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The Status of *Argiope trifasciata kauaiensis* (Araneae: Araneidae) on Kaua‘i, Hawai‘i

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Argiope trifasciata (Forsskål), the banded garden spider (Fig. 1), is an orb weaver found over much of the Earth — common in the Americas, Australia, northern Africa, and the Iberian Peninsula, but not reported from other parts of Europe and Japan. In 1900, on an expedition by the Royal Society of London to Kaua‘i in the Sandwich Islands (Hawaiian Islands), a female *Argiope* was collected and was described in *Fauna Hawaiiensis* by Simon as *Argiope avara kauaiensis*. Although females are quite common, no males were collected at that time — or at any time since. As a consequence, there are no male specimens of the species from Kaua‘i in any of the major museums (Bishop Museum, American Museum of Natural History, British Museum, etc.). Without seeing the male, Levi (1983: 286) synonymized this species with the widespread *Argiope trifasciata*.

Figure 1. Habitus of female *Argiope trifasciata* (Forrskål) from Kaua‘i.

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Figure 2. Habitus of male *Argiope trifasciata* (Forsskål) from Kaua‘i.

Kaua‘i, the second oldest of the main Hawaiian Island chain at 4.7 my (Clague, 1996), comprises 552 square miles (331 km^2) of varied volcanic island topography. Its elevations range from sea level to Kawaikini Peak at 5148 ft (1569 m). Recently, Spagna *et al*. (2015) noted that percent endemism increases monotonically with increasing elevation which reinforced the authors' decision to search the higher elevations of Kaua‘i intensively for the never-described male *Argiope trifasciata kauaiensis*. In more than 25 years of collecting experience on Hawai‘i Island, Kaua‘i, and to a lesser extent O‘ahu and Maui, the authors have collected no *Argiope trifasciata kauaiensis,* and only one specimen of *Argiope trifasciata* outside the higher elevations of Kaua‘i. *Argiope appensa* (Walckenaer) is commonly collected in all the above counties.

The reproductive organs of the *Argiope* females are sufficiently generalized that correct identifications to species-level are difficult. Significantly, the Kaua‘i females have some morphological differences from specimens of *Argiope* found in other locations in the world. Levi (1983) concluded, based on the information available at that time, that the specimens found on Kaua‘i represented only a color morph and were treated as *A. trifasciata.* Levi did not examine Simon's 1900 *Argiope avara kauaiensis* specimen; however, it appears he did examine other *Argiope trifasciata* specimens from the Bishop Museum. The late Dr. Joseph Beatty (pers. comm.), after observing the Kaua‘i females in their environment, believed that they were sufficiently different to merit raising them to *Argiope kauaiensis.* Suman (1964), who also had the opportunity to see this species in Hawai‘i, listed it as *kauaiensis* in his catalog of Hawaiian spiders.

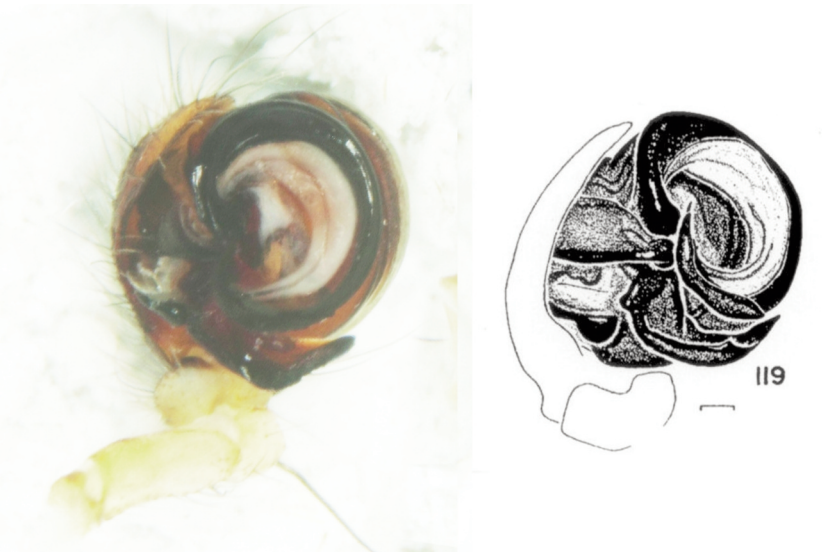

Figure 3. Comparisons of male pedipalps of *Argiope trifasciata* (Forsskål). (Left) Kauai specimen; (Right) from Levi (1983). Courtesy of Museum of Comparative Zoology, Harvard University.

METHODS

We made a collecting net (60 x 45 x 45 cm) from stiff wire, cloth netting, and a bamboo pole 4 m long. The long pole was required because the webs of this spider are usually 3–4 m above the ground. In searching for specimens, we walked the trails of the Koke‘e State Park (21.930°N, 159.605°W), Waimea Canyon State Park, and private land, such as the Kahili Mountain Trail (21.96328°N, 159.48661°W) at Kahili Mountain Park for almost three weeks. The first male and female found were kept alive and observed for a day or so, photographed (Figs. 1, 2), then preserved in 70% ethanol. Collection permits were obtained from the Hawaii Department of Land and Natural Resources (Division of Forestry and Wildlife; and the Division of State Parks), and the Natural Area Reserves System. Vouchers of specimens will be deposited in the Bishop Museum, Honolulu.

RESULTS

The sexes: To date, we have collected many adult females but only three mature males. Upon microscopic examination, we determined that the palp of the Kaua‘i male was identical (Fig. 3) to the palp of *Argiope trifasciata* from other locations as illustrated by Levi (1983), but various characteristics of the Kaua‘i female are different. Normally, the determination that the Kaua‘i male is similar to those of other locations would settle the question — the Kaua‘i *Argiope* is *A. trifasciata* — but when we look at the habitus of the female, we see a somewhat different picture. We found a male in the web (about 4 m above the ground) with a female, so there is little doubt that the male and female are paired correctly. More recently (December 2015), we collected another male, also in the female’s web.

Female shape and color: Normally species are not described based on color, but it should be taken into consideration. Conspicuous grey hairs on the dorsal side of the cephalothorax cause local residents to refer to them as the "spooky spider" or the "large grey spider." Simon (1900) eloquently and accurately described the Kaua'i female — including the almost round, marble-like abdomen (Fig.1). Kaston (1952) said that *A. trifasciata* has a more pointed abdomen. Levi (1983) said that "the dorsum of the abdomen is black with a light anterior resembling *Argiope bougainvilla (*Walckenaer*)* from the Solomon Islands and *Cyrtophora moluccensis* (Forsskål).

Female web location: Females are frequently found on webs built high above the ground, often between high tension power wires at 10–12 m or stretched between leafless limbs. At the very top of knife-edge ridges, they can be found in webs that are 2–5 m above the ground and continuously exposed to strong winds blowing up the ridge —estimated at 30 kph (20 mph), but they seem to be able to withstand the winds without damage.

Elevation: In 1988, we found one male that we identified as *Argiope trifasciata* in a Kaua'i orchard at 30m elevation. At the time, we assumed it to be the male of the widespread and characteristic *Argiope trifasciata*. A male found recently with the Kaua'i female was at 381 m elevation. Most of the potential *kauaiensis* specimens have been found at elevations from 400–1000 m. In some locations at high elevation (~1000 m), they are fairly common. Recently one of us (AW) collected a mature male and saw several apparently mature males and females at 760 m elevation along the Na Pali coast. At the Circle Bog in the Alaka'i Swamp (1300 m), metallic blue-black females were readily found.

Egg case: Bradley (2013) stated that *A. trifasciata* typically has a cream-colored egg case, but we have found about a dozen empty egg cases that were green.

Season: It appears that *A. trifasciata kauaiensis* is present year-round. We have taken adult females from January to April and September to October, and three adult males in February, September and December. According to Bradley (2013), in North America, males are present summer through autumn, females from late summer throughout November.

Material examined. HAWAIIAN ISLANDS: **Hawai'i**: Route #130, mile marker 88; tree shaking, 1 Feb 1997, J.W. & E.R. Berry, 1 male. **Kaua'i**: Kapa'a, Kawaiha'a Road, in orchard, 12 Jan 1988, J.W. Berry, 1 male; Koke'e State Park, Mohihi Road, in overhead power lines, elev. 3500 ft [1067 m], 31 Jan 1998, J.W. & E.R. Berry, 1 female; Kahili Mountain Trail, N21.96379°, W159.48758°; elev. 1250 ft [381 m], 20 Feb 2014, 1 male, 1 female; on road bank N22.128, W159.643; elev. 3500 ft [1067 m], 23 Feb 2014, J.W. & E.R. Berry, 3 females; Alaka'i Swamp, Circle Bog, N.22.124°, W159.877°, 27 Feb 2014, J.W. & E.R. Berry and Adam Williams, 1 immature specimen (~3-4 instar); Alaka'i Swamp, Circle Bog, N22.124°, W159.877°, elev. 4369 ft [1332 m], 27 Feb 2014, J.W. & E.R. Berry and Adam Williams, 1 female; MICHIGAN: Livingston County: E.S. George Reserve, Grids L, K + J-15, 12 Aug 1954, H.K. Wallace, 3 males, 2 females; same data, 22 Aug 1954, H.K. Wallace, 1 male.

DISCUSSION

Simon (1900) was probably correct when he listed the Kaua'i *Argiope* as a subspecies; and, as the World Catalog of Spiders (2017) accepts *Argiope trifasciata kauaiensis*, it is unnecessary for us to make any taxonomic changes at this time. Whether or not the female morphological changes signal some genetic drift toward speciation will probably be determined only by future DNA work.

At this point we have more questions than answers. What has pushed the species to very high elevations? How does one account for the high numbers at high elevations? Why are the males so rare?

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