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LIFE HISTORY AND IMMATURE STAGES OF A PLUME MOTH *SPHENARCHES ANISODACTYLUS* (LEPIDOPTERA: PTEROPHORIDAE) IN FLORIDA

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Abstract

The life history of *Sphenarches anisodactylus* (Walker) in Florida is presented. Descriptions and durations of life stages are given and bionomics relative to the Florida host, *Thalia geniculata* (Marantaceae) are discussed. Development time of laboratory

reared individuals from oviposition to adult emergence was 21.8 days for males and 22.5 days for females. There are four larval instars. Adults lived 14-19 days.

RESUMEN

Se presenta el ciclo biológico de *Sphenarches anisodactylus* (Walker) en Florida. Se proprcionan descripciones y duraciones de los diferentes estadíos; se discute la bionómica relativa al hospedero de la Florida, *Thalia geniculata* (Marantaceae). El tiempo de desarrollo de los individuós bajo condiciónes de laboratorio, desde oviposición hasta el estado adulto, fue de 21.8 días para machos y 22.5 días para hembras. Las larvas pasan por 4 estadíos. Los adultós vivieron de 14 a 19 días.

The Pterophoridae, or plume moths, are a mostly inconspicuous group of approximately 600 species worldwide (Stanek & Turner 1977). Twenty genera and 146 species have been identified from North America (Munroe 1983) with 29 species occurring in Florida (Kimball 1965). Plume moths are leaf skeletonizers, flower feeders or stemborers. Neunzig (1987) summarized information on pterophorid larvae and illustrated seven species. Immature stages of most North American plume moth species are unknown. There are several species of economic importance in the United States some occasionally causing serious damage. The most important of these is the artichoke plume moth, *Platyptilia carduidactyla* Riley, which is a pest of cultivated globe artichokes in California (Lange 1950). More biological information is available on this species than any other pterophorid in North America.

During a survey of insects occurring on the host plant *Thalia geniculata* L., a pterophorid larva was discovered feeding on the flowers. Reared adults were identified as *Sphenarches anisodactylus* (Walker) based on comparison of genitalia with the illustrations in Adamczewski (1951) and Yano (1963) as well as with identified material in the United States National Museum (USNM). Our larval material from *T. geniculata* is also identical to preserved USNM specimens from pigeon pea (*Cajanus cajan*) and matches illustrations and descriptions by Yano (1963) and those by Cotes (1891) under the name *Sphenarches caffer* (Zeller).

Larvae of *S. caffer* were reported tunneling in pods of *Dolichos lablab* in India (Cotes 1891). Walsingham, who identified Cotes' specimens, gave the distribution as West Africa (on "calabash"), Australia, Asia, as well as New Hebrides and Tonga Island in the Pacific (Cotes, 1891). Yano (1963) reports two varieties of calabash as hosts, *Lagenaria leucantha* Rosby var. *clavata* and *gourda*. Forbes (1930) listed it as generally occurring in the Old World tropics and reported *Caperonia* and pigeon pea as hosts in Puerto Rico and the West Indies. Bruner et al. (1975) listed it as a pest of pigeon pea in Cuba.

The most recent revisionary study which included this genus is Adamczewski (1951). Prior to Adamczewski's work, authors including Cotes (1891), Walsingham (1897), Meyrick (1910), and Forbes (1930), treated *S. anisodactylus* (Walker) 1864 as a synonym of *S. caffer* (Zeller) 1852). Although the name *caffer* is older, Adamczewski applies the name *anisodactylus* to all the records, specimens, and biological information previously considered under *caffer*. Without having examined Zeller's holotype of *caffer* (located at the Stockholm Museum, Sweden) he applied the name *caffer* to a single male specimen from Natal, considering it a topotype of *caffer*. Although we suspect *anisodactylus* is indeed a synonym of *caffer*, until all the types can be examined we must use the name *anisodactylus* according to Adamczewski.

Sphenarches anisodactylus is previously unreported from the United States. The only other *Sphenarches* in North America is *S. ontario* (McD.), which occurs in Ontario,

Canada (McDunnough 1927). While the life history of *S. anisodactylus* is known from leguminous hosts in the tropics, the following gives a detailed account of the life history on a completely unrelated host. In this case, both host and insect range from the tropics of extreme south Florida, to the more temperate areas of central and northeast Florida.

Materials and Methods

Field observations of *S. anisodactylus* on *Thalia* were made at least monthly from May 1979 to August 1980 and periodically thereafter through 1983 at three locations in Lee County, Florida. Other collections were made in Glades, Collier, Hendry, Broward and St. Johns counties. Field observations were made to determine seasonal occurrence and general abundance as related to host plant condition and flowering.

Sphenarches anisodactylus was also studied in the laboratory during 1982 to determine life stage characteristics and related behavior. During October 1982, 25-30 field collected pupae were returned to the laboratory and placed in a one cubic foot cage in a covered outdoor area. Emerging adults were provided with honey water and allowed to mate for an 8-12 day period. After mating, 5 females and 3 males were brought into the laboratory and held individually in plastic cylinders (22 cm high, 11 cm wide) with screened tops to determine longevity and fecundity. Females oviposit primarily on flower buds. A fresh flower bud was provided daily to each female and the number of eggs oviposited was recorded. Mean maximum and minimum temperatures in the laboratory during the study were 25.2 ± 0.6 and 23.4 ± 0.8. The photoperiod was maintained at 12 h for specimens held inside the laboratory.

The remaining adults were held together in the emergence cage in the laboratory. Fresh flowers for oviposition were provided as needed. After oviposition, 15 eggs, all oviposited on the same day, were removed with a camel hair brush and each placed on individual flowers in clear plastic dishes (8.8 cm diameter; 1.8 cm deep) to determine instar duration. A square (4 cm x 4 cm) piece of paper towel was moistened and placed in each dish to maintain humidity. After eclosion, a fresh flower and clean paper were provided daily.

Another group of 100-150 eggs were held together in an aluminum pan (22 cm diameter; 3.8 cm deep) with a glass cover and fresh flowers provided as needed to feed emerging larvae. The larvae from pan held eggs as well as some field collected larvae were used for head capsule measurements and overall body length. All measurements of larvae were based on specimens killed in boiling water and preserved in 70% ethyl alcohol. Head capsule measurements were made using a dissecting microscope equipped with a calibrated ocular grid. Most measurements were made at 40X. Adult measurements were made on pinned specimens. In larval and pupal descriptions, thoracic and abdominal segments are designated by the prefix T and A, respectively, followed by the segment number i.e. T1, A4, etc. General setal nomenclature follows Stehr (1987). Setal nomenclature of the labrum follows Heinrich (1916).

Description of Life Stages

Egg. (Fig. 1). Eggs are greenish white initially, later becoming pale amber. Egg shape is elongate-oval with a mean length and width of 0.48 mm ± 0.02 mm and 0.31 mm ± 0.01 mm respectively (n = 20). The chorion surface appears smooth but SEM examination at 160X reveals regular patterns of hexagonally arranged aeropyles. Chorionic ridges are absent. At magnification over 1500x, the surface appears rough and scaly. The micropyle is a pore-like opening at one end, which is slightly ribbed and surrounded by outwardly radiating ridges.

Larva. (Figs. 2-5). Early first instar larvae are pale green. Older larvae (instars 2-4)

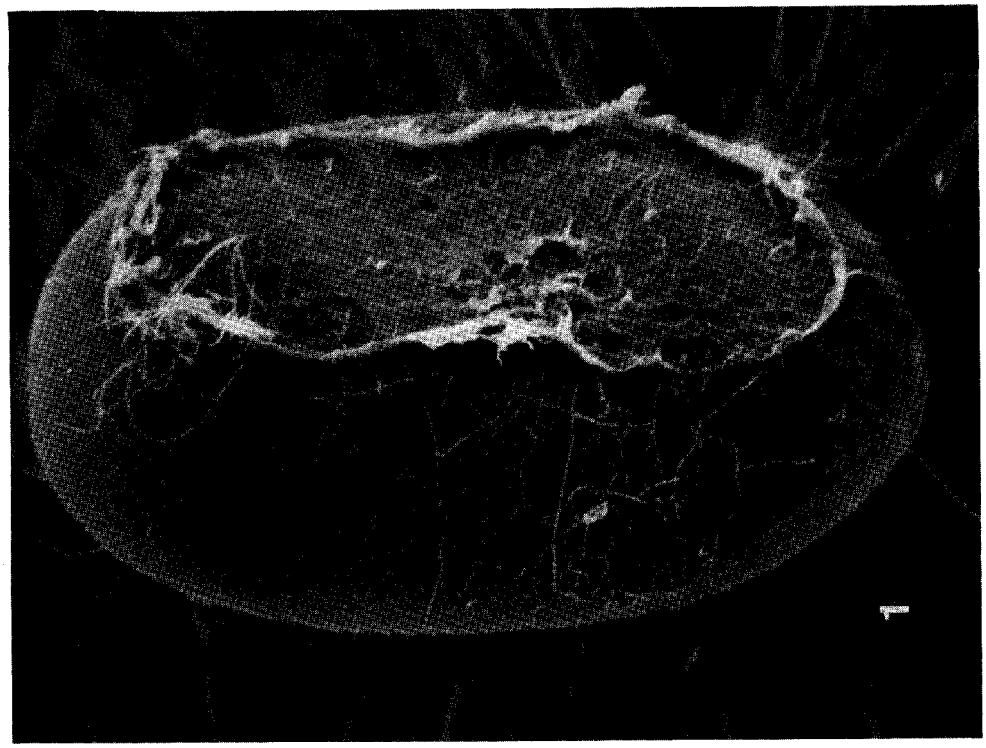

Fig. 1. *Sphenarches anisodactylus* ova: scanning electron micrograph at 160x. Debris of surface outlines zone of attachment to host plant.

usually become the color of the plant tissue they have been feeding on. Larvae that feed heavily on flower petals are distinctly rose purple while those that feed on the ovary or bracts are green. Mature larval length: 10-11 mm. Generally, the prepupa becomes pale green as feeding ceases. The following description is based on mature larvae.

Head. (Fig. 3). Hypognathous. Six stemmata with stemma 6 equidistant to 4 and to 5, stemma 4 and 5 usually closer to each other than to 3 or 6. Seta S1 posterior to stemma 2 and equidistant between stemma 1, 3, and 6. S2 posterior to stemma 1, seta base similar distance from stemma 1 as stemma diameter. S3 ventral to stemma 6 and posterior to stemma 5, slightly closer to stemma 6. Mandibles with five teeth (Fig. 4). Labral notch V-shaped extending 1/3 of way to base. Adfrontals reach epicranial notch; frontoclypeus extends 3/4 way to epicranial notch. F1 setae distinctly above Fa punctures, AF2 setae slightly posterior of P2 setae and about halfway between front and epicranial notch. AF1 seta slightly anterior to P1 seta. Labrum with seta M2 directly dorsal of M3. Seta M1 slightly ventral to M2. Seta L2 near ventral margin, L1 and L3 more dorsal and along lateral margin.

Thorax. Prothoracic shield sometimes with dark indentation between D1 and D2 setae; narrow dark margin along light mid-dorsal stripe. XD2 about equidistant from XD1 and SD1. D1 and SD2 setae spatulate. L group trisetose with posterior seta spatulate. SV group bisetose. Spiracle conical with collar-like sclerite.

T2 and T3 with trisetose L group on same pinaculum; L3 spatulate and less than 1/2 length of L1 and L2, SV bisetose, D1 spatulate, D2 slightly posterior and ventrad, D2 on T3 less than 1/3 length of D2 on T2. SD1 and SD2 on same pinaculum, SD2 spatulate and 1/3 length of SD1 on T3, 2/3 length SD2 on T2. Four to five short capitate setae on edge of or near D pinaculum. One short capitate seta behind D pinaculum 1/2 way

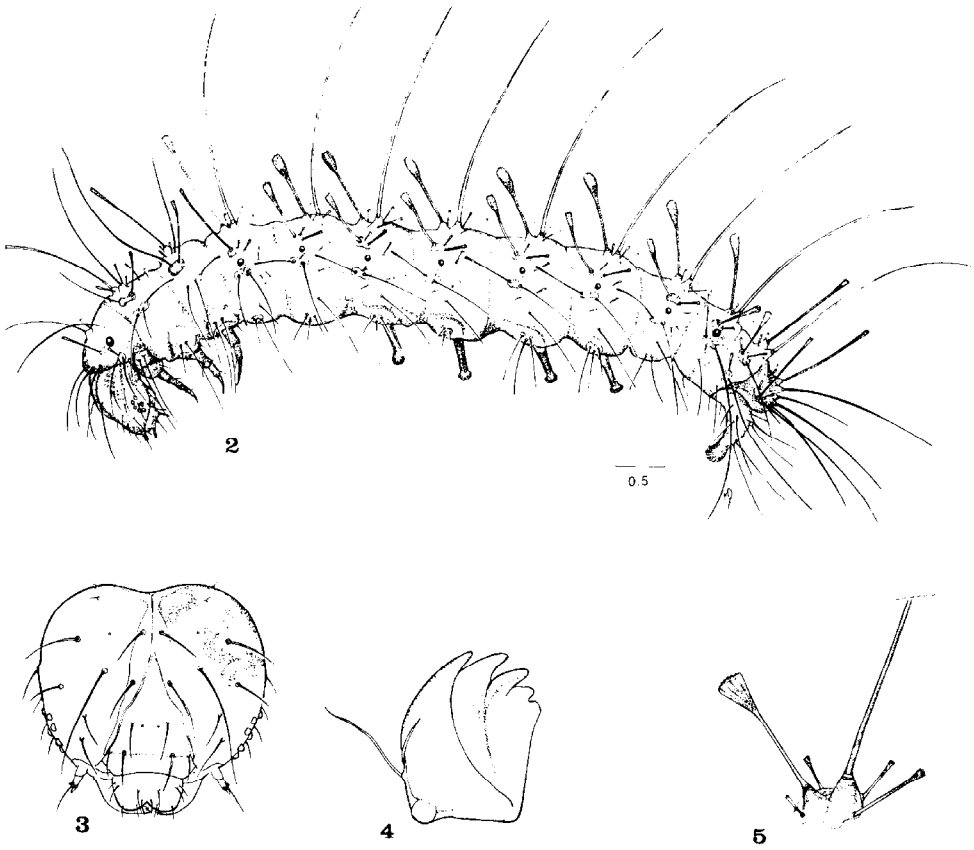

Fig. 2-5. *Sphenarches anisodactylus* mature larva: 2. larva; 3. head; 4. mandible; 5. dorsal pinaculum on A6.

between pinaculum and posterior margin of segment. T2 with about 8 very short capitate setae along posterior margin of segment.

Abdomen. Scattered very short capitate secondary setae on abdominal segments. D1 and D2 pinacula fused (Fig. 5) but with a furrow between setae, D1 spatulate extending anteriorly, D2 twice as long as D1, 1-4 short capitate setae on edge of common pinaculum. SD setae spatulate on a common pinaculum; A1-A7 with SD2 1/3 to 1/2 length of SD1 and less broadly spatulate; A8 with SD2 minute and capitate. One small capitate seta directly posterior to SD pinacula on A1-A7 but not on A8. SD pinacula on A2-6 with a short capitate seta between SD setae. L1 and L2 pinacula joined, slightly further from spiracle than SD pinaculum on A1, equidistant on A2; closer to spiracle than SD pinacula on A3-8. A1-8 with L3 remote, 1 1/2 to 2x as far from L1 and L2 than from SV pinaculum. L1 and L2 horizontally arranged on A8, a small capitate seta posterad on a pinaculum. SV group bisetose on A1, A7, trisetose on A2-6, unisetose on A8. V1 small, midventral distance between about 1/2 distance to SV on A1. 2 V1 near base of proleg on A3-6. Anal shield with 8 pair of setae, the most anterior and lateral pair spatulate. Anal proleg with at least 9 setae, slightly less peg-like than abdominal prolegs. Prolegs on A3-6 long and peg-like about 4X longer than wide. Seven to nine crochets in a uniordinal mesopenellipse, broadly open laterally.

PUPA. (Figs. 6-7). Length about 9 mm. Pale green initially, later becoming brown. Body surface except posterior 1/3 to 1/2 of A3/7 finely shagreened with thin transverse striations. Labial palps small. Maxilla 3/4 length of T1 legs. Antenna nearly as long as

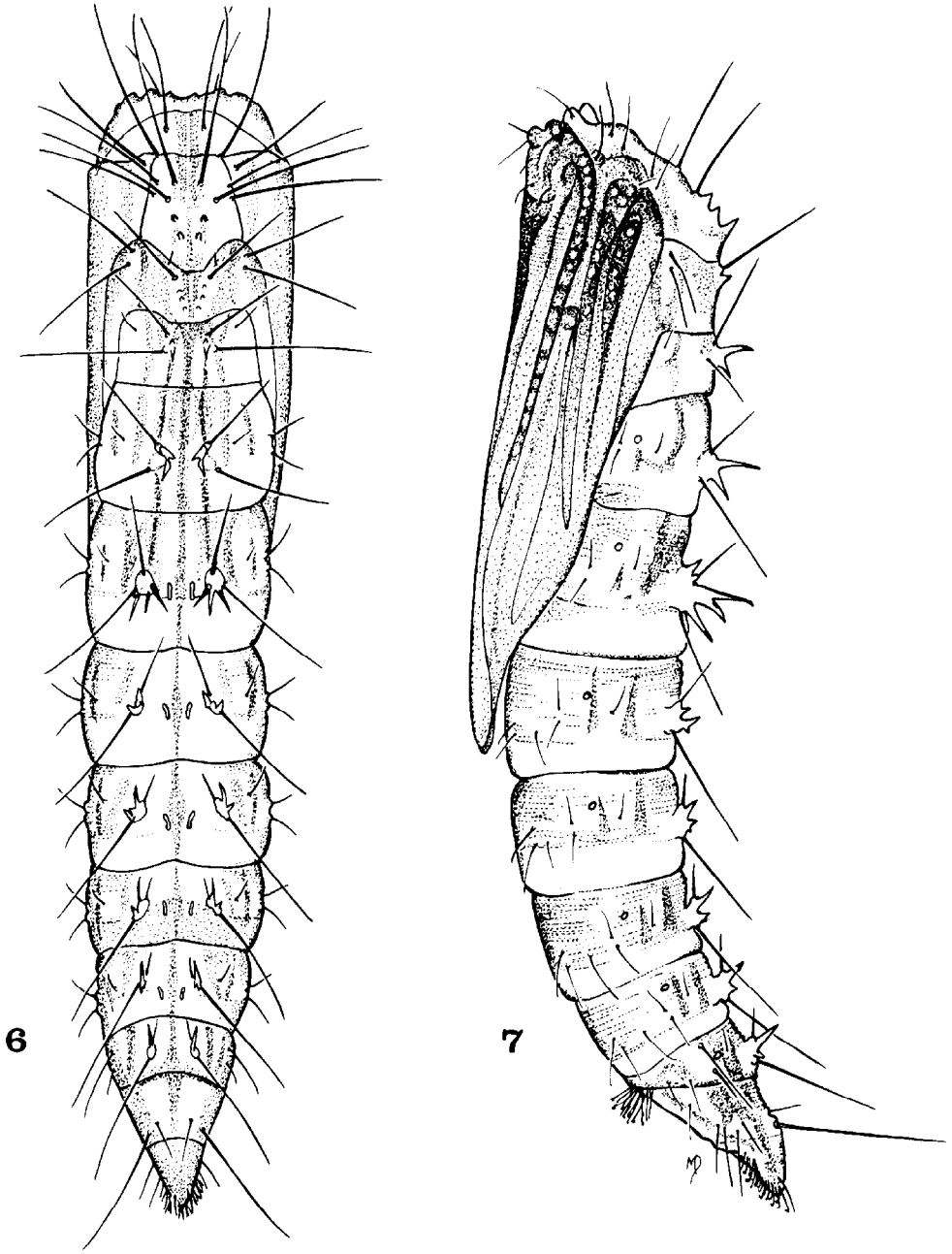

Figure 6-7. *Sphenarches anisodactylus* pupa: 6. dorsal view; 7. lateral view.

T1 legs with 2 setae basad. T1 nearly 3X wider than long, with 3 setae in a transverse row near posterior margin. T2 nearly 1/3 wider than long, D1, D2, SD1, and SD2 present. T3 nearly 2X as wide as long, 1 D seta, SD1, and SD2 present. Thoracic spiracle on T2 adjacent to T1. T1 leg extending to posterior margin of A3. T2 leg extending nearly to anterior margin of A6. Forewing extending slightly beyond T2 legs. T2-A3 with dorsal setae on a ridge. A9 and 10 taper to a point, intersegmental division less conspicuous than other abdominal segment. Abdominal spiracles on A2-7 round with those on A8 reduced and inconspicuous. Dorsal pinacula on A1-8 with 2 setae on

or near a prominent bispinose process; trispinose and largest on A3. A3-7 with a pair of small light colored bifurcate processes between D setae; one branch extending anterad, one posterad, best developed on A4, vestigial with one branch on A7. A1-8 with SD1 and SD2 present. A2-7 with L1 directed anterad, L2 directed posterad. SD and L pinacula distinctly posterior to spiracle on A2-7. SD directly above spiracle on A8 and L setae joined by a narrow ridge, L1 distinctly anterior to spiracle, and 4x length of L2, L2 distinctly posterior to L1 or L2 spiracle. Cremaster and anterior midventral part of A9 with dense covering of fine hook-tipped setae, variable in length.

ADULT. Adult males and females are 6.5 mm ± 0.4 mm and 6.3 ± 0.4 mm in body length respectively; the wingspan is 14.5 mm ± 0.6 mm for males and 15.0 mm ± 0.5 mm for females (n = 15). Genitalia and other adult characters are figured and described in Matthews (1989).

BIONOMICS

The host plant, *Thalia geniculata* (Marantaceae), is a perennial herb arising from thick rhizomes. Flowers occur along conspicuous zigzag (alternate) internodes on a widely and loosely branched panicle. Of the approximately 400 species in this family, all are exclusively tropical except *T. geniculata.* (Tarver et al. 1979). According to Godfrey & Wooten (1979), *T. geniculata* occurs along the coastal plain of South Carolina to Texas, Oklahoma and Missouri. *Thalia geniculata* is also reported from Africa and the West Indies (Small 1933, Evans 1979). In Florida, *T. geniculata* is established primarily in southern Florida and along the St. Johns River system (Tarver et al. 1979). Populations of *Thalia*, along with natural wetland areas in Florida, are disappearing as a result of development and altered hydrological cycles. If *T. geniculata* is the only host plant for *S. anisodactylus* in Florida, then the distribution or existence of this moth may parallel that of its host. The three *T. geniculata* populations studied in Lee County occurred in a cypress swamp, roadside ditch, and a lowland pasture.

In South Florida, *Thalia* growth and abundance was closely synchronized with the hydrological cycle. Seasonal regrowth begins in April or May usually the beginning of the wet season. At the sites studied, flowering began during June or July and peaked in October. December and January are relatively dry months in this area and the above ground portions of the plant recede greatly at this time. By the end of January, the study sites had become dry and little or no green growth was apparent until rains initiated regrowth later in the season.

Our field observations indicated that seasonal occurrence of *S. anisodactylus* is closely tied to flowering activity of *Thalia.* The earliest oviposition observed was in July, 1979, when an estimated five percent of the plants were in flower. Eggs are laid singly, primarily on the flower bracts. As many as 15-20 eggs per flower were not uncommon.

Larvae were most abundant in August and by late September all life stages were common on the flowers. Adults are inconspicuous and were occasionally observed resting on the leaves. In November 1979, 82 of 98 panicles observed at one site had at least one life stage present. The pupa is generally attached by the cremaster to a silken pad spun by the mature larva on the internodes or at the base of a bract if the flower has not already fallen from the panicle.

By late December, only an occasional unemerged pupa could be found. The life stage that overwinters is unknown, although a viable pupa was collected as late as 7 March in Collier County and emerged on 13 March.

Based on our laboratory results, the duration of the immature stages is approximately 22 days and adults live 14-19 days (Table 1). As many as four or five generations may occur from late July through December in South Florida. The duration of *S.*

TABLE 1. DURATION OF LIFE STAGES, HEAD CAPSULE AND LARVAL LENGTH MEASUREMENTS OF LABORATORY REARED *SPHENARCHES ANISODACTYLUS*.

	Duration in Days ♂			Duration in Days ♀			Head Capsule (width mm)[a]			Length (mm)	n
	x	±SD	n	x	±SD	n	x	±SD	n		
Egg[a]	3.0	0	25	3.0	0	25					
Larval instar 1	3.6	0.8	7	3.4	0.5	8	0.20	0	20	1.22-2.75	22
2	3.0	0.6	7	2.8	0.5	8	0.31	0.02	20	2.24-4.20	12
3	2.1	0.7	7	2.5	0.5	8	0.49	0.02	20	3.64-7.70	18
4	2.3	0.5	7	2.6	0.5	8	0.70	0.02	20	8.68-10.78	17
Prepupa	1.1	0.4	7	0.8	0.3	8					
Pupa	7.4	0.5	7	7.1	0.6	8					
Total development[b]	21.8	0.9	7	22.5	0.6	8					
Adult life span	17-19		3	14-19		5					

[a]Sex was not determined.
[b]Based on time from oviposition through pupal development.

anisodactylus immature stages is relatively short compared to the artichoke plume moth, *P. carduidactyla*, which requires 80-110 days at outdoor temperatures in California (a more northern latitude than south Florida) (Lange 1941).

Mating occurs during the night and probably during predawn hours. Pairs in copula may remain in an end to end position for several hours. Ovipositing females were never directly observed but oviposition probably occurred at or before dawn since none were observed ovipositing after 0700 hours or before 1800 hours. Lab reared females oviposited over a 2-6 day period with 1-22 eggs per female laid daily (minimum = 19, maximum = 64). Lange (1941) found that the artichoke plume moth had a preovipositional period of 3-8 days with an average of 170 eggs laid per female. The relatively long duration of oviposition probably contributes to the numerous overlapping generations of *S. anisodactylus* field populations in Florida. Numerous overlapping generations are also characteristic of the genus *Platyptilia* (Lange 1950).

The egg stage lasted 3 days (Table 1). Upon hatching, some larvae attempted to chew the chorion of adjacent unhatched eggs, and later migrated to the petals or bored into unopened portions of the flower. Rarely were more than two mature larvae found feeding on a single flower in the field, indicating migration to other flowers or possible mortality from unknown causes. Spiders are common predators on the panicle and could account for the heavy losses of larvae that remain exposed on outer bud surfaces. Larvae were observed feeding on all portions of the flower, especially the ovary. Larvae have 4 instars, occurring over an 11 day period in the laboratory (Table 1). Mature larvae move to the flower petiole (site of pupation), cease feeding, and become pale green in color. The mean duration of the prepupal stage was one day (Table 1). The pupal stage was approximately 7 days for both sexes (Table 1).

It is also interesting that *Sphenarches anisodactylus* is a pest of leguminous plants, dicots, throughout much of the tropics but is known only from *Thalia geniculata*, a monocot in Florida. In both cases, larvae prefer to feed in flowers and young pods. The only other pterophorid known to feed on a monocot is, *Platyptilia* jezoensis from Japan, which feeds on *Allium fistulosum* L. (Amaryllidaceae) (Yano 1963). It is likely that *S. anisodactylus* feed on *Thalia* in the tropics but this has not yet been reported. It is also feasible that *Sphenarches anisodactylus* may use additional hosts in Florida. Pigeon pea is not grown commercially in Florida but there may be small plantings for home use among recent immigrants from the tropics. There are also at least two species of *Caperonia* in Florida (Wunderlin 1982) which may serve as alternate hosts. Further biological studies may explain the extreme polyphagy of this species. Perhaps different biological races of *S. anisodactylus* occur that feed on different hosts. Secondary compounds used by *S. anisodactylus* for host recogition may also be similar in these unrelated plants.

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