

Stick Spider Data



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Phenomenon

The evolution of the same three ecomorphs on each of the Hawaiian Islands



Background

From the Atlantic: Hawaii: Where Evolution Can Be Surprisingly Predictable

“The most spectacular of these spider dynasties, Gillespie says, are the stick spiders. They’re so-named because some of them have long, distended abdomens that make them look like twigs. “You only see them at night, walking around the understory very slowly,” Gillespie says. “They’re kind of like sloths.” Murderous sloths, though: Their sluggish movements allow them to sneak up on other spiders and kill them.

During the day, stick spiders hide, relying on their camouflage to protect them from the beaks of honeycreepers. Each of Hawaii’s islands has species of stick spider that come in three distinctive colors—shiny gold, dark brown, and matte white. Go to Oahu and you’ll find all three kinds. Head to East Maui and you’ll see the same trio. It would be tempting to think that the same three species of stick spider, one for each color, have traveled throughout the island chain. But the truth is much stranger.



Gillespie has shown that the gold spiders on Oahu belong to a different species from those on Kauai or Molokai. In fact, they’re more closely related to their brown and white neighbors from Oahu. Time and again, these spiders have arrived on new islands and evolved into new species—but always in one of three basic ways. A gold spider arrives on Oahu, and diversified into gold, brown, and white species. Another gold spider hops across to Maui and again diversified into gold, brown, and white species. “They repeatedly evolve the same forms,” says Gillespie.

Collection Sites

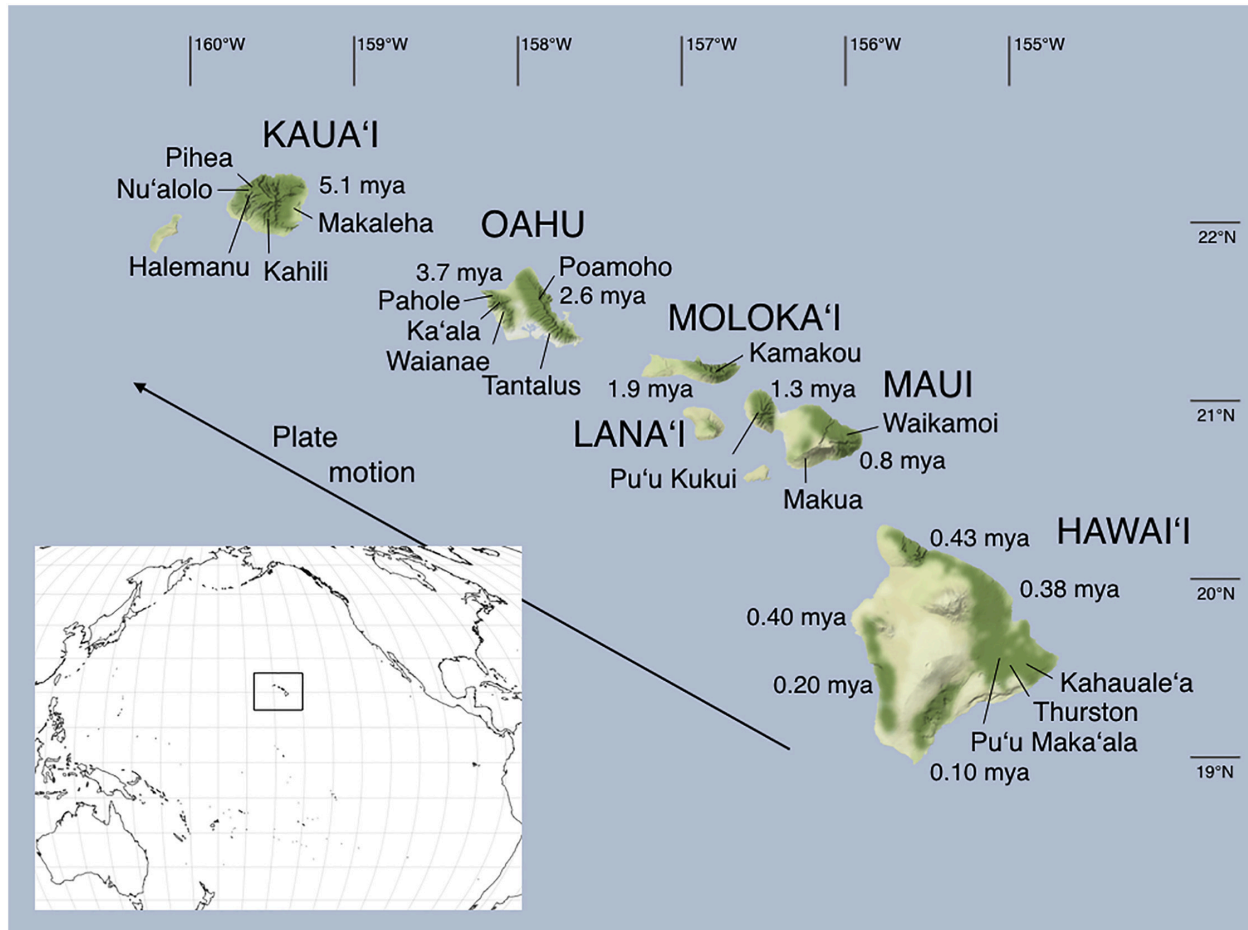


Figure 1. The Hawaiian Archipelago Chronosequence, Showing Collecting Sites for Specimens Used in the Current Study

Volcano ages are noted. Hawaii base map from

<http://mapstack.stamen.com>.

See also [Tables 1](#) and [S1](#).

Ecological Forms

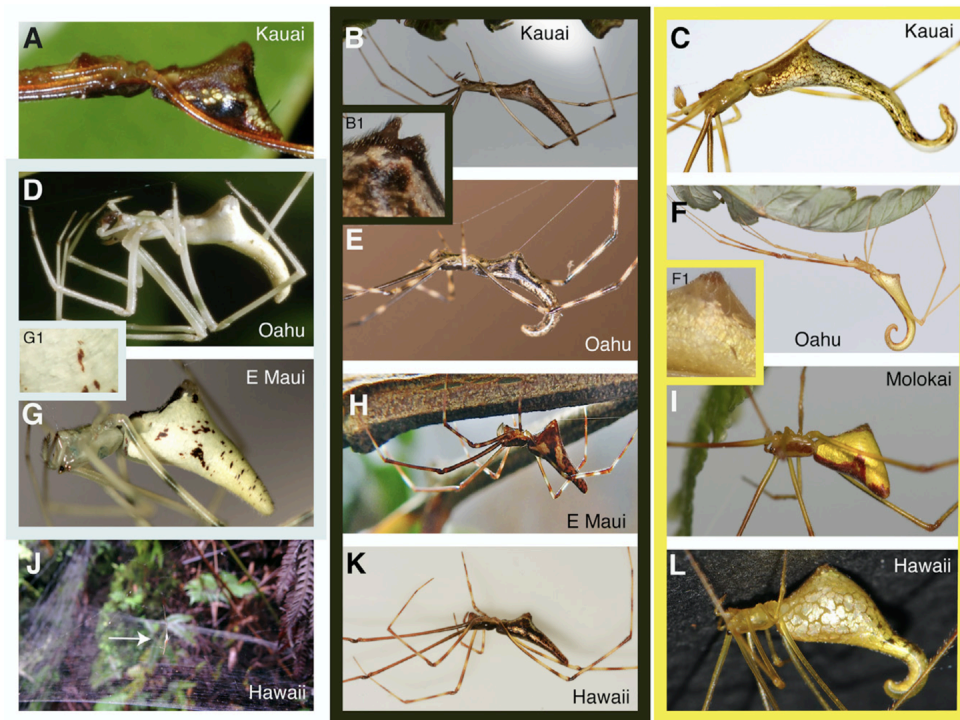


Figure 2. Ecological Forms of the Hawaiian *Ariamnes*

Colored boxes around images show the different ecomorphs: matte white, dark, and gold.

(A) *A. huinakolu*; Kauai, Makalehas; July 2008.

(B) *A. sp.*; Kauai, Pihea; November 2016.

(C) *A. kahili*; Kauai, Wailua River; November 2016.

(D) *A. sp.*; Oahu, Pahole; August 2008.

(E) *A. makue*; Oahu, Kaala; November 2016.

(F) *A. uwepa*; Oahu, Poamoho; November 2016.

(G) *A. corniger*; East Maui; November 2016.

(H) *A. laau*; East Maui; July 2013.

(I) *A. sp.*; Molokai; November 2016.

(J) *A. waikula* on web of *Orsonwelles*; Hawaii; July 2013.

(K) *A. hiwa*; Hawaii; July 2014.

(L) *A. waikula*; Hawaii, Saddle Road; July 2013.

Note that all of the gold forms—(C), (F), (I), and (L)—can exhibit color polymorphism, with red superimposed on the gold, as shown in (I). Photo credits: G. Roderick, (A–J), A. Rominger, (K), D. Cotoras, (L). Insets (B1, F1, and G1) show details of the guanine structure of the respective forms.

Hawaiian Stick Spider Characteristics

Table 1. The Hawaiian *Ariamnes* Stick Spiders and Associated Characteristics

Species	n	Island	Habitat	Body Form	Food ^a	Color	Microhabitat ^b	Ecomorph
<i>A. huinakolu</i>	5	K	wet forest	short	F&K	red/dark	in moss	short moss
<i>A. n. sp</i>	2	K	wet forest	long	F&K	dark	dead fern/rock	dark
<i>A. kahili</i>	7	K	wet forest	long	F&K	gold	under leaves	gold
<i>A. uwepa</i>	6	O	wet/mesic	long	F	gold	under leaves	gold
<i>A. n. sp.</i>	2	O	mesic/ dry	long	F	white	in lichen ^c	matte white
<i>A. makue</i>	6	O	mesic	long	F&K	br-blk/dark	dead ferns	dark
<i>A. poele</i>	6	Mo	wet forest	long	F	br-blk/dark	dead ferns	dark
<i>A. n. sp</i>	2	Mo	wet forest	long	F	gold	under leaves	gold
<i>A. melekakimaka</i>	7	WM	wet forest	medium	F&K	gold	under leaves	gold
<i>A. n. sp</i>	2	WM	wet forest	long	F	br-blk/dark	dead ferns	dark
<i>A. corniger</i>	8	EM	dry and wet	long	F	white	in lichen ^c	matte white
<i>A. alepeleke</i>	6	EM	wet forest	medium	F	gold	under leaves	gold
<i>A. laau</i>	7	EM	wet forest	long	F&K	br-blk/dark	dead ferns	dark
<i>A. waikula</i>	7	H	wet forest	long	F	gold	under leaves	gold
<i>A. hiwa</i>	8	H	wet forest	long	F	br-blk/dark	rock crevices	dark

K, Kauai; O, Oahu; M, Molokai; WM, West Maui; EM, East Maui; H, Hawaii; F, free-living state; K, kleptoparasitic association; br-blk, brown-black. See also [Table S1](#).^aAt night, species were found either in free-living state or in kleptoparasitic association with *Orsonwelles* spider webs. In some situations, spiders have only been collected in inactive state during the day, in which case feeding associations are unknown.

^bBy day, species were found camouflaged against specific microhabitats.

^cFruticose lichen, genera *Usnea* (Parmeliaceae) or *Alectoria* (Alectoriaceae).

Dated Phylogeny

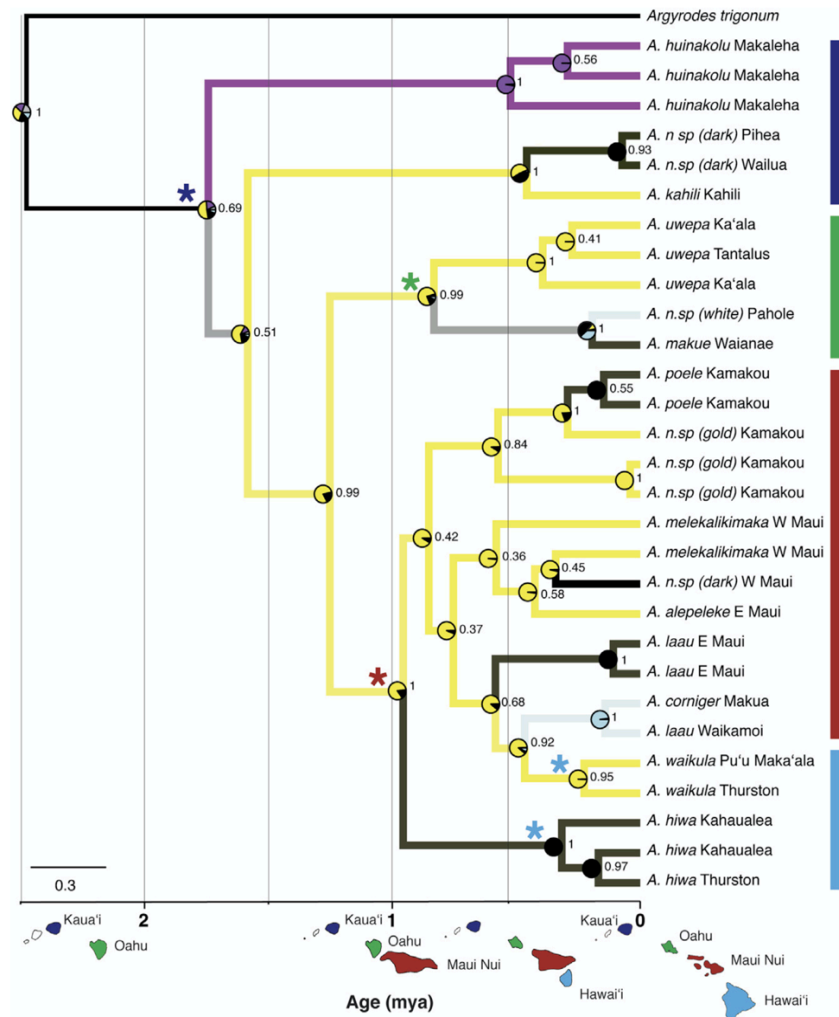


Figure 3. Dated Phylogeny of Hawaiian *Ariamnes* to Show the Time of Divergence Relative to the Age of the Islands

Vertical color bars on the right indicate island: dark blue, Kauai; green, Oahu; red, Maui Nui; light blue, Hawaii. Island arrangements at 2.5, 1.0, 0.5, and 0 mya are shown on the x axis (adapted from [15]). As indicated, both Kauai and Oahu were likely to have been large islands by the time the group reached the islands. Stars indicate colonization of the different islands. Colors of branches indicate ecomorphs (matte white, dark, and gold); purple indicates the unique short-bodied form on Kauai. The likelihood of each ecomorph is indicated at the nodes based on the best-fitting model of equal rates. See also Figures S2 and S3.

Spider Pigmentation

The shiny gold color, as well as the superimposed red marks, can be readily understood in terms of what is known of spider pigmentation, which is frequently the result of patterns of yellow, red, and black ommochrome pigments that are responsible for a wide variety of colors, including gold, red, violet, and black. Ommochromes are deposited in pigment granule cells that overlay a reflective background of crystals. The combination of all pigments yields a gold color.



Anole Ecomorphs

[Source](#)



Caribbean anoles can be categorized into six groups according to their body characteristics(morphology) and the ecological niches they occupy. The groups are referred to as ecological morphotypes, or ecomorphs. For example, the grass-bush anoles live on grass and small bushes, and typically have long legs and strikingly long tails that help them balance on thin branches and blades of grass.

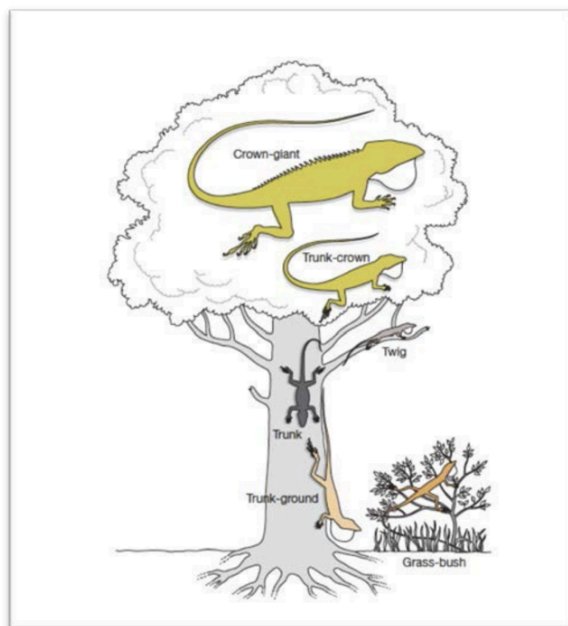


Figure 2: Anoles occupy a variety of ecological niches. Different types of anole lizards have evolved adaptations that enable them to be successful in different ecological niches—different parts of trees, grasses, and bushes. The figure shows the six ecomorphs of anole lizards found on the Caribbean islands in their habitats. (Reproduced with permission from Losos, J. *Lizards in an Evolutionary Tree*. UC Press, 2011).

Table 1 below lists the six anole ecomorphs found on the Caribbean islands and their body features.

Table 1: Six Ecomorphs of Anole Lizards Found in the Caribbean Islands.

Ecomorph	Body length	Limb length	Toepad lamellae*	Tail length	Color	Habitat
Crown-giant (canopy)	130-191 mm	Short	Large	Long	Usually green	High trunks and branches
Trunk-crown	44-84 mm	Short	Very large	Long	Green	Trunks, branches, leaves
Trunk	40-58 mm	Intermediate	Intermediate	Short	Gray	Trunks
Twig	41-80 mm	Very short	Small	Short	Gray	Narrow twigs
Trunk-ground	55-79 mm	Long	Intermediate	Long	Brown	Lower trunk and ground
Grass-bush	33-51 mm	Long	Intermediate	Very long	Brown	Bush and grasses

*Lamellae are scales found on the lizards' toepads. In general, the greater the number of lamellae, the larger the toepad.

More than 400 species of anoles have been described worldwide, and about 150 of them are found on the Caribbean islands. In the Caribbean, the number of species on any particular island is roughly related to its size. Cuba, the largest island, has 63 species, and Hispaniola, the second largest, has 41. Many of the species on each island fall into one of the six ecomorphs listed below in Table 2. Note that not all the islands have species that belong to each of the six ecomorphs.

Table 2: Ecomorphs Found on Each Caribbean Island.

Ecomorph	Crown-giant	Trunk-crown	Trunk	Twig	Trunk-ground	Grass-bush
Island						
Cuba	✓	✓	✓	✓	✓	✓
Hispaniola	✓	✓	✓	✓	✓	✓
Puerto Rico	✓	✓		✓	✓	✓
Jamaica	✓	✓		✓	✓	

SPOILER ALERT: Do not read the following before constructing your argument (ECR)

[Hawaii: Where Evolution Can Be Surprisingly Predictable](#) - The Atlantic, March 8, 2018

Repeated Diversification of Ecomorphs in Hawaiian Stick Spiders

<https://www.sciencedirect.com/science/article/pii/S0960982218301490>