Last Chance to See? A Review of the Threats to and Use of the Crocodile Lizard

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The Crocodile Lizard, listed in CITES Appendix II and as Endangered in The IUCN Red List of Threatened Species*, is becoming ever more popular among hobbyists. Rising international demand for the species is exceeding available supply of captive-bred specimens, resulting in an increase in illegally sourced wild specimens on offer. Wild populations are at the brink of extinction due to habitat destruction and over-collection for the trade and for local use. It is estimated that fewer than 1000 individuals are presently distributed in small and isolated sites in southern China and northern Viet Nam. In view of the constant decline of diminished populations, any further trade in wild specimens is detrimental to the survival of the species. This study addresses the current status of the threats to and the trade in Crocodile Lizards and highlights the need for immediate measures to protect remaining populations from extermination.*

Introduction

The Crocodile Lizard *Shinisaurus crocodilurus* is the only living representative of the family Shinisauridae. The species was originally described by Ahl (1930) from southern China, where its range is restricted to a few isolated sites due to its high ecological specialization (Huang *et al.*, 2008). The outstanding colour patterns and primaeval appearance, as well as an interesting semi-aquatic lifestyle, have made the species a desired target for the international pet trade from the 1980s onwards, with a strong interest from specialized collectors. Within two decades, harvesting of the species had caused dramatic declines of wild populations in China (CITES, 1990; Huang *et al.*, 2008) before the first Vietnamese subpopulation was discovered in the Yen Tu Nature Reserve (NR), northern Viet Nam by Le and Ziegler (2003). Initial morphological and molecular comparisons revealed no significant taxonomic separation between the two extant subpopulations (Ziegler *et al.*, 2008). Recent field surveys on the population status and ecology of the species in Viet Nam led to the discovery of two further subpopulations in two adjacent nature reserves, viz. Tay Yen Tu NR and Dong Son-Ky Thuong NR (van Schingen *et al.*, 2014a).

Owing to multiple anthropogenic hazards, populations of the Crocodile Lizard are now facing extinction in the wild (Huang *et al.*, 2008; van Schingen *et al.*, 2014b). Besides habitat degradation, present at almost all known sites (Huang *et al.*, 2008; van Schingen *et al.*, 2014b), over-collection for consumption and the pet trade has been recorded as a severe threat to the species in China, while only little comparable information is available for the recently discovered Vietnamese subpopulations. The declining subpopulations in China were estimated at only 950 individuals in 2004 (Huang *et al.*, 2008); a similar study conducted in 2013 revealed the presence of fewer than 100 individuals in Viet Nam (van Schingen *et al.*, 2014b) (Fig. 1). In response to the international demand for the species (e.g., Nguyen *et al.*, 2004; CITES, 1990; Anon., 2014a), this study provides an analysis of the trade in Crocodile Lizards and a review and updated evaluation of threats as baseline information for improved conservation measures.

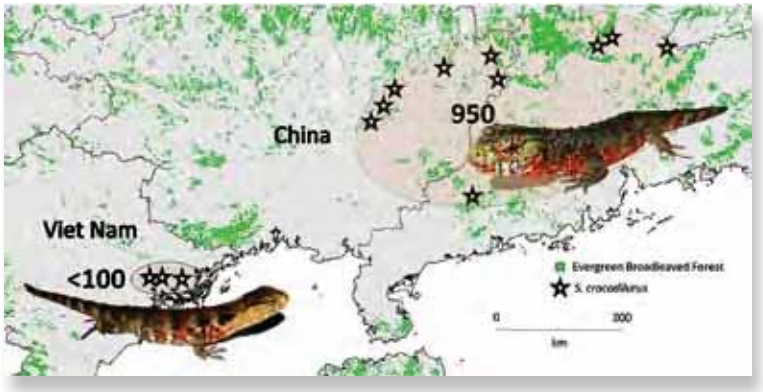

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Fig. 1. Estimated wild population size of the Crocodile Lizard *Shinisaurus crocodilurus* in China and Viet Nam. Estimates derived from Huang *et al.* (2008) and van Schingen *et al.* (2014b), respectively. The habitats of *S. crocodilurus* are entirely surrounded by cultivated and agricultural land in Viet Nam; locality records derived from the authors' field surveys and from literature (van Schingen *et al.*, 2014a; Huang *et al.*, 2014).

Distribution and Status

The Crocodile Lizard inhabits tropical evergreen broadleaf lowland forests in southern China (Guangxi Zhuang Autonomous Region, Guangdong Province) and northern Viet Nam (Bac Giang, Quang Ninh provinces) (Huang *et al.*, 2008; Le and Ziegler, 2003). It is particularly adapted to a specific forest ecosystem and individuals tend to rest at night on branches above pool sections of densely vegetated rocky streams (M. van Schingen, pers. obs.; Ning *et al.*, 2006; van Schingen *et al.*, in prep.), where they can be easily collected by poachers. The species can reach maturity after 13 months in captivity, but under natural conditions needs between two and four years (Yoshimi and Uyeda, 2011; Zollweg and Kühne, 2013). In addition, the period

of pregnancy of lecithotrophic viviparous species, such as the Crocodile Lizard, is about nine to eleven months, which is comparatively long for reptiles (Zollweg and Kühne, 2013; Z. Wu *in litt.*, 17 June 2014). Large areas of habitat have been cleared in the species's range (Huang *et al.*, 2008; Le and Ziegler, 2003) which, in Viet Nam in particular, have been entirely surrounded by cultivated or agricultural land, which makes evasion of the species to other sites impossible. According to a niche model approach by van Schingen *et al.* (2014a), the actual and potential distribution of the species—considering climate and vegetation cover—is severely fragmented. Li *et al.* (2012) projected that all original habitats of the Crocodile Lizard in China will have vanished in 2081–2100 as a result of climate change.

Legislation

The species has been listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since 1990, which includes species not necessarily yet threatened, but which could become so if trade is not strictly controlled. Recently, the Crocodile Lizard was classified as globally Endangered in *The IUCN Red List of Threatened Species* (Nguyen *et al.*, 2014). Furthermore, it is included as a Category I species in the "Wild animal protection law" in China (Huang *et al.*, 2008), and at the end of 2013 the Ministry of Agriculture and Rural Development (MARD) proposed that the species be listed in the governmental decree of Viet Nam (T.Q. Nguyen, pers. comm.).

Methods

Evaluation of threats to and use of the species

Field surveys were conducted in Viet Nam between June and July 2013 and May and July 2014, determining the threats to the Crocodile Lizard by direct observations within the species's habitat viz. Yen Tu NR and Dong Son-Ky Thuong NR, Quang Ninh Province and Tay Yen Tu NR, Bac Giang Province. Nearly 80 villagers living in the surroundings of the nature reserves, and authorities of Quang Ninh and Bac Giang provinces, Son Don, Uong Bi and Ky Thuong districts and of the three aforementioned nature reserves were questioned in order to determine the general cognizance, perception and use of the species in Viet Nam. In addition, a literature survey was undertaken to evaluate the threats to and use of the species in China.

Analysis of trade

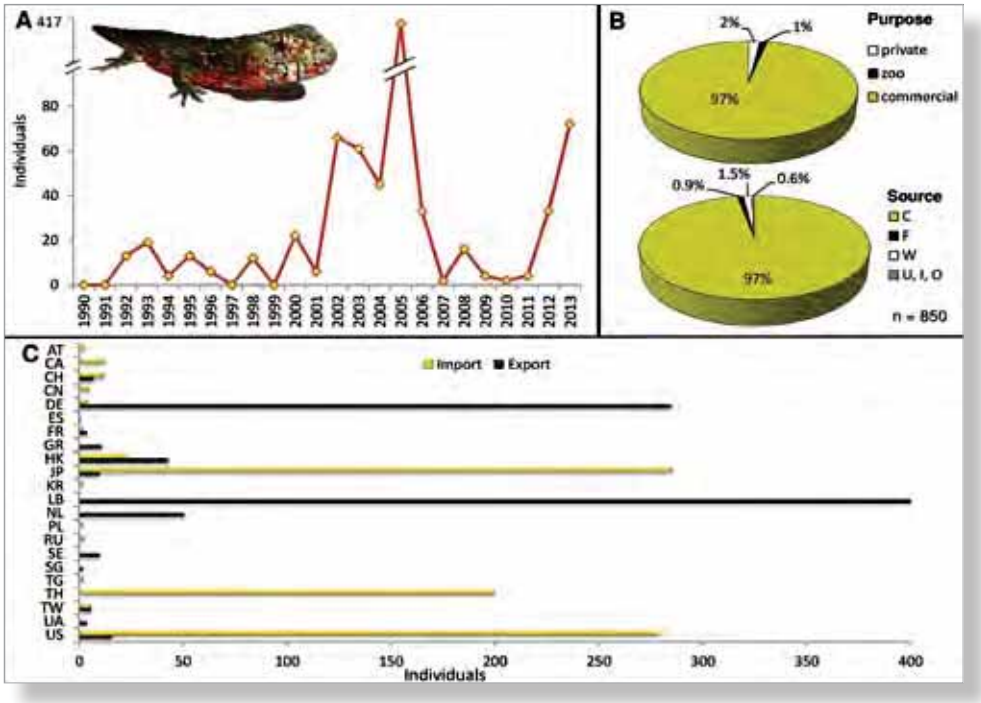
Trade data were obtained from the UNEP-WCMC CITES trade database (UNEP-WCMC, 1990–2013), which details all records of imports, exports and re-exports of CITES-listed species as reported by Parties. Data were available from 1990 to 2013. The analysis focused on the purposes "personal" (P), "commercial" (T), and "zoos" (Z), referring to live animals, since in the case of the Crocodile Lizard such trade is the most profitable. Internet platforms, reptile forums and Facebook pages were investigated to get an overview of the availability, demand, prices and evidence of illegal trade in this species. Four reptile fairs (three in Germany and one in Sweden) and 10 German pet shops were visited. Oral interviews were conducted with 26 dealers (20 from Germany, three from Sweden, two from the Czech Republic and one from Spain) on the respective reptile markets, 12 employees of pet shops that were visited, two zoo keepers (USA and Sweden) with experience in keeping Crocodile Lizards and 11 private keepers on their experiences in selling and keeping Crocodile Lizards, as well as to obtain information on origins and prices. A private keeper and two dealers of Crocodile Lizards in Viet Nam were contacted in writing. Data were collected mainly between August and December 2014. Names of interviewees are kept anonymous here for reasons of data privacy rights and internet links are not disclosed to prevent misuse.

Threats to the Crocodile Lizard and its Use in China

Literature survey

According to literature, consumption of Crocodile Lizards was traditionally believed to act as a cure for insomnia due to the long periods the animals spend motionless; they are also exploited for food (Herpin and Zondervan, 2006; Huang *et al.*, 2008; Nguyen *et al.*, 2014; Anon., 2014b). Li and Wang (1999) reported the sale of dried individuals in markets in China. While reports on any current use in traditional medicine were not found, cases of poaching for the pet trade are still being reported (Huang *et al.*, 2014; Kadoorie Farm & Botanic Garden, 2004; Zollweg, 2012). Interviews conducted by Huang *et al.* (2008) with 75 villagers living around the habitats occupied by Crocodile Lizards revealed that the majority (75%) had already hunted the lizard, but only 7.5% of those questioned had hunted the species for food or medicine (Huang *et al.*, 2008). The main motivation was to sell specimens to illegal traders for easy money (RMB10–1000~USD1.61–161.25) (Huang *et al.*, 2008).

The increasing application of electrofishing and use of poison for fishing are assumed to endanger the Crocodile Lizard in its aquatic phase (Huang *et al.*, 2008), and the sale of accidentally caught Crocodile Lizards on Chinese markets has often been recorded (Zollweg, 2011). In addition, the substitution of broadleaf forest for trees that produce more profitable timber contributes to the decrease of aquatic habitats, as do logging, water pollution from mining operations, and dam construction, which all change the natural water regime and degrade the species's habitats (Huang *et al.*, 2008; Huang *et al.*, 2014).



A: annual volumes of imports and exports of live specimens;
B: purposes of trade and source of animals *(C=captive bred, F=captive born, W=wild caught, U=unknown, I=confiscated or seized, O=pre-Convention)*;
C: Volumes of imports and exports of live specimens, per country *(AT=Austria; CA=Canada; CH=Switzerland; CN=China; DE=Germany; ES=Spain; FR=France; GR=Greece; HK=Hong Kong; JP=Japan; KR=Korea; LB=Lebanon; NL=Netherlands; PL=Poland; RU=Russian Federation; SG=Singapore; TG=Togo; TH=Thailand; TW=Taiwan; UA=Ukraine, US=USA)*

Fig. 2. International trade in Crocodile Lizards *Shinisaurus crocodilurus* from 1990–2013.
Source: UNEP-WCMC (1990–2013)

Threats to the Crocodile Lizard and its Use in Viet Nam

Literature survey and results of current survey

Crocodile Lizards soaked in rice wine were observed during the inspection of numerous local shops in Quang Ninh Province, Viet Nam, in 2013 (M. van Schingen, pers. obs.). A picture of a Crocodile Lizard preserved in alcohol was observed on the Facebook page of a Vietnamese pet shop, where the use of the species as a potency remedy was discussed.

Trade in live Crocodile Lizards in Viet Nam was recorded in 2002 at a tourist site (Yen Tu Temples, Quang Ninh Province) by Le and Ziegler (2003). At the time, some Crocodile Lizards were being offered as "baby crocodiles" to tourists for USD10–20 each. In May 2008, T.Q. Nguyen observed three specimens being offered for sale for USD5–6 at the same site. During recent field surveys, the authors discovered that cable cars had been installed to transport tourists to the top of the mountain where one, once remote, habitat of the Crocodile Lizard is situated. Recently employed forest rangers at this site have never seen a Crocodile Lizard, while some older rangers remembered that Crocodile Lizards had been frequently found at this site, as well as in lower regions of the mountains. Present surveys within these now easily accessible streams at the foot of the mountain revealed no presence of Crocodile Lizards. While 10 mature individuals had been recorded in 2013 in a stream at the top of the mountain, none could be found there in 2014.

Interviews with nearly 80 people in the remote villages situated within the species's habitats revealed a general ignorance about Crocodile Lizards and confusion with other lizards, as well as a lack of interest in this species. Only one farmer recalled cases of collecting Crocodile Lizards from nearby streams. Provincial authorities recognized the species from pictures, but assumed its extirpation from former localities.

According to recent field observations, the dramatic increase of habitat destruction and alteration as well as pollution are severe threats to the species in Viet Nam. Timber logging and slash-and-burn land clearance form a major threat to the species and coal mining activities were observed to cause drastic degradation of core habitats of the Crocodile Lizard. In 2014, local villagers were observed electrofishing in some habitat streams, which had not been the case the year before. At this site the rate of encounters with Crocodile Lizards dropped to three (one individual per stream) in 2014, compared to 11 during the same season in 2013.

Trade

Literature survey and results of current survey

Based on an interview with a reptile dealer, the first Crocodile Lizards appeared on the international pet market as early as 1982. Since 1985 an alarming rise in demand for Crocodile Lizards in the international pet trade has been recorded; specimens at that time fetched relatively high prices (e.g. DM995~USD595.63

FACEBOOK

Fig. 3. A distinctive primaeval appearance and striking colour pattern has resulted in an alarming rise in demand for Crocodile Lizards *Shinisaurus crocodilurus* by specialist collectors.

in Germany; CITES, 1990), although a pet shop in the USA was selling specimens for USD25 in 1987 (Hoffmann, 2006). While hundreds of specimens were legally imported from Hong Kong to Europe and the USA because the species had not been protected in the importing countries, the illegal sale of 3300 animals from Guangxi Autonomous Region, China, was reported between 1984 and 1986 (CITES, 1990). After being included in CITES Appendix II in 1990, the international trade in Crocodile Lizards suddenly switched almost entirely to specimens that were purported to be captive bred (~97%, UNEP-WCMC (1990–2013), Fig. 2). From 1990–2013, a mean of 39 ± 87 living individuals were annually recorded in international trade (Fig. 2); out of 850 animals, 97% were traded for "commercial" purposes and only 2% and 1% for "personal" and "zoo" purposes, respectively; the majority was imported by Japan (34%) and the USA (33%), followed by Thailand (23%) (Fig. 2). No exports from or imports to Viet Nam have been officially recorded (Fig. 2). A conspicuously high number (400) of allegedly captive-bred specimens was exported from Kazakhstan via Lebanon to Japan and Thailand in 2005, which makes Lebanon the major importer and re-exporter of Crocodile Lizards (Fig. 2). Kazakhstan has been a Party to CITES since 2000, whilst Lebanon acceded the Convention in 2013. Kazakhstan, as the country of origin, has not declared any imports or exports of Crocodile Lizards in its annual reports. Similar trade patterns involving a Kazakhstan-Lebanon connection have been observed in cases of trade in dendrobatid frogs and several reptile species, particularly from Madagascar (Nijman and Shepherd, 2009; 2011; Todd, 2011).

A case of definite trade with wild-caught individuals was confirmed by a German pet shop owner, who received three of reportedly numerous illegally imported specimens from China in 2003 from a dealer who was known for being involved in the fraudulent trade in reptiles. Furthermore, 104 Crocodile Lizards were seized at the border of Japan between 2007 and 2008 (Kanari and Auliya, 2011), and 19 individuals, collected in Viet Nam by a Vietnamese citizen, were smuggled from Cambodia to Thailand in 2014 (Robin des Bois, 2014).

Currently the trade in Crocodile Lizards has shifted almost entirely to the internet, partly via Facebook, which gives the dealer a reassuring level of security and control over the deal, especially when the legal origin of the specimens is doubtful. During the current research, the first internet offer (from the USA) was recorded in 2006 (USD700) on a reptile forum. There has subsequently been a conspicuous rise in offers and requests for this species, particularly on online reptile forums and in Facebook communities, especially in the USA and Germany. These mainly involve private individuals (81%) mostly offering their captive-bred offspring, but also pet shops and wholesalers (17%). Most of the observed entries (n=106) were from Europe (86%) (Germany 60%, Spain 5%, UK 4%, France 4%, Netherlands 3%, Belgium 2%, Slovakia 2%, Denmark 1%, Switzerland 1%, Russia 1% and Ukraine 1%), followed by the USA (10%) and Asia (Viet Nam 4%), but the origin in some cases was unclear. Crocodile Lizards are currently on offer for relatively high prices (e.g., ca USD1100, pet shop (USA), November 2013; juveniles for EUR490, pet shop (Germany), January 2015) on the internet and for a comparably low price (EUR150–300~USD174–348, BfN, *in litt.*, see also Bethge, 2014) at the reptile fair in Hamm, Germany. In December 2014, three Crocodile Lizards of unknown origin were observed by one of the authors at the reptile fair in Hamm in an unlabelled container, which was quickly concealed in a backpack once detected. Furthermore, even Crocodile Lizards reportedly originating from Viet Nam were observed at this reptile fair in 2014 being offered under the table (M. Zollweg, pers. comm., October 2014). Only since 2013 have Crocodile Lizards from Viet Nam been found being offered for sale on at least four different Vietnamese Facebook pages in Hanoi and Ho Chi Minh City; in 2014, one retailer in the country was offering specimens for export on his Facebook site (Fig. 3). While videos of several dozen captive adult lizards for sale were shown on Youtube.com, another dealer stated that he had almost 100 Crocodile Lizards from north Viet Nam for sale at his "farm". A hobbyist, keeping three wild-caught Crocodile Lizards from "the mountains of north Viet Nam", posted that there are many specimens available for sale and that retailers are allegedly highly interested in trading them on an international scale. Demand by hobbyists for Vietnamese specimens due to their more colourful appearance and for a supply of "fresh blood" for breeding has been frequently recorded on internet platforms.

Discussion

Considering the alarming status of the wild Crocodile Lizard population (Huang *et al.*, 2008; van Schingen *et al.*, 2014a; van Schingen *et al.*, 2014b), any collection of wild individuals is detrimental to the species's survival. This study shows that the trade in live animals has a highly detrimental impact on the species. Lack of comprehensive information on collection and use for traditional medicine in range countries means that it is not possible to assess with any certainty whether this is an additional threat, although the authors believe it is less significant than the live animal trade. Prices outside the range States remain lucrative (e.g. USD1100, pet shop (USA), 2013), leading to a growth of interest in selling to the international market. Specimens from Viet Nam have been on offer for export for USD180–350 (Facebook, 2014), while prices achieved in the national market seem to be rather low (USD5–25).

The shift in reported trade from wild-caught specimens to almost exclusively captive-bred specimens (>98%) after the species's listing in CITES Appendix II in 1990 is rather suspicious, since a very high mortality rate in captivity was reported at that time (CITES, 1990) and dealers of the species still state that the loss of a whole litter is commonplace due to the animal's sensitivity to stress, infection and inadequate water quality. Furthermore, dealers have confirmed that they still receive wild-caught specimens from China, mislabelled as "captive bred". Regarding the 400 allegedly captive-bred Crocodile Lizards exported from Kazakhstan to Lebanon in 2005, it is not far-fetched to conclude that such a trade pattern is a fraud to obtain "legal" CITES import permits for the laundering of smuggled animals into the trade. Besides the lack of established breeding facilities for such high quantities of an ecologically specialized species, it is further implausible that the alleged captive breeding group produced 400 hatchlings in 2005 and then suddenly stopped producing any offspring. Likewise, in Viet Nam, the large number of adult animals and the evident lack of proper enclosures—as illustrated in available pictures and videos—indicate that most specimens were wild caught, a fact confirmed in writing by a Vietnamese hobbyist. There is recent evidence for the covert sale of Crocodile Lizards from Viet Nam at the reptile fair in Hamm, Germany, even though reports on legal exports are lacking (M. Zollweg, pers. comm., November 2014). The present research shows that demand for the species exceeds supply, even though a few hobbyists successfully breed the species from time to time. The high interest of new bloodlines and morphs is currently increasing the pressure on wild populations, especially from Viet Nam. The remarkable increase in appearance of the species on relevant websites might also have triggered the increasing trade in Crocodile Lizards in Viet Nam. The aforementioned drop in encounters with adult individuals at some of the published habitat sites might be the consequence of locality data being misused by poachers. Experience in Viet Nam and China has demonstrated that only the more extensively monitored subpopulations are considered to be relatively secure and stable, indicating a positive effect of monitoring and research activities on wild populations.

Conservation Measures

For effective local conservation activities in Viet Nam, the authors' research team (Cologne Zoo, IEBR) initiated a comprehensive public awareness campaign. A brochure emphasizing the uniqueness of the last remaining lowland broadleaf forest ecosystem was created in order to support the conservation management, and to educate and raise awareness at the local authority level (Forest Protection Department (FPD), of Bac Giang Province, 2010). A poster (Fig. 4) was recently produced at the request of the FPD, highlighting the threats to this species within its remaining habitats and pointing out improved conservation measures; some 2000 copies have

Fig. 4. Poster developed for the awareness programme, available in Vietnamese, German and English.

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been distributed among the respective nature reserves, and FPD's of Bac Giang and Quang Ninh provinces, high schools, universities, ranger stations, offices of communes, villages surrounding the nature reserves and the Me Linh Station for Biodiversity (see Ziegler, in press). A follow-up petition letter was sent to several agencies recommending, for example, the improvement of forest ranger work, the upgrade of the protection status of the species's habitat in Yen Tu Mountain area, the control of coal mining activities in the core zones of the nature reserves and the development of sustainable ecological and religious tourism in the region. In addition, the authors participated in local conferences, and held symposia and workshops in Hanoi and Ho Chi Minh City.

In China, agreements with local farmers have already helped to maintain at least core zones for Crocodile Lizards within the Daguishan NR and also a breeding facility for release programmes has been successfully established (Zollweg, 2012). Such a breeding programme was recently also initiated in Viet Nam at the Me Linh Station for Biodiversity, with promising preliminary results (Fig. 5; Ziegler, 2015). After the development of a stable captive population and based on comprehensive knowledge on the ecology and natural history of wild populations (e.g. van Schingen *et al.*, in prep.), a release and monitoring programme is planned to restock wild populations in Viet Nam, in accordance with criteria stipulated by the International Union for Conservation of Nature (IUCN, 2013).

Conclusions

The poaching of Crocodile Lizards in detrimental quantities has long been reported from China and over the last few years has also been recorded from the recently discovered and much smaller subpopulations in Viet Nam (Huang *et al.*, 2008, Le and Ziegler, 2003, Nguyen *et al.*, 2014). While wild populations of Crocodile Lizards are decreasing, international demand for the species is increasing and habitat destruction and degradation are expanding. Suitable habitats, especially in Viet Nam, are now restricted to a small area around Yen Tu Mountain and the number of wild Crocodile Lizards there is now very low. Due to its sedentary behaviour and specialization, the species's extirpation in the wild is predictable if forest protection is not drastically improved at these sites and illegal poaching curtailed. Since the trade in this species for hobbyist collection has only recently started in Viet Nam, immediate measures are required to prevent further collection of wild specimens.

Recommendations

Based on the evident harmful illegal trade in wild-caught specimens and to enable a more efficient control and prevention of poaching, a transfer of the species from CITES Appendix II to I is strongly recommended. Such an upgrade—which would be implemented in the EU by listing the species in Annex A of the Reg. EC 338/97—would in particular enable the CITES Management Authorities in the European Union, one of the major markets in the reptile and amphibian trade, to control and monitor the domestic EU trade. According to European law the commercial use of specimens of Appendix I (Annex A of Reg. EC 338/97) species is in general strictly prohibited. In most EU member States, such specimens must be registered with the relevant authorities and are subject to strict measures of certification and marking. This also applies to captive-bred specimens; their commercial use requires an official exemption certified by the respective Management Authority (European

ANNA RAUHAUS

Fig. 5. Juvenile Crocodile Lizards *Shinisaurus crocodilurus* bred at the Me Linh Station for Biodiversity in northern Viet Nam for a restocking programme in the species's original habitats in Viet Nam.

Commission, 2015**).** The CITES Standing Committee as well as all Parties to CITES should be urged to look very closely into the fraudulent claims of captive breeding (Lyons and Natusch, 2011) and enforcement efforts have to be increased, particularly into the apparent increase in online trade, which is partly taking place in closed systems provided by social media such as Facebook.

Based on the findings within the remaining natural habitats in Viet Nam, an upgrade of the existing reserves, the extension of the protected area network and improved ranger work at the sites where the species occurs is strongly recommended (van Schingen *et al.*, 2014b). Furthermore, in order to identify yet unknown sub-populations, field surveys should be conducted within suitable habitats based on the niche model approach (van Schingen *et al.*, 2014a), e.g. in the border region of China and Viet Nam, although publishing exact locality data should be avoided to prevent the misuse of such information. Due to minor differences in ecology between Crocodile Lizards in China and Viet Nam (van Schingen *et al.*, in prep.), a more comprehensive genetic comparison would clarify the conservation status and importance of single and extant subpopulations (van Schingen *et al.*, 2014b), which is also important for potential future hybridization in captivity. In order to evaluate the impact of the awareness-raising campaign, the recently established monitoring systems should be continued in the long term.

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