Ball python *Python regius*

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Background and summary

Ball pythons (*Python regius*) are among the most popular reptile pets in the world. Benin, Ghana and Togo provide almost 100% of the specimens exported mainly to USA and EU since 1976. Ball pythons are thus the most heavily traded CITES-listed species exported from Africa, with hundreds of thousands of specimens involved in international trade every year. Specimens are exported under CITES source codes “C’, “R” and ‘W’, in 0.5%, 93.5% and 6% of the cases, respectively. The species has a large distribution, fast reproductive rate, and occurs in a wide range of habitats. However, despite the viability of sustainable ranching illegal trade is believed to be still occurring and even increasing. For instance, in Benin, an illegal link with the bush meat trade was discovered, leading to a prohibition on ranching. Trade focuses on the most vulnerable life stages, i.e. neonates and gravid females and harvest methods may damage nests. Agricultural mechanization, chemical pest controls and atmosphere warming coupled with frequent flooding in the species preferred habitat (climate change) are likely to worsen the situation. In some areas, notably Benin, harvesting has therefore become a potentially serious threat to wild populations. In some areas local traditions and taboos may protect the snakes from over-harvesting. Considering all abovementioned we make recommendations for future management.

Species overview

Distribution

Ball pythons occur over sub-Saharan West and Central Africa (Fig. 1), from Senegal and Sierra Leone to southeastern Sudan and northwestern Uganda (De Vosjoli et al. 1995; Sillman et al. 1999; Chippaux 1999; 2001 & 2006). They are native of Benin, Cameroon, Central African Republic, Congo, The Democratic Republic of Congo, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, South Sudan, Togo and Uganda. Within this region their geographic distribution is very discontinuous and populations are fragmented. Thus, in Benin for example, the species can now be found mainly in areas of worship (Toudonou 2007) where it benefits from traditions and taboo protection (Gorzula et al. 1997; Eniang et al. 2006; Toudonou 2007).

Basic biology

Ball pythons occur in a wide range of habitats, including closed vegetation like forests, bushy and dryland rainforest patches, and occasionally permanently flooded habitats (see Luiselli & Angelici 1998; Akanni et al. 2002), open lands such as Guinea savannahs, grasslands, woodlands, etc. (De Vosjoli et al. 1995), as well disturbed areas. The species is adapting more and more to anthropogenic habitats such as farmlands and fallow lands (Gorzula et al. 1997; Luiselli & Angelici 1998; Akanni et al. 2002; Aubret et al. 2005, Broghammer 2004; Toudonou 2007). Besides, they are nocturnal and both terrestrial and tree-dwelling animals. In fact, they hide in burrows during daytime and use more arboreal niches during nights, particularly the males (Luiselli & Angelici 1998).

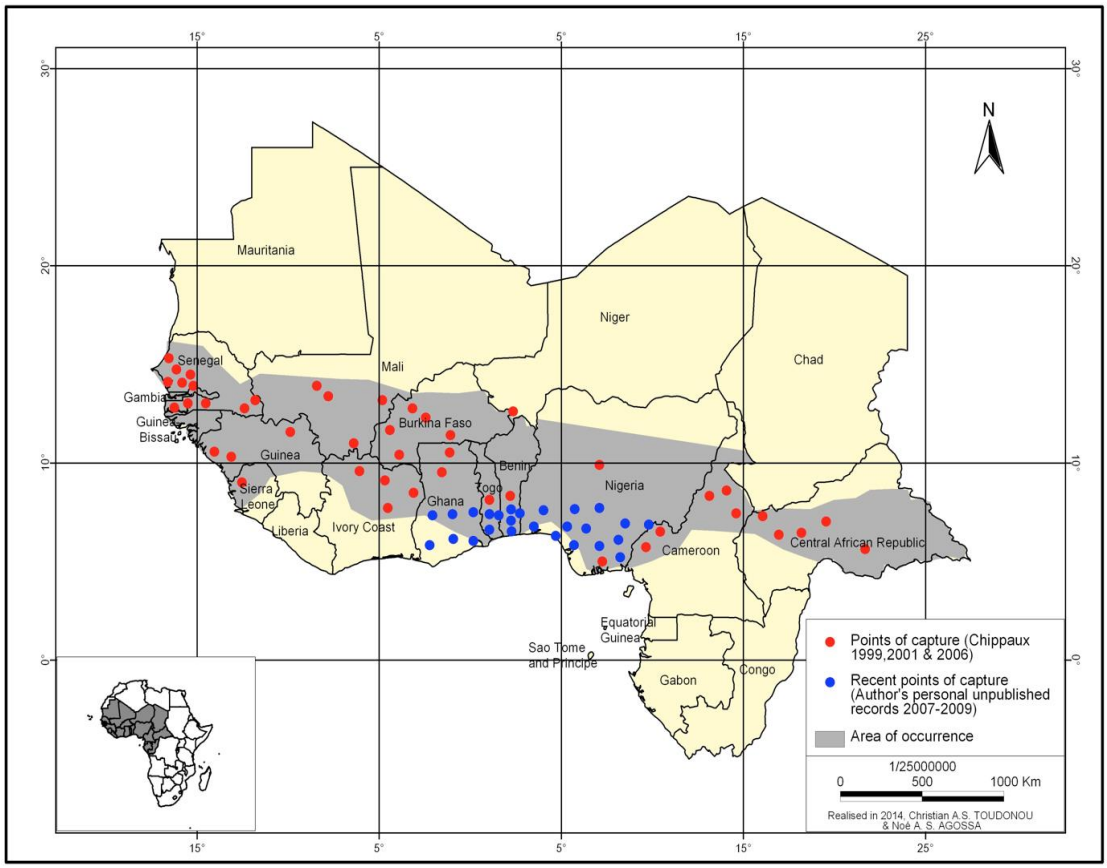

Fig. 1. Distribution range of Ball pythons (*Python regius*).

Ball pythons reach reproductive maturity from 27 to 31 months for females and 16 to 18 months for males. Clutches in Ghana range from 6 to 15 eggs while those in Benin and Togo comprise 4 to 8 eggs. Reproductive phenology is presented in Fig. 2. Similar to many heavy-bodied snakes, Ball pythons are opportunistic ambush predators. They feed on birds and rodents (Luiselli & Angelici 1998). In average, Ball pythons live for up to 10 years in the wild (Bartlett & Bartlett 1997; Gorzula et al. 1997; Bartlett et al. 2001).

	Periods											
Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Specimens harvested		**Eggs**			**Neonates**			**Young Ball pythons**			**Gravid females**	
Reproduction		**Eggs laying**		**Brooding**	**Eggs hatching**						**Mating**	
Export of specimens	**Other specimens (e.g. special coloration)**				**Neonates & Other specimens (e.g. special coloration)**					**Other specimens (e.g. special coloration)**		

Fig. 2. Reproductive phenology of Ball pythons (*Python regius*) in relation to trade.

Table 1. Variables that influence a species' resilience to use and the attributes of Ball pythons.

Variable	Use resilience key[1]		Resilience of ball pythons
	High	**Low**	
Distribution	Broad	Narrow	Broad
Habitat specificity	Broad	Narrow	Broad
Dietary specificity	Generalist	Specialist	Generalist
Reproductive output	High	Low	Medium
Growth rate	High	Low	High
Reproductive rate	High	Low	Medium
Time until maturation	Short	Long	Short
Population size	High	Low	High
Population density	High	Low	Medium[2]
Population connectivity	High	Low	Medium
Dispersal ability	Good	Poor	Medium
Genetic variability	High	Low	Low

[1]For example, if a species' reproductive output is high then it is more likely to have a high resilience to use than a species that has a low reproductive output.
[2]Population density could be considered high in Ghana, medium in Togo and low in Benin.

Status and threats

Status

P. regius is listed on CITES Appendix II and classified as Least Concern by the IUCN in the Red List of Threatened Species (Auliya & Schmitz 2010). However, the status of the species differs within each range country, with some indications that the species is declining in Benin.

Farmers and ball python collectors unanimously report that the species is under severe threat in Benin, and explain the situation in different ways. For farmers, increases in several crop pest infestations following overpopulation (e.g. rodents, birds, etc.) and its corollaries are associated to a reduction of pythons (see Meirte 1999; Sinsin et al. 1999; Vodounnon 1999). From the collectors' perspective, the decrease in harvest rate (number of snakes collected daily), the need to look for new collection localities, and an increase in collection efforts and costs, are symptomatic of the species rarefaction (Toudonou 2007). For instance, collectors declared that harvest rates have dropped from 5-10 snakes daily, twenty years ago to less than 1 snake per day in recent years (Toudonou 2014 unpublished). According to interviewed actors, in the past ball pythons were easily collected within 1 km radius around collectors' villages. At present, however, collectors travel at least 40 km (76% of the surveyed actors) to be successful. In addition, due to the species rarefaction, all hunters have abandoned their initial places of collection (Toudonou 2007; Toudonou 2014 unpublished). It appears that the species has become extirpated, from some areas of the country where no individuals were found on surveys (Toudonou 2007). In Benin both the area of occupancy and extent of occurrence have decreased by approximately 20% and 60% respectively (Toudonou 2014 unpublished). According to this information, the species should be considered as '**Endangered**' in Benin and reassessed in its whole distribution range.

None of the major exporting countries have special regulations on the species, except local rules and taboos in relation to the snake cult that prevails in some localities (Gorzula et al. 1997; Eniang et al. 2006; Toudonou 2007).

Threats

The expansion of agriculture mechanization and the use of chemical pest controls are potential threats to ball pythons. However, the main identified threat for the species at the local level (e.g. Benin) is hunting pressure. Harvests target the most important life stages (i.e. eggs, neonates and gravid females) in the species life-history, and the collected gravid females are not always returned to the wild as required in the ranching system, but are consumed as bushmeat. Hence, the situation in some range countries is very different to that shown in official reports, since in reality "R" (ranching) source specimens are replaced by "W" (wild) source specimens. Preliminary investigations carried out on this trade in several markets of southern Benin, describe this trade in the sub-region (Toudonou et al. 2014b in prep.). In these investigations, traders declared that 90% of their annual sales are provided by middlemen in contact with exporters. And it is shown that the volumes/numbers of Ball python carcasses are positively correlated with the period of reproduction of the species in the wild as well as with the active season of exportations, only in the markets in connection with official exporters (i.e. Badagry (Nigeria side) and Ifangni (Benin side) – two bordering localities). Finally, harvesting techniques for capturing pythons cause the destruction/spoiling of female oviposition sites (Goode et al. 2005; Toudonou 2007; Toudonou 2012).

Trade characteristics

Source of animals in the pet trade

According to gross exports data (2000-2013; CITES Trade Database) major export countries are Benin (39.1%), Togo (34.6%) and Ghana (26.7%). Of these, 0.5% of all specimens traded in the last ten years were sourced as captive breed (C), 93.5% as ranched (R) and 6% as proceeding from the wild (W). Fig. 3 shows the proportion of each specimen source code by exporting country; however, official figures do not reflect the real situation. For example, in Ghana effective progress has been made in Ball python ranching and therefore there is no doubt about the capacity of Ghanaian exporters to produce ranched specimens (Gorzula et al. 1997). Unfortunately, the same is not true for Benin (see Toudonou 2003; Toudonou et al. 2004b; Toudonou 2007) or Togo, where the ranching of the species is still questionable (Ineich 2004, 2006; Toudonou personal observations). Thus, exports from Benin and Togo may be composed of wild-caught and captive-bred specimens exclusively. Due to illegality and lack of honest reporting, there are considerable discrepancies between the number of live specimens traded according to exporters vs that provided by importers, both in terms of total figures and with regard to source code of specimens. Source (e.g. wild-caught, ranched or bred in captivity) is intentionally manipulated by traders to fit the information in the issued CITES permits and certificates (Toudonou 2007), or used in different ways by importing and exporting countries.

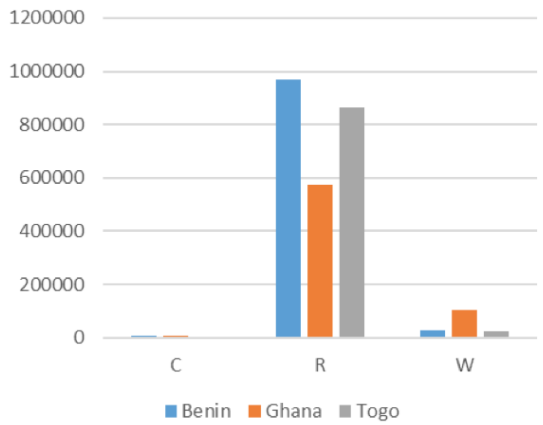

Fig. 3. Ball pythons gross exports by source and country (2000-2013). (Source: UNEP-WCMC CITES Trade Database, 2015).

Trade & price trends

The value of Ball pythons has been consistently decreasing along years. Nowadays, prices have dropped to less of one seventh (e.g. 3 U$S in 2013 (see Toudonou et al. 2014b, in prep.) compared to those of 1975 (see Gorzula et al. 1997; Ineich 2004; Ineich 2006; Toudonou 2007). It is important to point out that prices have dropped much more rapidly than the numbers of specimens exchanged. This is indicative of either a market saturation and/or the successful breeding of the species in importing countries. However, the recent discovery of wild specimens with a special colour morph– resulting from albinism and other genetic mutations (see Broghammer 2004) – leads to a renewed interest in importing Ball pythons from African countries. Prices for such rare specimens can reach up to 13,000 U$S (Auliya & Schmitz 2010).

Conclusions

The Ball python is a snake species with a good capacity to adapt to different habitats. It still occurs in its original range, exhibiting a different conservation status from one country to another, but with a decrease in abundance, at least, in Benin, due to intense collection driven by the pet trade and the bushmeat demand. In fact, both the area of occupancy and extent of occurrence have decreased in Benin. Harvest targets the most vulnerable biological stages (i.e. gravid females and neonates) while hunting techniques and methods employed affects nesting habitat. In addition, agriculture mechanization, use of chemicals and climate change (e.g. warming, flooding) may worsen the situation in the future. Thus, in Benin, where the concerns are the highest, the species should be considered threatened and updated population information is needed. Fortunately, local traditions and taboos associated with snake cults in Ball python range are very effective in controlling harvests and keeping the hunting pressure near zero in sacred areas.

Recommendations

The following actions can help improve the overall conservation status of the species and reverse the current negative trend in Benin:

- To develop (particularly in Benin and Togo) captive breeding strategies in order to reduce the pressure on wild populations. To this end, the trade stakeholders (i.e. exporters, collectors, middlemen, snake meat vendors) in exporting countries, should be trained in captive husbandry techniques;
- To promote Python ecotourism with the assistance of collectors and other breeders, worship communities (e.g. “Temple de python” in Ouidah – Benin). In addition, traditions and taboos in favour of the species conservation should be encouraged by assisting the concerned localities in improving the management of sacred forests, organizing awareness campaigns, etc.;
- To strengthen national regulation authorities in trade control and monitoring including stricter control policies for alleged ranching operations;
- To design and implement a management program for the Ball python at the regional/subregional level, mainly in countries that host the most vulnerable populations.
- Non-detriment finding for Ball pythons should focus on conducting yearly surveys of at common collection sites (as in Gorzula, 1997). Monitoring of the number of gravid females collected should also be improved to better understand collection trends.

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References

Akani, G.C., Eyo, E., Odegbune, E., Eniang, E.A., Luiselli, L. 2002. Ecological patterns of anthropogenic mortality of suburban snakes in an African tropical region. Isr. J. Zool.48: 1-11.

Aubret, F., X. Bonnet, M. Harris, S. Maumelat. 2005. Sex Differences in Body Size and Ectoparasite Load in the Ball Python, *Python regius*. *Journal of Herpetology*, 39/2: 312-215.

Aubret, F., X. Bonnter, R. Shine, S. Maumelat. 2002. Clutch size manipulation, hatching success and offspring phenotype in the ball python (*Python regius*). *Biological Journal of the Linnean Society*, 78: 263–272.

Auliya, M. & Schmitz, A. 2010. *Python regius*. The IUCN Red List of Threatened Species. Version 2014.2. <www.iucnredlist.org>. Downloaded on **03 September 2014**

Barker, D., T. Barker. 2006. "The Ball Python Care Sheet" (On-line). Accessed August 24, 2014 at http://www.vpi.com/publications/the_ball_python_care_sheet.

Bartlett, P., B. Griswold, R. Bartlett. 2001. *Reptiles, amphibians, and invertebrates: an identification and care guide*. Hauppauge, New York: Barrons Educational series.

Bartlett, R., P. Bartlett. 2000. *Ball Pythons*. Hauppauge, New York: Barrons Educational series

Broghammer, S. 2004. Ball pythons Habitat, Care and Breeding. M&S Verlag, 2nd revised Edition, 2004, Germany, 88 p.

Buffrenil de, M.V. 1995. Les élevages de reptiles du Bénin, du Ghana et du Togo. Report to the Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Lausanne, Switzerland, 38 p.

Chippaux, J-P. 1999. Les serpents d'Afrique Occidentale et Centrale. Ed. IRD, Paris, 1999, 278 p.

Chippaux, J-P. 2001. Les serpents d'Afrique occidentale et centrale. Éd. IRD, Collection Faune et Flore tropicales 35, Paris, pp. 1-292

CITES trade statistics derived from the CITES Trade Database, UNEP World Conservation Monitoring Centre, Cambridge, UK.

De Vosjoli, P., R. Klingenberg, T. Barker, D. Barker. 1995. *Ball Python Manual*. Santee, California: Advanced Vivarium Systems.

Ellis, T., M. Chappell. 1986. Metabolism, temperature relations, maternal behavior, and reproductive energetics in the ball python (*Python regius*). *Journal of Comparative Physiology B*, 157/3: 393-403.

Eniang, E. A., Egwali, E., Luiselli, L., Ayodele, I., Akani, G. C. and N. Pacini. 2006. Snake bushmeat from the forest markets of south- eastern Nigeria. Natura (Milan) 95: 33-46

Goode, M.J., Horrace, W.C., Sredl, M.J. and Howland, J.M. 2005. Habitat destruction by collectors associated with decreased abundance of rock-dwelling lizards. Biological Conservation 125 (1): pp. 47-54.

Gorzula, S, Nsiah, W. O. and Oduro, W. 1997. Survey of the status and management of the royal python (*Python regius*) in Ghana. Report to UNEP-CITES, 55 p..

Greene, H. 1997. *Snakes: The Evolution of Mystery nd Nature*. Berkeley, California: Berkley University of California Press.

Hammer, Ø., Harper, D.A.T. and P. D. Ryan. 2001. Paleontological Statistics software package for education and data analysis. Paleontologia Electronica 4 (1):9 pp.

Harris, M. 1999. Assessment of the status of seven reptile species in Togo. Report to the Commission of the European Union, Ref EC 98/0072, Bruxelles.

Ineich, I. 2004. Les élevages de reptiles et de scorpions au Bénin et au Togo, plus particulièrement la gestion des quotas d'exportation et la définition des codes "source" des spécimens exportés. Rapport d'étude réalisée pour le Secrétariat de la CITES, report to UNEP-CITES secretary, 81 p.

Ineich, I. 2006. Les élevages de reptiles et de scorpions au Bénin, Togo et Ghana, plus particulièrement la gestion des quotas d'exportation et la définition des codes "source" des spécimens exportés. Projet CITES A-251. Rapport d'étude réalisée pour le Secrétariat de la CITES, report to UNEP-CITES secretary, 80 p.

Luiselli, L. 2006. Why do males and females of Python regius differ in ectoparasite load?. Amphibia-Reptilia, 27/3: 469-471.

Luiselli, L. and Angelici, F.M. 1998. Sexual size dimorphism and natural history traits are correlated with intersexual dietary divergence in royal pythons (Python regius) from the rainforests of southeastern Nigeria. Ital. J. Zool. 65: 183-185.

Luiselli, L., Akani, G. C., Eniang, E. A. and E. Politano. 2007. Comparative ecology and ecological modeling of sympatric pythons, Python regius and P. sebae. In R. W. Henderson, and R. Powell (Eds.). Biology of the boas and pythons, pp. 88–100. CPG/Biological Science Press, New York.

Luiselli, L., Bonnet, X., Rocco, M. and G., Amori. 2011. Conservation Implications of Rapid Shifts in the Trade of Wild African and Asian Pythons. BIOTROPICA 0(0): 1–5; 2011, 10.1111/j.1744-7429.2011.00842.x http://www.cebc.cnrs.fr/publipdf/2012/LB44_2012.pdf

Madsen, T., Ujvari, B., Shine, R. and M., OLSSON. 2006. Rain, rats and pythons: Climate-driven population dynamics of predators and prey in tropical Australia. Austral Ecology (2006) 31, 30–37 doi:10.1111/j.1442-9993.2006.01540.x

Meirte, D. 1999. Effets des captures de serpents sur les dégâts causés aux cultures par les rongeurs. In: Actes Séminaire National sur le commerce international des reptiles capturés dans la nature et les dégâts causés aux cultures par les Rongeurs. Cotonou 24-28 Mars 1997, Benin. Ed. Flamboyant, ISBN: 2-909130-63-0, Cotonou, 1999, pp. 179-180

Mensah, G.A., Toudonou, A.S.C. and Pomalegni, C.B. 2005. Collection des serpents du centre et du sud du Bénin, rapport de synthèse, Fonds compétitifs INRAB, 55 p.

Mukhtar, M., Y. Une, H. Kawabata, A. Takano, H. Sato, H. Watanabe. 2009. Trypanosoma cf. varani in an Imported Ball Python (*Python regius*) From Ghana. The Journal of Parasitology, 95/4: 1029-1033.

Ott, B., S. Secor. 2007. Adaptive regulation of digestive performance in the genus Python. Journal of Experimental Biology, 210: 340-356.

Platt, T. and A. Bush. 1979. Spinicauda regiensis n. sp. (Nematoda: Heterakoidea), a parasite of the ball python (*Python regius*). Journal of Helminthology, 53/3: 257-260.

Reading, C. J., Luiselli, L. M., Akani, G. C., Bonnet, X., Amori, G., Ballouard, J. M., Filippi, E., Naulleau, G., Pearson, D. and L. Rugiero. 2010. Are snake populations in widespread decline? Biol. Lett. 6: 677–680

Sillman, A., J. Carver and E. Loew. 1999. The photoreceptors and visual pigments in the retina of a boid snake, the ball python (Python regius). Journal of Experimental Biology, 202/14: 1931-1938.

Sinsin, B., Ahopkpè, E., Daouda, I., Kindomihou, V. and Houngnandan, O. 1999. Capture et commercialisation des reptiles dans les départements du Zou, du Mono, de l'Ouémé et de l'Atlantique. *In* : Actes Séminaire National sur le commerce international des reptiles capturés dans la nature et les dégâts causés aux cultures par les Rongeurs. Cotonou 24-28 Mars 1997, Benin. Ed. Flamboyant, ISBN: 2-909130-63-0, Cotonou, 1999. pp. 163-177

Sloboda, M., M. Kamler, J. Bulantova, J. Votypka and D. Modry. 2007. A New Species of Hepatozoon (Apicomplexa: Adeleorina) from Python regius (Serpentes: Pythonidae) and Its Experimental Transmission by a Mosquito Vector. The Journal of Parasitology, 93/5: 1189-1198.

Starck, J., P. Moser, R. Werner, P. Linke. 2004. Pythons metabolize prey to fuel the response to feeding. The Royal Society, 271/1542: 903-908.

Toudonou, A. S. C., Penner, J. Rödel, M-O and B. Sinsin. 2014a. Ball Pythons (*Python regius*) in the wild in Benin (West Africa): range and population characteristics. In process

Toudonou, A. S. C., Penner, J. Rödel, M-O and B. Sinsin. 2014b. Ball python trade in Benin and implications for the species conservation. In process.

Toudonou, A.S. C., Penner, J., Sinsin, B. and M-O., Rödel. 2012. Les ophidiens snakes. In Etat actuel de la biodiversité animale| Current state of animal biodiversity. Pp 303-308

Toudonou, A.S.C. 2003. Diversité des serpents dans les agrosystèmes et leur importance socioculturelle au sud et centre Bénin. Mémoire pour l'obtention du diplôme d'Ingénieur Agronome option:Aménagement et Gestion des Ressources Naturelles, Faculté des Sciences Agronomiques (FSA), Université d'Abomey Calavi, 85 p.

Toudonou, A.S.C. 2007. Exploitation and conservation of Ball python (Python regius) in Benin. Thesis for obtaining Master of Science degree, major: Management & Planning of Natural resources- Speciality: Herpetology, Faculty of Agronomic Sciences (FSA), University of Abomey Calavi, 53p.

Toudonou, A.S.C. 2011. Serpents Snakes. In Neuenschwander, P., Sinsin, B. & Goergen, G. (eds). 2011. Protection de la Nature en Afrique de l'Ouest: Une Liste Rouge pour le Bénin. Nature Conservation in West Africa: Red List for Benin. International Institute of Tropical Agriculture, Ibadan, Nigeria. Pp 186-197.

Toudonou, A.S.C., Mensah, G.A. and B. Sinsin. 2004a. Le serpent: une nouvelle ressource alimentaire dans les départements du centre et du sud du Bénin. Bulletin de la Recherche Agronomique du Bénin 45: pp. 29-36.

Toudonou, A.S.C., Mensah, G.A. and B. Sinsin. 2004b. L'élevage des serpents et autres reptiles au Bénin. Bulletin de la Recherche Agronomique du Bénin 46: pp. 25-32.

Toudonou, A.S.C., Mensah, G.A. and Sinsin, B. 2004b. L'élevage des serpents et autres reptiles au Bénin. Bulletin de la Recherche Agronomique du Bénin 46: pp. 25-32.

Vodounnon, S. 1999. Bio-éthologie, dynamique des populations et incidences économiques de deux rongeurs nuisibles (*Mastomys natalensis* et *Arvicanthis niloticus*) en culture cotonnière au Bénin. *In*: Actes Séminaire National sur le commerce international des reptiles capturés dans la nature et les dégâts causés aux cultures par les Rongeurs. Cotonou 24-28 Mars 1997, Benin. Ed. Flamboyant, ISBN: 2-909130-63-0, Cotonou, 1999, pp. 59-71.