews in the nearby villages (n = 21 villages). In each village, 4 to 12 local persons were interviewed. All interviewers were males, and the same was for interviewees, as only men collect frogs in Togo. Interviewees were asked about the presence of the species by presenting them photos of the frogs and by imitating their advertisement call (high-pitched whistles). With the support of two local guides, and based on the results of the interviews, potential sites of the species were identified. Small waterfalls in forested areas, streams with a width of about two to three meters and streambeds with rocks or pebbles (mainly quartzites) were targeted as survey sites, as these habitat features were already seen to be associated with C. derooi populations in the past (e.g., Segniagbeto et al., 2013). All identified sites were surveyed between 7 and 10 pm. Air temperature was not recorded because it is very constant at the study areas, and because all surveys were made in the same period of the year (November, i.e. end of the wet season). The name-places and the distance walked in each site are presented in Table 2. The field team consisted of 3 people (GHS and two students). Surveys were undertaken with the team proceeding slowly upstream, until walking became impossible because the terrain became too difficult to traverse. Flashlight and head torches were used for exploring the sites. The length of the stream which could be investigated varied between sites from 200 m to 1.8 km (Table 2). At each site, all the observed frogs were counted. Adults and subadults were pooled in our counts. All members of the team walked slowly and parallel to each other, thus ascertaining that no specimen was counted twice. Tadpoles and newly metamorphosed individuals were observed but not counted. However, their presence was always recorded.

Density of *C. derooi*, at each site, was determined as the number of adult individuals that were observed per km of transect. Four times per year, interviews with, and examination of collected animals by, reptile farms in Lomé were carried out in order to monitor the current trade of species. During these surveys, the dealers were interviewed about the collected animals, and any details of interest (apparent abundance, locality of capture, destination country, etc.) were recorded.

RESULTS AND DISCUSSION

In total, 23 independent sites were visited and in 21 of them a total of 138 local people were interviewed (Table 1). Overall, in six distinct localities (including four localities were also interviews were made) we recorded 522 *C. derooi* individuals, 349 in 2015 and 173 in 2016 (Table 2). A greater number of *C. derooi* were observed in the southern part of Togo's ecological zone IV compared to the northern part (Fig. 1). Our surveys did not reveal the presence of the species in Diguengue, Assoukoko, Akloa, Danyi Atigba and Mount Agou, despite all sites being surveyed twice (once

Table 1. Summary of areas and localities investigated for *C. derooi* in the forest area of Togo, where also interviews with local people were conducted.

Area investigated	Localities	State of record	Number of people interviewed
	Yégué	No record	8
Adele area	Assoukoko	No record	9
	Dikpéléou	No record	6
	Diguengue	No record	12
	Akloa	No record	10
Akloa area	Wobè	No record	6
	Tomégbé	No record	4
Danyi area	Danyi Atigba	No record	7
	Yikpa Dzigbé	Presence ascertained	4
	Yikpa Anyigbé	Presence ascertained	11
	Kouma Tokpli	No record	6
	Agomé Tomégbé	No record	6
	Kamétonou	No record	5
Kloto area	Agomé Yoh	No record	8
	Kouma Konda	Presence ascertained	7
	Anédi	Presence ascertained	5
	Kouma Adamé	No record	4
Agou mountain	Kouma Tsamé	No record	6
	Kébo Dzigbé	No record	6
area	Kébo Dogbadzi	No record	4
	Kébo Kpéta	No record	4

in each year of study). Based on its habitat features, the mountain side at Agou looked particularly suitable for the species. However, the species was not detected. Based on our interview data and subsequent field surveys, the local communities appeared to often confuse *C. derooi* with the widespread, abundant, and similarly aquatic *Hoplobatrachus occipitalis*. It should be noted that, in Djiguégué and Akloa, the hilly areas were extremely difficult to access and the area had many small waterfalls within a forest environment. Interviews with people from some villages in this area indicated the potential presence of the species. The respective areas thus should be re-surveyed and this will entail the use of specialist climbing equipment.

The presence of the species was confirmed in just two forest regions which are known to have supported the species in the past: Missahohe and Danyi Yikpa (Hulselmans, 1972; Bourgat, 1979; Kulo, 1980; Hillers et al., 2009; Segniagbeto et al., 2013). More in detail, the species was recorded at six distinct sites within these two main areas, two out of which were newly discovered during the present investigations and one was rediscovered after 1980 (Fig. 2). In other three sites, the presence of the study species was confirmed (Fig. 2). The greatest number of C. derooi (30.65% of the total number of encountered adult individuals per km of transect; see table 2), were observed at the Zoto site, in the Missahohe forest, followed by Douane, also situated in Missahohe forest (Table 2). All sites where the species was present were surrounded by unsuitable habitat (forestry operations and coffee and cocoa cultivation in the former forest). Our **Table 2.** Summary of Togolese localities where *C. derooi* was recorded, including survey dates and number of observed (No.) individuals. Abundance is defined as number of individuals \times km-1. Tadpoles were observed at all sites.

Localities	First surve	ey (2015)	Second Survey (2016)		Transect length (km)	no. frogs x km ⁻¹ (year 2015)	no. frogs x km ⁻¹ (year 2016)
	Date	No. of C. derooi	Date	No. of <i>C. derooi</i>			
Yikpa	2 Nov	30	9 Nov	25	1.8	16.66	13.88
Camalo I, Missahohe	4 Nov	70	12 Nov	45	1.3	53.85	34.61
Zoto, Missahohe	8 Nov	120	10 Nov	40	0.8	150	50
Douane, Missahohe	8 Nov	50	10 Nov	20	0.5	100	40
Camalo, II Missahohe	9 Nov	14	12 Nov	8	0.2	70	40
Anedi, Missahohe	10 Nov	65	11 Nov	35	0.45	144.4	77.77



Figure 3. Small waterfall, habitat of *C. derooi* in Danyi Yikpa, south-western Togo.

surveys indicate that the Togolese population of *C. derooi* is highly fragmented.

Our observations confirm the known habitat preferences of this species (Fig. 3), which is associated with torrents. At Camalo II, some individuals were also found, under the water, in rock crevices or by being dug from the mud. Adults, especially calling males, were observed sitting on rocky substrates outside of the water. Some individuals were observed 10 m above torrents within the spray zone of waterfalls.

The habitats of all C. derooi populations are seriously threatened by logging and agricultural encroachment. The few remaining forests throughout the hilly forest area along the border between Togo and Ghana are being converted into plantations (mostly coffee and cocoa) at increasing rates. According to the FAO (2011), 43.6% of forest ecosystems in Togo have been destroyed since 1990. The increasing production of charcoal by the local populations, following the recent fall in the global prices for coffee and cocoa, is accelerating the ongoing process of forest fragmentation and degradation. What is left of these forests today is practically confined to forest islands in hard-to-reach areas and along watercourses. Because of the rapid population growth, these forest relics are increasingly damaged as well. Even in the Missahohe Forest, which is a protected area, the habitats of C. derooi are heavily degraded (Segniagbeto et al., 2013). Indeed, although legally protected at the country scale, this forest is heavily subjected to illegal timbering, hunting and other resource exploitation activities.

Another threat to the populations of C. derooi is the exploitation of adults for domestic consumption and the international food trade. To date, the level of exploitation has not been quantified and requires further study. In neighboring Bénin, a dramatically increasing exploitation of frog populations for regional and international food market has been documented (Mohneke et al., 2010). In addition, other Conraua species are exploited for meat in West and Central Africa (e.g. Conraua goliath, see Herrmann et al., 2005). There is also indication that the C. derooi population at Yikpa is exploited for local consumption. The interviewed population of this small village (10 people, all men), situated between Togo and Ghana, indicates that the species is well known and interviewees reported that frogs are sold for 100 CFA per frog (= 0.17 \$ or $0.15 \in$) to local households. This population and those of the Missahohe Forest are furthermore exploited, especially to supply the demand for frog meat from the Chinese workforce in Togo. In addition, interviewed collectors at the various sites also acknowledged that they collect *C*. *derooi* for Togolese reptile farms which export frogs for the international pet trade. This exploitation was confirmed by two of the nine reptile farms that were surveyed (Mare and Toganim). Indeed, about 50 (range: 15-100) C. derooi individuals per year were exported from Togo to the European Union between 2010 and 2015 (Segniagbeto, unpublished data). Nonetheless, this export has now been stopped due to the recommendation of the senior author to the 'Direction des Ressources Forestrières' of the Togolese Republic (year 2015) and to the collectors as well.

However, given that habitat alteration is presumably the main threat for C. *derooi* in Togo, we advise that urgent measures should be taken to protect and (where necessary) restore the remaining habitats of this species in Togo.

Because of the very few known sites, the high fragmentation of the range, and the rampant habitat loss, we consider that this species should be still considered as CR by IUCN. In this regard, it should be mentioned that *C. derooi* has been subjected to conservation initiatives in Ghana, coordinated by Caleb Ofori-Boateng and internationally supported by various donors (e.g. see http://www. saveourspecies.org/projects/amphibians/conservation-critically-endangered-togo-slippery-frog-conraua-derooi; lastly accessed: 20 August 2017). Thus, it would be very important that similar international attention should be attributed to the Togolese populations as well.

ACKNOWLEDGEMENTS

The two field surveys were within the framework of the project "Conservation of the Togo slippery frog (*Conraua derooi*) in Missahohe and Assime forests areas (Togo, West Africa)" funded by Stiftung Artenschutz's "Amphibian Funds" in cooperation with the "Verband der Zoologischen Gärten e.V." (VdZ). We are very grateful for their support. We further thank Jan Kamstra and Jaime García Moreno from the Netherland's Committee of the IUCN by their facilitation contact with the Stiftung Artenschutz. We are very thankful to Agbo-Zegue Ngo who provided logistics for the field surveys, and to two anonymous referees for helpful comments on the submitted draft.

REFERENCES

- Addra, T.C., Fahem, A.K., De Jong, T., & Mank, T. (1994). Atlas du développement régional du Togo. Lomé, PNUD, DTCD, DGPD, DNCN, Editogo/CARSEUC, 207 pp.
- Akpagana, K. (1989). Recherches sur les forêts denses humides du Togo. PhD thesis. Bordeaux: Université de Bordeaux, 181 pp.
- Bourgat, R. (1979). Trématodes d'Amphibiens du Togo. Bulletin du Muséum national d'Histoire naturelle 4: 597–624.
- Bourgat, R., Roure, C. & Kulo, S.-D., 1996. Nouvelles données sur les Trématodes d'Amphibiens d'Afrique occidentale. Description d'*Haematoloechus aubrae* n. sp. *Revue zoologique de Suisse* 103 (2): 383–394.
- Ern, H. (1979). Vegetation Togos. Gliederung, Gefährdung, Erhaltung. *Willdenowia* 9: 295-312.
- FAO (Food and Agriculture Organization) (2011). Global forest resources assessment 2010; progress towards sustainable forest management. Rome, FAO Forestry Paper 147, 378 pp.
- Herrmann, H.-W., Böhme, W., Herrmann, P.A., Plath, M., Schmitz, A. & Solbach, M. (2005). African biodiversity hotspots: the amphibians of Mt. Nlonako, Cameroon. *Salamandra* 41: 61-81.
- Hillers, A., Boateng, C.O., Segniagbeto, G.H., Agyei, A.C., & Rödel, M.-O. (2009). The amphibians in the forests of southern Ghana and western Togo. *Zoosystematics and Evolution* 85: 127–141.
- Hulselmans, J.L.J. (1972).Contribution à l'herpétologie de la République du Togo, 4. Description de *Conraua derooi* n. sp.(Amphibia). *Revue de Zoologie et de Botanique africaines* 84: 153–159.
- Isaac, N. J., Redding, D. W., Meredith, H. M., & Safi, K. (2012). Phylogenetically-informed priorities for amphibian conservation. *PLoS ONE*, 7, e43912.

- Kouamé, N.G., Boateng, C.O., & Rödel, M.-O. (2007). A rapid survey of the amphibians from the Atewa Range Forest Reserve, Eastern Region, Ghana. A Rapid Biological Assessment of the Atewa Range Forest Reserve, Eastern Ghana. *RAP Bulletin of Biological Assessment* 47, pp. 76–83. McCullough, J., Alonso, L.E., Naskrecki, P., Wright, H.E., & Osei-Owusu, Y. (Eds.). Arlington, Virginia: Conservation International.
- Kulo, S.-D. (1981). Présence au Togo de Metapolystoma cachani (Gallien, 1957) Combes, 1976 (Monogena) chez l'amphibien Ptychadena longirostris (Peters, 1870). Bulletin de la Société zoologique de France 106: 177–181.
- Lamotte, M., & Perret, J-L. (1968). Révision du genre Conraua Nieden. Bulletin de l'Institut fondamental d'Afrique Noire, Sér A, 30: 1603–1644.
- Leaché, A.D., Rödel, M.-O., Linkem, C.W., Diaz, R.E., Hillers, A., & Fujita, M.K. (2006). Biodiversity in a forest island: reptiles and amphibians of the West African Togo hills. *Amphibian and Reptile Conservation* 4: 22–45.
- Lindenmayer, D. & Scheele, B. (2017). Do not publish. *Science* 356 (6340): 800–801.
- Mohneke, M., Onadeko, A.B., Hirschfeld, M., & Rödel, M.-O. (2010). Dried or fried: amphibians in local and regional food markets in West Africa. *TRAFFIC Bulletin* 22: 117–128.
- Papadakis, J. (1966). Enquête agro-écologique en Afrique Occidentale. Liberia, Côte d'Ivoire, Ghana, Togo, Dahomey, Nigeria. Vol 2, Atlas. Rome: FAO, 43 pp.
- Rödel, M.-O., & Agyei A.C. (2003). Amphibians of the Togo-Volta highlands, eastern Ghana. *Salamandra* 39: 207–234.
- Rödel, M.-O. & Schiøtz, A. (2004). Conraua derooi. The IUCN Red List of Threatened Species 2004: e.T58253A11758064.http://dx.doi.org/10.2305/IUCN. UK.2004.RLTS.T58253A11758064.en. (Downloaded on 14 July 2017).
- Schiøtz, A. (1964). A preliminary list of amphibians collected in Ghana. Videnskabelige Meddelelser fra dansk Naturhistorik Forening 127: 1–17.
- Segniagbeto, G.H., Bowessidjaou, J.E., Dubois, A., & Ohler, A. (2007). Les Amphibiens du Togo: état actuel des connaissances. *Alytes* 24: 72–90.
- Segniagbeto, G.H.,Okangny, D., & Luiselli, L. (2013). The endemic *Conraua derooi* in immediate conservation need in Togo. *FrogLog* 108: 23–24. Available at: http:// www.amphibians.org/froglog/fl108/
- Trochain, J.-L. (1980). *Ecologie végétale de la zone intertropicale non désertique*. Toulouse: Université Paul Sabatier, 468 pp.

Accepted: 11 September 2017