



## INTRODUCED SPECIES

# Preliminary Dietary Analysis for the Non-indigenous Oustalet's Chameleon, *Furcifer oustaleti* (Mocquard 1894) (Squamata: Chamaeleonidae), in Southern Florida

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Oustalet's Chameleon, *Furcifer oustaleti* (Mocquard 1894) (Squamata: Chamaeleonidae), is indigenous to Madagascar (Henkel and Schmidt 2000). This species is found in a variety of dry and humid habitats, including montane wet savannas, deciduous dry forests, tropical rain-

forests, degraded habitats, and inside villages and cities, but is often rare in primary forests (Glaw and Vences 2007). It is one of the largest extant chameleons, growing to 700 mm total length (Henkel and Schmidt 2000). This species has been introduced to southern Florida, USA, where it has



An adult male Oustalet's Chameleon (*Furcifer oustaleti*) on an Avocado Tree (*Persea americana*). Photograph by Kenneth L. Krysko.



An adult female Oustalet's Chameleon (*Furcifer oustaleti*) sleeping in an Avocado Tree (*Persea americana*). Photograph by Kenneth L. Krysko.



An adult female Oustalet's Chameleon (*Furcifer oustaleti*) on an Avocado Tree (*Persea americana*). Photograph by Kevin M. Enge.

been established for more than a decade (Gillette et al. 2010). In its native range, *F. oustaleti* has been reported consuming insects (Spawls et al. 2004), birds (Garcia and Vences 2002), and fruits (Takahashi 2008). Other than its establishment, nothing is known about its natural history in Florida. In this paper, we document a preliminary diet analysis for this non-indigenous species in Florida.

#### Materials and Methods

On 29 November at 1900–2200 h and on 30 November 2011 at 1900–2130 h, four and five people, respectively, conducted night-time surveys for *Furcifer oustaleti* within the extensive Avocado (*Persea americana*) groves reported by Gillette et al. (2010) in Florida City, Miami-Dade County, Florida. We surveyed only a very small section extending from the northwest (25.42936°N, 80.513542°W, WGS84; elev. < 2 m), northeast (25.42936°N, 80.505462°W), southwest (25.428026°N, 80.513509°W), and southeast (25.428036°N, 80.505473°W). Like other introduced species of chameleons in Florida (e.g., Veiled Chameleon, *Chamaeleo calyptratus*; see Krysko et al. 2004), diurnally active species such as *Furcifer oustaleti* are extremely difficult to detect among vegetation during the day. At night, however, these lizards turn lighter while sleeping and perched above ground

on tree branches and other vegetation. Chameleons are easy to detect at night using bright flashlights and headlamps, because light reflects off the lizards' scales causing them to shine brightly. Captures were made by hand and chameleons were euthanized humanely within four hours after capture. Voucher specimens and photographs were deposited in the Florida Museum of Natural History (FLMNH), University of Florida (UF collection). Specimens were sexed, measured to the nearest mm ( $\pm 0.02$  mm) using digital calipers, and stomachs were dissected for dietary data. Tissue samples for genetic analyses were taken from some specimens before ultimately being either fixed in 10% formalin and subsequently preserved in 70% ethanol, or prepared as articulated skeletons. We identified consumed items at least to Order. Statistical analyses were performed using SigmaStat (ver. 3.5). For all tests,  $\alpha = 0.05$ . Means are reported  $\pm$  one standard error.

#### Results

On the first night, we found 16 *Furcifer oustaleti*, of which 12 were collected (UF 166074–85). On the second night, we found 30, of which 27 were collected (UF 166086–91, 166093–113). Our specimens represented juveniles and adults of both sexes. Seven *F. oustaleti* were not collected because they were too high in trees. Two specimens (UF



Oustalet's Chameleon (*Furcifer oustaleti*) on an Avocado Tree (*Persea americana*). Photograph by Joseph A. Wasilewski.

166091 and UF 166105) were not dissected for dietary items and not used in our analyses.

Of our analyzed sample of 37 *Furcifer oustaleti*, males (SVL range = 11.23–26.98 mm, mean = 18.69 ± 1.08 mm, N = 22) were significantly larger (Mann-Whitney Rank Sum, T = 216.00, P = 0.034) than females (SVL range = 9.02–22.07 mm, mean = 14.81 ± 0.83 mm, N = 15). However, all *F.*



Cuban Brown Anoles (*Anolis sagrei*) are prey of Oustalet's Chameleons (*Furcifer oustaleti*) in southern Florida. Photograph by Kenneth L. Krysko.



Group photo with 27 Oustalet's Chameleons (*Furcifer oustaleti*) collected on 30 November 2011. Photograph by Joseph A. Wasilewski.

*oustaleti* examined contained at least one food item, although all items were not identifiable because of extensive digestion.

We found at least six different consumed items (Table 1), including four invertebrates (likely all native except for one non-indigenous snail; excluding potentially the same taxa), one vertebrate (non-indigenous), and one plant (non-indigenous). Imperial Moth (*Eacles imperialis*) and other moth larvae were the most frequently consumed invertebrates. One *Furcifer oustaleti* (UF 166101) contained three *E. imperialis*, one geometrid moth larva, and a non-indigenous Asian Tramp Snail (*Bradybaena similaris*). Two *F. oustaleti* (UF 166075 and UF 166110) contained as many as three items, but they were all either *E. imperialis* or Brown Anoles (*Anolis sagrei*), respectively. Five *F. oustaleti* contained Avocado (*Persea americana*) leaf/stem fragments, but we believe that these items were ingested inadvertently when consuming live animal prey and are not included in statistical analyses. Two *F. oustaleti* (UF 166081 and UF 166087) contained an unidentified item(s) that caused their stomach lining and contents, and subsequent ethanol preservative, to turn purple.

*Furcifer oustaleti* containing multiple items (SVL range = 12.02–26.00 mm, mean = 16.69 ± 1.43 mm, N = 11) were not significantly larger (Mann-Whitney Rank Sum, T



A Knight Anole (*Anolis equestris*) sleeping on an Avocado Tree (*Persea americana*). Photograph by Kenneth L. Krysko.

= 149.50,  $P = 0.05$ ) than individuals with a single item (SVL range = 12.19–26.98 mm, mean = 17.91 ± 1.11 mm, N = 18). *Furcifer oustaleti* containing multiple taxa (SVL range = 12.02–15.30 mm, mean = 13.90 ± 0.70 mm, N = 4) were not significantly larger (Mann-Whitney Rank Sum, T = 34.00,  $P = 0.107$ ) than individuals with a single taxon (SVL range = 12.19–26.98 mm, mean = 18.02 ± 0.96 mm, N = 25).



Imperial Moth (*Eacles imperialis*) larva on an Avocado Tree (*Persea americana*). These larvae are a seasonally abundant food item of Oustalet's Chameleon (*Furcifer oustaleti*) in southern Florida. Photograph by Kevin M. Enge.

**Table 1.** Preliminary dietary analysis of the non-indigenous Oustalet's Chameleon (*Furcifer oustaleti*) in southern Florida. Non-native species are marked with an asterisk (\*). Snail taxonomy follows Bouchet et al. (2005).

Content	N	Voucher	Sex	SVL (cm)
Imperial Moth larva ( <i>Eacles imperialis</i> , Saturniidae)	1	UF 166074	Male	21.29
	3	UF 166075	Female	16.73
	1	UF 166076	Male	26.98
	1	UF 166077	Male	14.51
	2	UF 166078	Male	12.94
	1	UF 166083	Male	21.35
	1	UF 166086	Male	22.10
	2	UF 166088	Male	21.48
	1	UF 166089	Female	16.21
	1	UF 166090	Male	14.65
	1	UF 166097	Female	19.58
	1	UF 166099	Male	15.48
	1	UF 166100	Female	12.19
	3	UF 166101	Male	15.30
	1	UF 166102	Female	12.02
	1	UF 166103	Male	24.72
	2	UF 166104	Female	12.88
	2	UF 166108	Male	26.00
	1	UF 166111	Female	13.77
	2	UF 166113	Male	23.50
Geometrid Moth larva (Geometridae)	1	UF 166101	Male	15.30
Unidentified moth larva	1	UF 166102	Female	12.02
	1	UF 166080	Male	12.38
	1	UF 166085	Male	22.98
	1	UF 166094	Male	15.97
	1	UF 166095	Male	12.81
	1	UF 166096	Female	22.07
	1	UF 166106	Male	12.94
Grasshopper (Orthoptera)	1	UF 166087	Female	13.03
	1	UF 166112	Female	15.76
Unidentified winged insect	1	UF 166111	Female	13.77
Asian Tramp Snail* ( <i>Bradybaena similaris</i> , Bradybaenidae)	1	UF 166101	Male	15.30
Cuban Brown Anole* ( <i>Anolis sagrei</i> , Dactyloidae)	1	UF 166077	Male	14.51
	3	UF 166110	Female	14.48
Avocado* (leaves/stem) ( <i>Persea americana</i> , Lauraceae)		UF 166080	Male	12.38
		UF 166083	Male	21.35
		UF 166085	Male	22.98
		UF 166102	Female	12.02
		UF 166113	Male	23.50
Unidentified item(s)		UF 166079	Male	22.39
		UF 166081	Female	9.02
		UF 166082	Female	17.26
		UF 166084	Male	16.36
		UF 166093	Female	14.13
		UF 166098	Female	13.12
		UF 166107	Male	11.23
	UF 166109	Male	23.99	



A Cuban Treefrog (*Osteopilus septentrionalis*) in southern Florida. Photograph by Christopher R. Gillette.

Other non-indigenous herpetofaunal species observed during our searches were the Cuban Treefrog (*Osteopilus septentrionalis*), Cuban Brown Anole (*Anolis sagrei*), and Knight Anole (*Anolis equestris*).

#### Discussion

Most *Furcifer oustaleti* were found by two individuals, suggesting that the quality of headlamps or flashlights as well as having a well-developed search image are major factors in finding chameleons. Despite euthanizing specimens within a few hours after collection, we were not able to identify all food items. At least some of that might be attributable to chameleons consuming much of their daily prey early in the day, similar to observations of diurnally active anoles (R. Powell, pers. commun.). Regardless, waiting longer likely would have allowed further digestion and prevented identification of even more dietary items.

Our dietary study should be viewed as preliminary because sampling was conducted during a very limited time of year, and available prey items (i.e., caterpillars) are seasonal. However, adult *Eacles imperialis* are recorded from April through November in Florida, and geometrids (ca. 260 species) are found throughout the year (Tuskes et al. 1996, Heppner 2007).

Although our sample size was small, larger *Furcifer oustaleti* appear to have the ability to consume a single larger item (i.e., large *Eacles imperialis* larva) than smaller chameleons

(e.g., UF 166101) that consumed multiple smaller items. Of the two *F. oustaleti* that contained an unidentified item(s) that caused the stomach lining and contents, and subsequent ethanol preservative, to turn purple, one (UF 166087) also contained parts of a grasshopper, but we are uncertain if this or some other ingested item caused the purple coloration.

Florida has the largest number of introduced and established herpetofaunal species in the world (Krysko et al. 2011). Many introduced species are considered invasive when they have either widely distributed populations (Colautti and MacIsaac 2004) or cause harm to the environment, economy, or human health (Executive Order 13112, Invasive Species Advisory Committee 2006; Kraus 2009). Over 99% of Florida's Avocado groves are in southern Miami-Dade County (Palmateer 2009), and potential impacts of the *Furcifer oustaleti* population on native herpetofauna in these groves are probably minimal.

*Furcifer oustaleti* is not only firmly established in parts of southern Florida, but native *Eacles imperialis* and other moths were the most frequently consumed items found in this study during our short sampling period. These native moth larvae are feeding on non-indigenous Avocado leaves (host plant), but insect pests seldom affect fruit production significantly (Crane et al. 2007). If fruits are not present, an Avocado tree can sustain at least 40% defoliation of its canopy (Palmateer 2009). At least one geometrid moth larva was eaten; several geometrid species of Loopers affect Avocados in Florida, and

the Avocado Looper (*Epimecis detexta*) has been considered a pest in Florida since 1985 (Glenn et al. 2003). Defoliation and fruit damage by Loopers is sporadic, but defoliation in

2002–2003 required several insecticide applications (Peña 2003). Infestation levels of Looper larvae are highest during spring and summer (Peña and Johnson 2001, Palmateer



The threat display of a male Oustalet's Chameleon (*Furcifer oustaleti*). Photograph by Christopher R. Gillette.

2009). Determining whether *F. oustaleti* consume Looper larvae during that time of year would be interesting. Several attempts to introduce exotic biological control agents for Loopers have failed in Florida (Peña 2003), and *F. oustaleti* may represent an inadvertent biological control agent.

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