資料２

未判定外来生物の輸入届出の概要

特定外来生物による生態系等に係る被害の防止に関する法律第２１条に基づき、未判定外来生物の輸入の届出の概要は以下のとおり。

１．届出の内容

（１）届　出　の　日：平成 19 年 3 月 13 日（火）
（２）届出の受理日：平成 19 年 3 月 15 日（木）
（３）届 出 の 種 類：未判定外来生物の輸入の届出（法第２１条関係）
（４）未判定外来生物の種類、入手国名、生態的特性に関する情報

未判定外来生物の種類	入手国名	生態特性に係る情報	
		本来の生息地･生育地の分布状況	文献その他の根拠を示す資料
アノリス・アングスティケプス *Anolis angusticeps*	キューバ	キューバ（ピノス島を含む）、バハマ	「Morphology, ecology, and behavior of the twig anole, *Anolis angusticeps*」 「Anolis angusticeps Hallowell, 1856」 「The evolution of ecological performance in *Anolis* Lizards」

２．届出の添付資料

○生態系等に関する文献等

・Irschick D.J. and J.B. Losos. 1996. Morphology, ecology, and behavior of the twig anole, *Anolis angusticeps*, p.291-301. *In* R. Powell and R.W. Henderson (eds.), Contributions to West Indian Herpetology: A Tribute to Albert Schwartz. Society for the Study of Amphibians and Reptiles, Ithaca (New York). Contributions to Herpetology, volume 12.
・Anolis angusticeps Hallowell, 1856
http://www.homestead.com/Anolis/angusticeps.html
・The evolution of ecological performance in *Anolis* Lizards
http://www.tulane.edu/~irschick/ecol_perf.htm

（別添のとおり）

Morphology, Ecology, and Behavior of the Twig Anole, *Anolis angusticeps*

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Abstract.—The polychrotid lizard *Anolis angusticeps* is superficially similar to twig anoles, an anole ecomorph that has arisen several times independently in the Greater Antilles. We examined the habitat use, locomotor behavior, and morphological characteristics of *A. angusticeps* to determine whether it exhibits characteristics similar to other twig anoles. Our results indicate that in all respects, *A. angusticeps* is a typical twig anole. As predicted, *A. angusticeps* is typically found on supports of narrow dimensions, walks slowly, displays infrequently, and is similar morphologically to other twig anoles. The cryptic coloration, slow movements, and infrequent display behavior of twig anoles support the hypothesis that these lizards have evolved to be inconspicuous. The crypticity of twig anoles may have arisen because they use a habitat (narrow supports) in which rapid escape may be difficult and therefore have evolved to hide from potential predators.

Introduction

Within the Greater Antillean islands of the West Indies, an amazing radiation of *Anolis* lizards has occurred, producing a set of morphologically distinct forms, termed "ecomorphs" (Rand and Williams 1969; Williams 1972, 1983). Previous work has shown that these ecomorphs differ in habitat use, morphology, and behavior (Moermond 1979*a*, 1979*b*; Mayer 1989; Losos 1990*a*, 1990*b*, 1990*c*). Remarkably, these forms have, with some exceptions, convergently evolved on each of the islands, producing largely similar within-island sets of ecomorphs.

Although many Greater Antillean *Anolis* can be placed into a particular ecomorph category (Losos 1992), the classification of some species is still uncertain. *Anolis angusticeps*, believed to have originated on Cuba (Williams 1969), but now found on several Bahamian islands, is such a species. Superficially, *A. angusticeps* resembles twig anoles by its possession of a slender body, short tail, and short legs (although these characteristics have not been quantified to date). However, observations on habitat use in *A. angusticeps* are conflicting; in the Bahamas, Schoener (1968) reported that this species uses the typical habitat of twig anoles (narrow supports on the periphery of trees and bushes). In contrast, others have described the structural habitat of this species in Cuba as typical of trunk-ground or trunk anoles. For example, Collette (1961) observed *A. angusticeps* primarily on tree trunks, fence posts, rocks and the ground, whereas Schwartz and Thomas (1969) described finding this species on rocks, shrubs, fence posts, trees, and the ground. Observations by Ruibal (1964) and Hardy (1967) also describe finding this species in habitats other than narrow branches or twigs. Clearly, more data are needed to clarify the ecomorph status of *A. angusticeps*.

We examined whether *Anolis angusticeps* exhibits morphological, ecological, and behavioral characteristics of other twig anoles. These characteristics are as follows: (1) twig anoles are slender and possess a short tail and short legs (Williams 1983; Hedges and Thomas 1989; Losos 1990*a*); (2) twig anoles use narrow branches, move by walking slowly, and are highly cryptic (Williams and Rand 1969; Webster 1969; Hicks and Trivers 1983; Losos

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1990*a*, 1990*b*). Furthermore, several authors (Hicks and Trivers 1983; Losos 1990*b*) have demonstrated that the twig anole *A. valencienni* displays infrequently relative to other anoles. One possible reason for the infrequent displays of *A. valencienni* is that this species, like other twig anoles, relies on crypticity to avoid detection. Therefore, we predicted that *A. angusticeps* should also display infrequently so as to avoid bringing attention to itself. Finally, in addition to testing the above predictions, we also examine intersexual differences in habitat use and locomotor behavior in *A. angusticeps*.

MATERIALS AND METHODS

Morphometrics

To examine whether *Anolis angusticeps* is similar morphologically to other twig anoles, we compared external morphological characteristics of *A. angusticeps* from Cuba ($n = 13$) and South Bimini Island ($n = 11$) to 31 other Greater Antillean *Anolis* whose ecomorph status is known. Appendix 1 provides museum numbers for Cuban specimens. The ecomorph status for most of these 31 anoles has been established based on previous morphological, ecological, and behavioral analyses (see Losos 1990*a*, 1990*b*, 1990*c*; Losos 1992 for details on how anole ecomorphs are characterized), although values for a few species mentioned here have not been published. We took the following measurements on preserved adult male (data from other anoles are from adult males) *A. angusticeps* (following Losos 1990*a*): snout-vent length (SVL), number of subdigital lamellae under the fourth phalanx of the hindfoot, and length of the forelimb, hindlimb, and tail. Similar data are available for 31 other Greater Antillean species (Losos 1990*a*, 1992, and unpublished data; see Appendix 2 for species used in morphometric comparisons).

Ecological and Behavioral Data

To examine whether *Anolis angusticeps* exhibits the predicted ecological and behavioral characteristics, we collected field data on 16 adult male and 8 adult female *A. angusticeps* on South Bimini, Bahamas from 13–20 April 1992. South Bimini is a small (approximately 8 km^2), flat island primarily covered by bushes and trees. The weather during the week of observation was sunny and warm with few clouds and relatively little wind. Given the difficulty of distinguishing adult females and subadult males by sight, we only included animals in our analyses that were caught after the observational period and sexed. During normal activity hours (0900–1700 h), we examined available habitats (e.g., high in trees, rocks on the ground) on relatively undisturbed parts of the island. Upon sighting a lizard, we observed the lizard from a distance of 2–7 m for 30 min, or until it disappeared (range = 11–30 min, mean [SE] = 25.4 ± 1.2 min). All lizards that were obviously disturbed or observed for less than 10 min were not included in the analysis. All observational data were recorded into a microcassette recorder and later transcribed.

Each movement was categorized as a walk, run, or jump. Walks (equivalent to "crawls"; e.g., Moermond 1979*a*) were slow movements where all four limbs remained in close contact with the substrate during movement. Runs were quick movements whereby one or more limbs were cycled quickly above the substrate. Jumps were quick movements where the lizard intentionally jumped either between or on substrates. The percentage of time that each lizard spent displaying was measured by recording all display events (i.e., head-bobs, dewlap extensions) and summing the amount of time that lizards engaged in these activities. The following ecological and behavioral measurements were quantified for each lizard: (1) perch type, height, and diameter; (2) percent time spent displaying; and (3) percent of total movements that were walks, runs, and jumps. Perch type was the substrate on which the lizard was initially observed (e.g., branch, tree trunk). Perch height was the height above the ground at which the lizard was first observed. Perch diameter was the diameter of the substrate on which the lizard was first observed.

Statistical Analyses

All statistical analyses were performed on SYSTAT (Wilkinson 1990). All morphological and habitat variables were $\log_{10}$ transformed prior to statistical analyses. All morphological variables increase with size (SVL) (one-tailed least-squares regresssions, P < 0.001); to remove the effects of size we calculated residuals from regressions (ordinary least squares) between each morphological variable (dependent variable) and our measure of size (SVL) (independent variable). These residuals represent SVL-allometry free shape variables (Bookstein 1989). Mean residual values for each species were subsequently used in statistical analyses. We examined whether *Anolis angusticeps* exhibits morphological characteristics similar to other twig anoles by performing a discriminant function analysis (DFA) with both Cuban and Bahamian *A. angusticeps* and 31 other Greater Antillean *Anolis*. To test with which of the ecomorphs the Cuban and Bahamian populations of *A. angusticeps* would group, both populations were classified *a posteriori* based on the analysis of the 31 other species. To determine how strongly each of the morphometric variables contributed to each of the discriminant axes, we performed multiple regressions using as dependent variables the discriminant function scores and as

TABLE 1. Morphological, ecological, and behavioral characteristics of Greater Antillean *Anolis* ecomorphs. Data were gathered from Losos (1990*a*) and Losos (unpublished data). Ecomorphs are indicated as follows: trunk-ground (T-G), trunk-crown (T-C), grass-bush (G-B), crown-giant (C-G), twig (TW), and trunk (Tr). The numbers in parentheses in the ecomorph columns for morphology, behavior, and ecology are the number of species representing that ecomorph type for that data base. See Appendix 2 for the list of species used in these comparisons. For the morphological variables, numbers not enclosed in brackets are mean (± 1 SE) non-size removed values for each ecomorph type, whereas numbers in brackets are mean (± 1 SE) size-removed (residual) values for each variable. All measurements are in mm unless otherwise indicated. The behavioral and ecological variables are not size-removed values. Percent (%) display is the mean (± 1 SE) amount of time that ecomorphs spend displaying (per observation period). Percent (%) walks, runs, or jumps are the mean (± 1 SE) percentages of the total number of movements (per observation period) that ecomorphs perform these locomotor movements.

Characteristic	T-G	T-C	G-B	C-G	TW	Tr
Morphology	9	9	6	3	4	1
SVL	62.3 ± 2.6	59.5 ± 4.0	44.7 ± 1.0	132.6 ± 14.0	48.8 ± 2.0	51.3
Hindlimb length	52.0 ± 3.0 (0.07 ± 0.01)	39.9 ± 2.6 (−0.02 ± 0.02)	34.8 ± 1.1 (0.06 ± 0.01)	94.9 ± 8.2 (−0.03 ± 0.02)	25.2 ± 4.7 (−0.13 ± 0.02)	38.3 (0.03)
Forelimb length	30.8 ± 1.8 (0.06 ± 0.01)	26.0 ± 1.6 (0.01 ± 0.02)	17.7 ± 0.7 (−0.01 ± 0.01)	58.7 ± 6.0 (−0.05 ± 0.01)	15.9 ± 3.4 (−0.11 ± 0.01)	25.9 (0.09)
Lamellae number	18.9 ± 0.2 (−0.06 ± 0.01)	24.7 ± 1.2 (0.07 ± 0.01)	18.9 ± 0.5 (0.0 ± 0.01)	29.8 ± 0.8 (0.01 ± 0.01)	18.8 ± 1.6 (−0.02 ± 0.02)	18.0 (−0.04)
Tail length	120.6 ± 5.3 (0.02 ± 0.01)	107.4 ± 10.5 (−0.02 ± 0.01)	122.6 ± 5.0 (0.17 ± 0.02)	258.8 ± 21.2 (0.01 ± 0.03)	60.6 ± 10.3 (−0.17 ± 0.03)	71.5 (−0.12)
Behavior	5	6	4	1*	3	3
% walks	24.4 ± 3.3	49.3 ± 10.3	44.1 ± 8.1	45.0	80.1 ± 4.5	15.2 ± 7.3
% runs	54.2 ± 2.9	39.8 ± 9.0	30.6 ± 4.9	45.0	8.6 ± 4.1	83.1 ± 8.0
% jumps	21.4 ± 2.5	10.9 ± 4.5	25.3 ± 4.3	10.0	11.3 ± 0.8	1.7 ± 0.8
% display	5.7 ± 1.2	6.0 ± 1.4	3.4 ± 0.9	—	1.3 ± 0.002	2.0 ± 0.8
Ecology	5	6	4	1	3	3
Perch height (m)	1.1 ± 0.2	3.7 ± 0.8	0.6 ± 0.1	3.5	2.7 ± 0.5	1.9 ± 0.5
Perch diameter (cm)	22.5 ± 3.7	19.3 ± 3.9	2.9 ± 1.7	33.2	2.9 ± 1.7	22.2 ± 2.6

* No data available for display behavior in *Anolis garmani*.

independent variables the size-removed variables. Percentage data were arcsin square-root transformed prior to statistical analyses. All statistical analyses were two-tailed unless otherwise indicated.

For comparative purposes, we present data on habitat use and behavior for a subset of the 31 anoles used in morphometric comparisons (data from Losos 1990*a*, unpublished data; see Appendix 2 for species used in ecological and behavioral comparisons). However, some anoles used in ecological/behavioral comparisons were not used in morphological comparisons and vice versa. Ecological and behavioral data were collected in a manner similar to that described for *A. angusticeps* (see Losos 1990*a* for exact protocol). As in morphometric comparisons, because previously collected data were gathered on adult males, only values for adult male *A. angusticeps* are included in these comparisons.

RESULTS

Morphometric Analyses

Table 1 provides mean (± 1 SE) values for ecomorphs used in morphometric analyses and Table 2 provides mean (± 1 SE) morphological values for Cuban and Bahamian *Anolis angusticeps*. The discriminant function analysis based on morphology of 31 Greater Antillean *Anolis* species was significant (Figure 1; Wilk's lambda = 0.003, $F_{16,76}$ = 16.76, $P < 0.001$) and classified all 31 species to predesignated ecomorph categories. *Anolis angusticeps* from both Cuba and the Bahamas were classified *a posteriori* as twig anoles (probability = 1.0 for both populations). Standardized partial regression coefficients for the multiple regressions between discriminant functions and the morphometric variables are in Table 3. The first three discriminant functions exhibited high canonical correlations (the higher the correlation the greater the amount of variation explained along that axis) but the fourth function had a markedly lower canonical correlation (Table 3). Therefore, the fourth function explains little of the variance among ecomorphs.

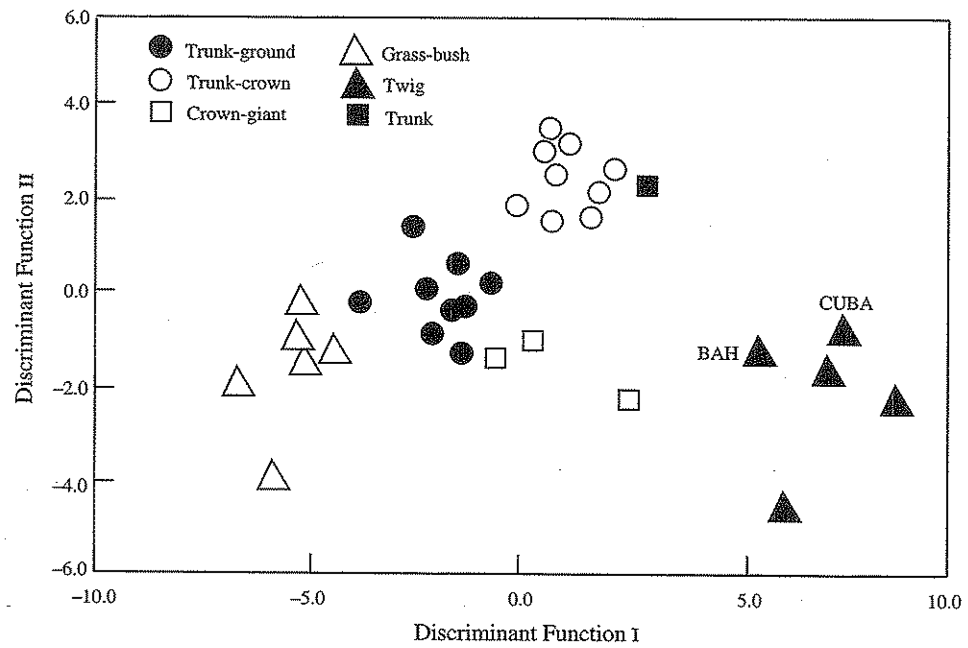

FIGURE 1. A plot of discriminant function II (y-axis) against discriminant function I (x-axis). Discriminant functions were generated from a discriminant function analysis of 31 *Anolis* species belonging to six ecomorph types (both Cuban and Bahamian *A. angusticeps* populations were included *a posteriori* in the DFA, and are presented here for purposes of comparison to other *Anolis*). Each point represents a different species, each symbol an ecomorph type. Symbols with BAH and CUBA adjacent are Bahamian and Cuban samples of *A. angusticeps*. See text for details of the analysis.

TABLE 2. Morphological, ecological, and behavioral characteristics of *Anolis angusticeps*. Values not in parentheses for morphological variables are mean (± 1 SE) non size-removed values for Bahamian and Cuban samples. Values in brackets are size-removed (residual) values generated from regressions with 31 other anole species. Because mean values for *A. angusticeps* were used to remove size effects, no standard error bars are given for size-removed values. All measurements are in mm unless otherwise indicated. The ecological/behavioral variables also represent mean (± 1 SE) values, but for Bahamian males and females. Percent (%) walks, runs, or jumps is the mean percentage of locomotor movements that males and females used during observational periods. Percent (%) display is the mean amount of time that males and females spent displaying during observational periods.

Variable	Sample	
Morphology	Bahamian (n = 11)	Cuban (n = 13)
SVL	47.7 ± 1.1	37.6 ± 0.8
Forelimb length	16.6 ± 0.3 (−0.07)	11.3 ± 0.4 (−0.11)
Hindlimb length	26.0 ± 0.5 (−0.11)	17.7 ± 0.5 (−0.15)
Lamellae number	19.6 ± 0.4 (0.00)	19.4 ± 0.3 (0.05)
Tail length	64.9 ± 2.0 (−0.14)	47.0 ± 1.2 (−0.17)
Ecology / Behavior	Males (n = 16)	Females (n = 8)
Perch height (m)	2.2 ± 0.3	1.8 ± 0.4
Perch diameter (cm)	2.3 ± 0.5	0.7 ± 0.2
% walks	89.3 ± 2.0	92.4 ± 3.7
% runs	1.9 ± 0.9	0.5 ± 0.4
% jumps	8.8 ± 1.7	7.1 ± 3.6

With the exception of hindlimb length and DFA I, all morphometric variables are significantly correlated with each of the discriminant functions ($P <$ 0.001). Tail length exhibits a high negative correlation with DFA I, indicating the utility of this character in segregating ecomorphs. In general, twig anoles (including Bahamian and Cuban *Anolis angusticeps*) exhibit very high values of DFA I (short tails) whereas grass-bush anoles exhibit very low values of DFA I (long tails) (Figure 1). Forelimb length exhibits a high positive correlation with DFA II indicating that anoles with high values for this variable possess long forelimbs. Trunk-crown anoles and the one trunk anole (*A. distichus*) tend to have high positive values for DFA II, indicating long forelimbs for these anoles. Twig anoles and grass-bush anoles tend to exhibit intermediate or low values of DFA II, indicating moderately short forelimbs for both ecomorphs. Hindlimb length loaded highly only on DFA IV, but inspection of Tables 1 and 2 shows that Bahamian and Cuban *A. angusticeps* and twig anoles in general possess high negative residual values for hindlimb length, indicating short hindlimbs for these anoles. Overall, Bahamian and Cuban populations of *A. angusticeps* differ only slightly from one another in size-removed morphological characteristics (Figure 1, Table 2).

Ecology and Behavior of *Anolis angusticeps*

Both male and female *Anolis angusticeps* perched on branches or twigs in bushes, crowns of trees, or on branches jutting from fallen trees. None of the

TABLE 3. Standardized partial regression coefficients from multiple regressions between each of the four discriminant functions (dependent variable) and four size-removed morphometric variables (independent variables). Discriminant function scores were generated from a discriminant function analysis of 31 *Anolis* species. Canonical correlations are also provided (higher correlations represent a greater proportion of variance explained by that axis). See text for details.

	Function			
Variable	I	II	III	IV
Hindlimb length	0.02	−1.07	0.15	−4.13
Forelimb length	−0.27	1.58	0.15	2.40
Lamellae number	0.12	0.53	−0.65	−1.11
Tail length	−0.88	0.14	−0.50	2.11
Canonical correlations	0.97	0.89	0.82	0.05