

# A fertile hybrid between *Ctenosaura similis* (GRAY, 1831) and *C. bakeri* STEJNEGER, 1901 (Squamata: Iguanidae) on Isla de Utila, Honduras

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## Abstract

A case of a natural fertile hybrid between *Ctenosaura bakeri* and *C. similis* on Isla de Utila is reported, which represents the first record of a fertile backcross within the subfamily Iguaninae. The hybrid is a female which was collected in gravid conditions and which, in morphological, colouration, scalation and clutch data, showed characters being intermediate between *C. bakeri* and *C. similis*. Characters of the offspring were distinct from those of their mother and of *C. bakeri*, but rather similar to *C. similis*, indicating a successful backcross of the hybrid female with a *C. similis* male. Potential factors, which may contribute to the natural hybridization between both species, as well as the recent impact on the *Ctenosaura*-populations on Utila are discussed.

Key words: Reptilia; Squamata; Iguanidae; *Ctenosaura bakeri*, *C. similis*; Honduras; Isla de Utila; fertile hybrids.

## Introduction

The island of Utila, situated off the Caribbean coast of Honduras and only 41 km<sup>2</sup> in size, is inhabited by two species of *Ctenosaura*: *C. bakeri* and *C. similis*. Both species are distinct in their phenotype and ecology. The endemic *C. bakeri* exclusively inhabits mangrove swamp, whereas *C. similis* inhabits dry and open areas on the island. Phylogenetic analyses, based on morphological and molecular data demonstrated that the two species belong to different subgroups within *Ctenosaura* (KÖHLER et al. 2000). The most parsimonious explanation for the occurrence of both species on Utila is therefore, that *C. bakeri* developed from an ancestor in situ on the island and that *C. similis* entered Utila later.

A first case of natural hybridization between *C. bakeri* and *C. similis* was reported by KÖHLER & BLINN (2000): Incubation of eggs from a freshly killed female *C. bakeri* resulted in two hatchlings that, with respect to colouration and pholidosis, showed characters intermediate between *C. bakeri* and *C. similis*. Hybridization is possible among lizard species and can result in hybrid zones as has been shown in some cases (e. g. HILLIS & SIMMONS 1986, MONTANUCCI 1983). In this paper, on the basis of morphological, colouration, scalation and clutch data, we report a case of a fertile female hybrid between *C. bakeri* and *C. similis*. The female was conspicuous due to its unusual appearance. Additionally, it was gravid and produced viable offspring. Factors, which may contribute to the natural infrageneric hybridization between the two species and the possible impact on the *Ctenosaura*-populations of Utila are discussed. Another reported case of natural, but intrageneric hybridization within the Iguaninae was reported between the Galapagos iguanas *Amblyrhynchus cristatus* and *Conolophus subcristatus* (RASSMANN et al. 1997), but no evidence for fertile hybrids has been found (F. TRILLMICH, pers. comm.). Thus, our results represent the first record of a fertile hybrid within the subfamily Iguaninae, which produced viable offspring.

## Material and Methods

During March 2001, the supposed hybrid female was discovered at the north coast of the Utila island. The female was caught with a noose and kept until ovoposition at the Iguana Station Utila in a cage (2 × 2 × 2 metres), which was equipped with branches, water bowl and two nesting boxes, each filled with moistened sand. Eggs were incubated in an automatic incubator in moistened Vermiculite at a constant temperature of 30 °C, the average natural incubation temperature of *C. bakeri* (A. GUTSCHE, unpubl. data). Snout-vent length and tail length (SVL, TL; measured with a steel tape measurer to the nearest 1 mm), egg length (measured with calipers to the nearest 0.1 mm) and weight (electronic balance, measured with an accuracy of 0.1 g and 5.0 g, Types MH5K5 and 466-45, Kern/Germany) were recorded for the female after capture, for the eggs after they were laid and for the hatchlings one day after hatching. Colouration was described by the basic dorsal colour and whether dark dorsal crossbands were present or not. Enlarged mid-dorsals were counted from the first differentiated scale in the nuchal region to the last noticeable enlarged median dorsal scale or, in case of continuous crest, to the first enlarged median caudal crest scale. For caudal intercalary scales, the number and arrangements of complete rows of small smooth scales between whorls of enlarged spinous caudal scales were assessed. To compare the data of the hybrids, data for *C. bakeri* were adopted from A. GUTSCHE (unpubl. data) and KÖHLER (1995) and for *C. similis* from FITCH & HENDERSON (1978), KÖHLER & STREIT (1996) and WIEWANDT (1985).

## Results

The putative hybrid female was detected at Iron Bound beach, north coast of Utila, in gravid condition. This sandy beach is an egg laying site for females of both *C. bakeri* and *C. similis*. The hybrid female, with a SVL of 200 mm and a weight of 327 g (measured before egg laying), was approximately 2 ½ years old and in its first year of reproduction. Its tail was slightly longer than that of *C. bakeri*, with a TL/SVL ratio of 1.78 compared to a mean of 1.59 in adult *C. bakeri*, and therefore seemed to be closer to *C. similis*, which have longer tails (Tab. 1). The number of 48 enlarged median dorsals in the hybrid was much lower than that for *C. similis* (mean 76.7) and typical for *C. bakeri* (Tab. 1). In the hybrid female, the intercalary scales in the anterior 1-4 intercalary spaces were anomalously reduced in number and size, whereas two complete rows of intercalary scales are normally found in *C. bakeri* and in *C. similis* (which have sometimes three complete intercalary rows in the first two intercalary spaces). The most conspicuous characteristic of the hybrid female was its colouration. The basic colour was a mixture of turquoise-green/grey-brown, typical for *C. bakeri*, and not the grey-brown as found in *C. similis*. However, it had prominent dark dorsal crossbands, which are present in *C. similis* and absent in *C. bakeri* (Fig. 1).

The clutch size of 21 eggs in the hybrid fell within the range of clutch sizes of *C. similis* (12-88), and is more than the maximum number of 16 eggs, recorded for *C. bakeri* (Tab. 1). Also the egg size in the hybrid, in respect to length and weight, was somewhat smaller than in *C. bakeri* (Tab. 1). Nine of the 21 eggs died during incubation, but twelve hatchlings (42.9 %) in good condition hatched after an incubation period of  $96 \pm 2.09$  (93-100) days. Their tail length, with an average TL/SVL ratio of 2.29, was much longer than the average 1.87 in juvenile *C. bakeri* (Tab. 1). The average number of 71.0 dorsals in the hybrid hatchlings differed clearly from the count found in *C. bakeri* (mean 44.6), but also the hybrid female itself (48 dorsals)

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Charakter	Hybrid Female	Hybrid Hatchlings	<i>C. similis</i> Adults	<i>C. bakeri</i> Hatchlings	<i>C. bakeri</i> Adults
TL / SVL	1.78	2.29 ± 0.08 2.13–2.37 n = 12	2.1 ± 0.21 <sup>A</sup> 1.5–2.4 n = 136	1.87 ± 0.07 1.71–1.98 n = 64	1.59 ± 0.08 1.43–1.74 n = 54
Enlarged median dorsals	48	71.0 ± 2.81 67–75 n = 12	76.7 ± 5.75 <sup>A</sup> 61–96 n = 136	see Adults	44.6 <sup>B</sup> 40–53 n = 36
Dark dorsal crossbands	yes	yes	yes	no	no
Clutch size	21	n. a.	43.4 <sup>C</sup> 12–88 k. A.	n. a.	9.3 ± 2.7 5–16 n = 73
Egg length (mm)	28.9 ± 1.39 26.0–32.0 n = 21	n. a.	28 <sup>C</sup> /20–31 <sup>D</sup> n. a. n. a.	n. a.	30.43 ± 1.62 27.0–35.0 n = 127
Egg mass (g)	6.09 ± 0.42 5.4–7.3 n = 21	n. a.	n. a.	n. a.	6.52 ± 0.53 5.3–7.9 n = 139

Tab. 1. Data of the hybrids between *C. similis* and *C. bakeri*. Given are in this order (i) mean ± SD, (ii) min/max values, (iii) size of the samples if available. n. a. – not available. Data adapted from: <sup>A</sup> KÖHLER & STREIT 1996, <sup>B</sup> KÖHLER 1995, <sup>C</sup> FITCH & HENDERSON 1978, <sup>D</sup> WIEWANDT 1985.

Daten der Hybriden im Vergleich zu *C. similis* und *C. bakeri*. Angegeben sind in folgender Reihenfolge (i) Mittelwert ± Standardabweichung, (ii) Minimum/Maximum Werte, (iii) Probengröße, sofern vorhanden. n. a. – nicht vorhanden. Daten übernommen von: <sup>A</sup> KÖHLER & STREIT 1996, <sup>B</sup> KÖHLER 1995, <sup>C</sup> FITCH & HENDERSON 1978, <sup>D</sup> WIEWANDT 1985.

and fell within the range of *C. similis*. All hybrid hatchlings showed some anomalous arrangements of their intercalary scales. In some specimens, their number and size were reduced. Other hatchlings had two complete intercalary rows on the right side of the tail (typical for *C. bakeri*) and three on the left side (typical for *C. similis*). Body colour of the hybrid hatchlings was not the uniform dark grey-brown as found in juvenile *C. bakeri*. The dorsal surfaces of the head and body were a bright greenish colour, merging to pale brown on the lateral surface of the body and on the tail. This colouration is typical for juvenile *C. similis*. Also present were the dark dorsal crossbands typically found in *C. similis* (Tab. 1).

## Discussion

*Ctenosaura bakeri* and *C. similis* are clearly distinct in their morphometry, colouration and scalation, and likewise clutch data yielded significant differences (DE QUEIROZ 1987, 1990; FITCH & HENDERSON 1978; KÖHLER & STREIT 1996; KÖHLER et al. 2000). The putative hybrid female showed characters of both *C. bakeri* and *C. similis*, indicating that it represents a specimen of hybrid status. Characters of its offspring were distinct from characters found in their mother and in *C. bakeri*, but rather similar to *C. similis*, which most likely is due to a backcross of the hybrid female with a *C. similis* male. The results suggest that fertile hybrids between the two species can occur and produce viable offspring. Yet, *C. bakeri* is strictly a mangrove dweller, whereas *C. similis*



Fig. 1. Hybrid female after egg laying. Conspicuous are the dark crossbands, typically found in *C. similis* and absent in *C. bakeri*. Photo by A. GUTSCHE.

Hybrid-Weibchen nach der Eiablage. Auffallend sind die dunklen Seitenstreifen, die typisch für *C. similis* sind und bei *C. bakeri* fehlen.

inhabits open and dry habitats, usually in some distance from mangrove swamps. However, in areas like Iron Bound, both habitats neighbour and individuals of both species have been observed to travel into the adjacent habitat (A. GUTSCHE, unpubl. observ.). Also, the reproductive behaviour and the seasonality of reproduction allows interbreeding, in that both species are polygynous with seasonally territorial males (A. GUTSCHE, unpubl. observ.; FITCH & HENDERSON 1978) and both mate from January to March on Utila (A. GUTSCHE, unpubl. observ.). Territorial males of both species claim places that include some females, whereas non-territorial males travel and try to copulate with females in either the proximity of or inside these territories. Occasionally, iguana males can be successful in coercing females into matings. Such matings were observed in *C. bakeri* (A. GUTSCHE, unpubl. observ.) and in marine iguanas (TRILLMICH 1983).

It is not clear whether mingling of both species is a frequent event on Utila. Since 1997, more than 1000 adult and juvenile *C. bakeri* were captured, but except for the first record (KÖHLER & BLINN 2000) and the specimens described herein, no more individuals with unusual morphological characteristics have been detected. Possibly, due to their ecological specialization, hybridization between *C. bakeri* and *C. similis* may be a rare event. Backcrossing may blur the characterization and discovery of hybrids, since the hatchlings already adopted a rather “pure” morphology. Thus, the actual rate of introgression could be higher than recently recorded. Secondly, whereas

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*C. bakeri* has been studied intensively, only few data on *C. similis* are available from Utila. Our data suggest, that hybridization has little impact on the morphology of the *Ctenosaura*-populations on Utila, but the question whether its putative contribution to the genetic evolution on the island is more significant may trigger further studies.

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### Ein fertiler Hybride zwischen *Ctenosaura similis* (GRAY, 1831) und *C. bakeri* STEJNEGER, 1901 (Squamata: Iguanidae) auf Isla de Utila, Honduras

Beschrieben wird der Fund eines natürlichen fertilen Hybriden zwischen *C. similis* und *C. bakeri* auf der Isla de Utila. Dieser Fund repräsentiert den Erstnachweis einer fruchtbaren Rückkreuzung innerhalb der Subfamilie Iguaninae (vgl. KÖHLER & BLINN 2000, RASSMAN et al. 1997). Der Hybride, ein Weibchen in trüchtigem Zustand, wurde im März 2001 gefangen und die abgelegten Eier in leicht feuchtem Vermiculite bei konstant 30 °C inkubiert. Erfasst wurden Kopf-Rumpf- und Schwanzlänge (KRL, SL), Körpermasse, Gelegedaten, Färbung, Anzahl der Dorsalia sowie Anzahl und Anordnung der caudalen Intercalaria.

*C. similis* und *C. bakeri* sind anhand dieser Merkmale eindeutig differenzierbare Arten (DE QUEIROZ 1987, 1990; FITCH & HENDERSON 1978; KÖHLER & STREIT 1996; KÖHLER et al. 2000). Das Weibchen zeigt Merkmale beider Arten. Die türkis-grün/grau-braune Färbung (Abb. 1) und die Anzahl von 48 Dorsalia (Tab. 1) sind typisch für *C. bakeri*, während die Relation SL/KRL mit 1,78 über dem Durchschnitt adulter *C. bakeri* (1,59) und im Bereich von *C. similis* liegt (Tab. 1). Die anterioren caudalen Intercalaria sind in Größe und Anzahl anormal reduziert. Auffallendstes Merkmal des Hybriden waren die dunklen Seitenstreifen (Abb. 1), die typisch für *C. similis* sind und nie bei *C. bakeri* auftreten. Die Gelegegröße liegt mit 21 Eiern im Bereich von *C. similis* (12-88) und deutlich über der von *C. bakeri* (5-16). Mittlere Eilänge und -masse lagen unter denen von *C. bakeri* (Tab. 1). Die Merkmale der Jungtiere waren von denen juveniler *C. similis* kaum differenzierbar, was auf eine Rückkreuzung des Hybrid-Weibchens mit einem *C. similis*-Männchen schließen lässt. Die Relation SL/KRL mit durchschnittlich 2,29 lag über der juveniler *C. bakeri* (1,87), ebenso die mittlere Anzahl von 71 Dorsalia (Mittelwert 44,6 bei *C. bakeri*) und fiel in den Bereich von *C. similis* (Tab. 1). Alle Jungtiere zeigten verschiedene anormale Ausprägungen der anterioren caudalen Intercalaria. Ihre Körperfärbung war nicht uniform dunkel grau-braun (typisch für juvenile *C. bakeri*), sondern leuchtend grün mit hellbraunen Übergängen an den Flanken (typisch für juvenile *C. similis*) und den für *C. similis* typischen dunklen Seitenstreifen.

Mehrere potentielle Faktoren können zur natürlichen Hybridisierung beider Arten beitragen. *C. bakeri* besiedelt exklusiv den Mangrovesumpf und *C. similis* offene, trockene Gebiete. In einigen Bereichen grenzen beide Habitate aneinander, und Wanderungen einzelner Exemplare ins benachbarte Gebiet wurden beobachtet (A. GUTSCHE, nicht publ. Beobachtung). Beide Arten sind polygyn mit saisonal territorialen Männchen und haben auf Utila überlappende Paarungssaisons von Januar bis in den März (A. GUTSCHE, nicht publ. Beobachtung). Weiterhin gibt es bei Leguanen von Männchen erzwungene und erfolgreiche Paarungen, zum Beispiel bei *C. bakeri* (A. GUTSCHE, nicht publ. Beobachtung) und Galapagos-Meeresleguanen (TRILLMICH 1983). Seit 1997 wurden auf Utila über 1000 *C. bakeri* gefangen. Außer den bei KÖHLER & BLINN (2000) und den hier beschriebenen Exemplaren gab es keine weiteren Tiere mit auffälligen Merkmalen. Hybridisierung zwischen *C. bakeri* und *C. similis* scheint demzufolge ein rares Ereignis zu sein, möglicherweise aufgrund der ökologischen Trennung. Jedoch liegen kaum Daten von *C. similis* auf Utila vor und zusätzlich kann Rückkreuzung die Erkennung von Hybridmerkmalen auf phänotypischer Basis verhindern. Die tatsächliche Introgressionsrate und deren Einfluss auf die *Ctenosaura*-Populationen auf Utila muss in künftigen Studien geklärt werden.

Schlagwörter: Reptilia: Squamata: Iguanidae: *Ctenosaura bakeri*, *C. similis*; Honduras; Isla de Utila; fertile Hybriden.

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