

A New Record of an Introduced Species, the Brown Anole (*Anolis sagrei*) (Duméril & Bibron, 1837), in Taiwan

Gerrut Norval^{1,*}, Jean-Jay Mao², Hsin-Pin Chu³ and Lee-Chang Chen⁴

¹Global Village Education Center, No. 436, Chongshan Road, Chiayi City, Taiwan 600, R.O.C.

²Pingtung Rescue Center for Endangered Wild Animals, National Pingtung University of Science and Technology, No. 1, Hsuehfu Road, Neipu, Pingtung, Taiwan 912, R.O.C.

³Taitung Animal Propagation Station, No. 30, Community 27, Binlang Village, Beinan, Taitung County, Taiwan 954, R.O.C.

⁴No. 12, Lane 13, Guonguang Street, Junan Township, Miaoli, Taiwan 350, R.O.C.

(Accepted June 6, 2002)

Gerrut Norval, Jean-Jay Mao, Hsin-Pin Chu and Lee-Chang Chen (2002) A new record of an introduced species, the brown anole (*Anolis sagrei*) (Duméril & Bibron, 1837), in Taiwan. *Zoological Studies* 41(3):332-336. Brown anoles (*Anolis sagrei*, also classified as *Norops sagrei*) were collected from an area surrounding a plant nursery (23°25'51"N, 120°28'30"E) in Santzepu, Sheishan District, Chiayi County. To our knowledge, this is the 1st record of this species in Taiwan. Since Taiwan is far from where *A. sagrei* naturally occurs, we suspect that it was introduced through anthropogenic means.

<http://www.sinica.edu.tw/zool/zoolstud/41.3/332.pdf>

Key words: *Norops sagrei*, Distribution, Anthropogenic introduction, Exotic.

The genus *Anolis* (family Iguanidae or Polychrotidae, subfamily Polychrotinae, suborder Sauria) is a large group of lizards (about 400 species) (Losos et al. 1998). Anoles naturally occur throughout the warmer regions of North and South America, as well as on surrounding islands.

The brown anole (*Anolis sagrei*) is a native of the Bahamas and Cuba (Campbell 1996). It is also known from islands such as Swan Island, Honduras (Rodriguez Schettino 1999), Cayman Brac, and Little Cayman (Losos et al. 1993), and introduced populations have been recorded from Jamaica, Grand Cayman (Roughgarden 1995), Belize (Rodriguez Schettino 1999), Mexico, Florida, Texas, (Conant and Collins 1991), Louisiana (Steven and Lance 1994), and Georgia in the US (Campbell 1996). Köhler (2000) recently suggested the reclassification of *A. sagrei* as *Norops sagrei*, based on morphological characteristics.

MATERIALS AND METHODS

Two males (SMF79960 and SMF79961) and 1 female (SMF79962) were collected in September 2000 from a road near a plant nursery (23°25'51"N 120°28'30"E) in Santzepu, Sheishan District, Chiayi County (Fig. 1), and were sent to the Senckenberg Museum, Frankfurt am Main, Germany to verify our identification. There, they were compared to specimens from Cardeñao and Habama, Cuba (SMF54007, SMF54008, SMF24848, SMF24849, and SMF24850); San Pedro Sula, Honduras (SMF77743 & SMF77744); and the Yucatan Peninsula, Mexico (SMF77506). Between 13 and 23 November 2000, a further 28 specimens, field numbers 0005 to 0032, catalog number NMNS-3721, were collected from the area around the nursery and sent to the National Museum of Natural Science in Taichung, Taiwan. All these specimens were used to study characteristics of the scales as follows: a count of the interorbital (IO) as well as the interparietal/interorbitals (IP/IO) scales; the number of scales in the 2nd row of scales between the canthal ridges (2.

*To whom correspondence and reprint requests should be addressed. Tel: 886-5-2234965. E-mail: gerrutnorval507@yahoo.com

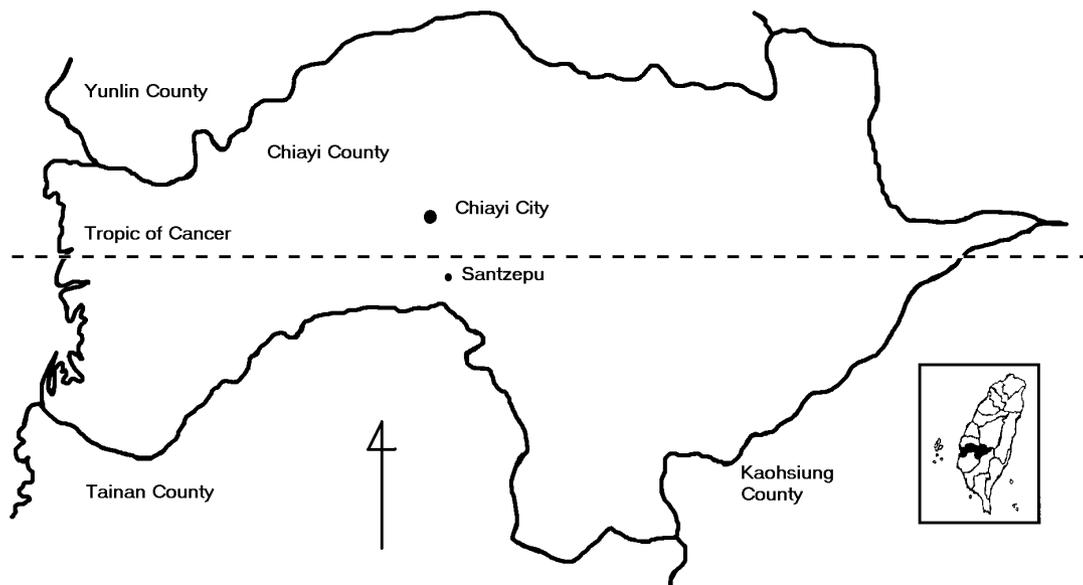


Fig. 1. Location map of Santzepu, Sheishan District, Chiayi County.

Canth.), as well as the number of internasal (IN) scales, not including the supranasal scales; the number of scales in the second loreal scale row; the number of scales between the subocular scales and supralabials (SO/SPL); and the number of supralabials (SPL), not including the rostral, only counted to the center of the eye, and not the entire length of the upper lip. For this study, the number of lamellae under the 4th toe, the longest toe, on the left hind foot, as well as the number of enlarged postanal (PA) scales were counted. Also, the number of scales in a 5-mm length along the center of the dorsal (Dors. 5mm) and ventral (Ventr. 5mm) sides, 1 head length from the neck were counted.

Diagnosis: This is a small (about 125-213 mm in total length) (Conant and Collins 1991), light brown to almost black lizard with the ability to change its color (Rodriguez Schettino 1999). The iris is brown or green (Rodriguez Schettino 1999), and both eyelids are moveable. The ear openings are clearly visible, and the body is covered with small, keeled, granular scales (Rodriguez Schettino 1999). Males have a large orange to red dewlap (throat fan) with a whitish border (Conant and Collins 1991). Both sexes have a long tail, which is almost twice as long as the SVL.

Description: Specimens from Taiwan appeared as follows. The snout is short, slightly depressed and pointed. Both eyelids are moveable, and the round ear opening is visible. Males and females have dewlaps, but the dewlaps of the

females are much smaller, and no females were seen displaying them. Males also have caudal, nuchal, and dorsal crests, which females lack. The limbs are thin and well developed. As with other anoles, the hind limbs are longer than the front limbs. The 5 toes on each foot are thin and cylindrical with a nail at the end of each toe and gecko like adhesive pads (lamellae) under the toes. Both sexes have a long tail that is on average 1.97 times longer than the SVL. Males that have never suffered tail-loss have a crest along the top of the tail.

Scalation: Scales on the head are larger than the other dorsal scales, and are keeled or multi-keeled. A canthal ridge is clearly visible on both sides of the head (Fig. 2). The upper and lower labials are larger than the other scales on the side of the head. The loreal scales are arranged in 4 to 7 longitudinal rows between the preoculars and postnasals, and below the canthals (Fig. 3). Small, round, granular scales cover the limbs and dorsal area of the body. The ventral scales are larger than the dorsal scales and are also slightly keeled. The scales on the tail (including the sub-caudals) are more pointed and more strongly keeled, giving them a rough appearance.

Coloration: These lizards have the ability to change their color and thus can have very diverse coloration. The belly and throat are a creamy white, often with gray spots or lines under the throat. The edges of the eyelids are light beige. The dorsal colors of males, females and juveniles

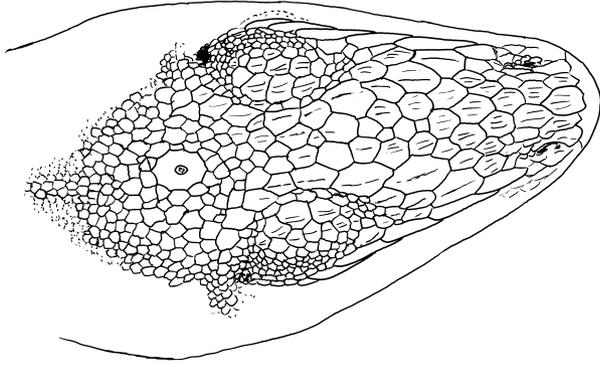


Fig. 2. Dorsal view of the head of a male *Anolis sagrei*.



Fig. 3. Lateral view of the head of a male *Anolis sagrei*.

show variations. Male ground color varies from light gray, beige-brown, to almost black. When attempts were made to capture males, darker ones changed their color to a lighter shade. Usually, they are light brown with a series of yellow spots that form 2 lines on each flank that extend to the tail. There are also some yellow spots on the limbs, head, and back. They often have a lighter shaded line that runs along the spine with dark brown to black chevron markings on both sides of the line. The dewlap is orange to red, with a white to yellowish edge. The under-throat scales give the dewlap a white or black speckled appearance, depending on the coloration of the male at the time.

Females basically have the same ground color as males. They also have a light, almost white, line that extends from the back of the head along the spine to the end of the tail. There are often black triangular markings on both sides of this line which are often fused to form a black and brown zigzag pattern on both sides along the line.

These black markings usually have yellow edges. There are often 2 yellow lines on each flank. The dewlap is the same color as that of the males, but much smaller.

Juveniles resemble females, and young males are often difficult to distinguish from adult females.

Ecological and behavior notes: Males are larger than females and show strong territorial behavior to other members of the same species. Males bobbed their heads, raised and lowered their tails, and extended the dewlap if a female or rival male came too close. Some males leapt to the floor to chase off intruders when they came too close. Brown anoles seem to prefer areas that have very low or little ground cover. This was also noted in studies done in other parts of the world where this species has been introduced (Losos et al. 1993). They are very common in orchards and betel palm (*Areca catechu* L.) plantations in Santzepu, Chiayi County. There they perch on tree trunks and leap to the ground, where they make short dashes among debris, or seek shelter if attempts are made to catch them. Males were also observed perching on walls and other objects in the area surrounding the plant nursery. Females were seen on tree trunks or on the ground under the trees. A few road kills were also found on the road near the plant nursery.

Mating was observed in July 2000 (summer), and 1 egg was found among debris under a tree; another female laid a single egg in a water bowl while in captivity.

DISCUSSION

Even though there was large individual variation in scale characteristics, specimens from Taiwan showed no observable variation from specimens from Cardeñao and Habama, Cuba (SMF54007, SMF54008, SMF24848, SMF24849 and SMF24850); San Pedro Sula, Honduras (SMF77743 and SMF77744); and the Yucatan Peninsula, Mexico (SMF77506); except for SMF24850, which was the only specimen with no interorbital scales (Table 1). Large numbers of these lizards were observed around the study area (23°25'51"N 120°28'30"E), but nowhere else in Chiayi County.

A study on a population in Miami, FL, USA, found that males become reproductive at about 39 mm SVL and females at about 34 mm SVL (Lee et al. 1989). Of the collected specimens, the small-

est male (SMF79961) measured 47.7 mm and the largest (NMNS-3721, field number 0008) 62.1 mm SVL, while the smallest female (NMNS-3721, field number 0014) measured 34.9 mm SVL and the largest (NMNS-3721, field number 0005) 44 mm SVL, which means they were all of reproductive size. Many others of the same size were observed in the agricultural area and cemetery near the plant nursery. Since the highest concentration occurred in the immediate vicinity of the plant nursery, this supports the idea that this is a founder population.

This species is known to have dispersed by vehicular rafting in Florida (Campbell 1996). Since the area in which they now occur in Taiwan is mainly an agricultural area, it is most likely that they will also spread to other parts of the island in this manner. Many vehicles enter and leave the Santzepu area every day, and farmers often cart their crops and implements to other areas of Chiayi County. This could make it easy for these lizards to be accidentally introduced into other areas of Taiwan. At present, a study is underway to examine the interaction of this introduced species with other indigenous lizard species within the study area in Taiwan. The distribution and spread of *Anolis sagrei* within Taiwan are also being monitored.

Acknowledgments: Special thanks are extended to Dr. Gunther Köhler of the Senckenberg

Museum, Frankfurt am Main, Germany for his advice on the scale counts and specimen identification; and also to Dr. Graham Alexander, Dr. Martin Whiting, Prof. Kuang-Yang Lue, and Prof. Jonathan Losos for their comments and for reviewing this paper. Also, the kind assistance of Ms. Yu-Pin Lin with the photographing of the anoles as well as with data collection is acknowledged.

REFERENCES

- Campbell TS. 1996. Northern range expansion of the brown anole (*Anolis sagrei*) in Florida and Georgia. *Herpetol. Rev.* **27**: 155-157.
- Conant R, JT Collins. 1991. The Peterson field guide series: a field guide to reptiles and amphibians. Eastern and Central North America. 3rd ed. Boston: Houghton Mifflin.
- Köhler G. 2000. Reptilien und amphibien mittelamerikas. Band 1: Krokodile, Schildkröten, Echsen. Germany: Offenbach.
- Lee JC, D Clayton, S Eisenstein, I Perez. 1989. The reproductive cycle of *Anolis sagrei* in southern Florida. *Copeia* **4**: 930-937.
- Losos JB, TR Jackman, A Larson, K De Queiroz, L. Rodriguez-Schettino. 1998. Contingency and determinism in replicated adaptive radiations of island lizards. *Nature* **279**: 2115-2118.
- Losos JB, JC Marks, TW Schoener. 1993. Habitat use and ecological interaction of an introduced and native species of *Anolis* lizard on Grand Cayman, with a review of the outcomes on anole introductions. *Oecologia* **95**: 525-532.
- Rodriguez Schettino LR. 1999. The iguanid lizards of Cuba.

Table 1. Morphological comparison of *Anolis sagrei* from different localities

Locality	Mexico	Cuba		Honduras		Taiwan	
	(Yucatan)	(Cardeñao and Kabama)		(San Pedro Sula)		(Chiayi)	
	♂ ^a	♂ ^a	♀	♂	♀	♂	♀
IO	1	0-2	2	1	1	1-2	1-2
IP/IO	3-4	2-3	2-3	3	3	2-3	2-4
Loreal	4	4-5	5	4	4-5	4-6	4-5
SPL	5-6	4-6	5	4-5	4-5	5-6	4-6
2. Canth.	7	5-6	6	5	6	4-7	4-7
IN	7	5-7	6	6	6	5-6	4-6
Lamellae	33	29-33	31	32	30	29-35	28-34
PA	3	1-5	0	4	0	2-5	0
Dors. 5 mm	17	10-16	19	11	14	11-17	17-25
Ventr. 5 mm	13	9-12	13	9	12	8-12	11-15
HL (mm)	12.2	11.2-16.2	10.7	15.7	12.7	13-17	10-11.9
SVL (mm)	41.2	38.8-62.7	38.2	59.4	48.1	47-62.1	34.9-44
Tail-L (mm)	61	36 ^b -105	38 ^b	112	72	40 ^b -115	65-79
Tibia-L (mm)	10.2	9.5-16.7	9.2	15.5	12.1	11.6-14.9	7.7-10.5
N	1	4	1	1	1	15	16

^aIncluding sub-adults.

^bTail loss.

Gainesville, FL: University Press of Florida.
 Roughgarden J. 1995. *Anolis* lizards of the Caribbean: ecology, evolution, and plate tectonics. New York: Oxford

University Press.
 Steven GP, WF Lance. 1994. *Anolis sagrei*. Herpetol. Rev. 25: 33.

Appendix 1. List of specimens examined and localities of origin

Locality	Specimen numbers
Chiayi (Taiwan)	♂: SMF 79960, 79961; NMNS-3721 field numbers: 0006, 0008, 0009, 0010, 0011, 0013, 0016, 0018, 0019, 0020, 0022, 0023, 0024 ♀: SMF 799062; NMNS-3721 field numbers: 0005, 0007, 0012, 0014, 0015, 0017, 0021, 0025, 0026, 0027, 0028, 0029, 0030, 0031, 0032
San Pedro Sula (Honduras)	♂: SMF 77743 ♀: SMF 77744
Yucatan Peninsula (Mexico)	♂: SMF 77506 (sub-adult)
Cardeñao (Cuba)	♂: SMF 54007, 54008
Kabama (Cuba)	♂: SMF 24848, 24850 (sub-adult) ♀: SMF 24849

Notes: SMF= Senckenberg Nature Museum, Frankfurt am Main, Germany;
 NMNS= National Museum of Natural Science, Taichung, Taiwan

臺灣新記錄外來種蜥蜴，沙氏變色蜥 *Anolis sagrei* (Duméril & Bibron, 1837)

Gerrut Norval¹ 毛俊傑² 朱賢斌³ 陳李昌⁴

沙氏變色蜥是於嘉義縣水上鄉三界埔地區的一處苗圃被發現、採集，此為臺灣的新記錄種。由於該物種原始分布地區與臺灣相距甚遠，可能是藉由人為的因素被引入。

關鍵詞：沙氏變色蜥，分布，人為引入，外來種。

¹地球村文教機構

²國立屏東科技大學保育類野生動物收容中心

³行政院農業委員會畜產試驗所臺東種畜繁殖場

⁴苗栗縣竹南鎮國光街13巷12號