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Wing dimorphism of the water strider *Limnogonus franciscanus* (Stål) (Heteroptera: Gerridae) in a seasonal tropical climate

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The seasonal occurrence of wing morphs of *Limnogonus franciscanus* was studied in a mangrove swamp by taking monthly samples during nineteen months. Altogether 428 males and 413 females were collected. The percentage of winged individuals remained constant at ca. 3.2% throughout the study period. There were no differences between sexes in the proportions of winged and wingless morphs. The frequency of gravid females peaked during the rainy periods.

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1. Introduction

The wing-length patterns of tropical water striders in constantly breeding populations are not well studied. Selvanayagam and Rao (1986) showed seasonal changes in the wing morphs of *Gerris spinolae* in South Western India (*G. spinolae* Lethierry & Severin is a synonym of *Aquarius adelaidis* (Dohrn), see Andersen 1990). The proportion of winged individuals increased from the dry season minimum of ca. 20% to almost 100% just after monsoon rains. The plentiful rains in seasonal tropical areas generate many water bodies suitable for water strider breeding. It could be expected that water striders would take advantage of such new water bodies by producing long-winged individuals capable of migrating to new habitats during the rainy period. On the other hand, intraspecific competition in a constantly breeding population is expected to favor individuals with rapid reproduction, especially during a period when new living space appears owing to the rise in water level. This will be promoted, if the flying apparatus is not developed (e.g. Spence 1989). This study reports how a constantly breeding population of a dimorphic water strider species responses to a seasonally changing environment.

The species studied here, *L. franciscanus*, is common and widely distributed in the West Indies, Central America and Mexico, extending north into Florida and the southern parts of Texas (Smith 1988). Based on notes about wing dimorphism in *L. franciscanus* (Hynes 1948, Cobben 1960, De Kort-Gommers & Nieser 1969, Nieser & Alkins-Koo 1991), it seems that the species is dimorphic in almost all sites and the proportion of long-winged and short-winged individuals varies among sites.

The rainfall pattern at my study site in Barbados, resembles to some extent the monsoon climate in SW India (cf. *Gerris spinolae* above). Approximately 75% of the average 1 200-mm yearly rain, falls in the seven months from June to mid-

December. The driest months are February to April (Rouse 1966). Temporary pools, lasting some months, are abundant during the rainy season. The yearly temperature maximum occurs during the rainy period. The day length varies about 2 hours over a year.

In temperate zones it is common to find seasonal variation in the proportions of water strider wing morphs. The variation seems to be regulated by environmental cues like photoperiod and/or temperature (e.g., Vepsäläinen 1978, Spence 1989, Spence & Andersen 1994). Vepsäläinen (1978) suggested that in Europe increasing day length indicates early summer and acts as a switch to produce short-winged individuals which will produce a second generation during the same summer. According to Vepsäläinen (1978), low temperatures indicate stability of the site and also favor the production of short-winged individuals.

The primary question in this study is: Are there seasonal changes in the proportions of wing morphs in the continuously-breeding, tropical population of *L. franciscanus* and are the possible changes related to rainfall or day length? This paper represents the first detailed assessment of wing dimorphism in a tropical, constantly breeding water strider species.

Table 1. Numbers of winged (LW) and wingless (SW) morphs of *Limnogonus franciscanus* in monthly samples collected in 1992–93 from Graeme Hall Mangrove Swamp in Barbados. Rainfall data is from Rockley (1 km West from Graeme Hall, Barbados Meteorological Institute). ? = no sampling.

	Males		Females			
	LW	SW	LW	SW	Gravid	Rain, mm
1992						
May	1	19	0	21	12	178.0
June	0	32	1	32	21	134.2
July	2	26	0	19	8	47.5
Aug.	0	26	1	26	13	116.1
Sept.	0	11	1	11	1	80.9
Oct.	1	28	1	19	1	14.2
Nov.	3	19	2	14	1	107.3
Dec.	0	19	0	18	1	30.9
1993						
Jan.	0	13	3	16	2	57.4
Feb.	?	?	?	?	?	28.8
Mar.	0	19	0	22	2	50.1
Apr.	0	14	0	17	2	19.5
May	0	11	0	16	1	72.7
June	0	18	1	17	4	67.0
July	1	27	2	27	10	53.1
Aug.	0	35	0	39	13	31.5
Sept.	0	15	1	17	14	88.1
Oct.	3	41	0	29	15	130.8
Nov.	2	42	1	39	2	90.4

2. Material and methods

I studied a population of *L. franciscanus,* consisting of several thousand individuals, throughout a year by taking monthly samples over 19 months from a mangrove swamp in Barbados, West Indies. The site, Graeme Hall Swamp, is the only one harboring a large population of *L. franciscanus* on the island. The swamp (ca. 35 ha) is an area of pond, marsh, and mangrove forest located near the south coast of Barbados (59°35´W, 13°03´N) in a densely populated area. It is the last surviving mangrove forest in Barbados and has a long history of human use.

I collected water striders with a pond net while walking slowly along a trail approximately 0.5 km long which crossed the swamp, separating marsh and mangrove forest. The trail was under water during the rainy seasons and during the dry seasons there was water on both sides of the trail, especially in a ditch on the mangrove side. I attempted to catch all adults encountered. Females having swollen abdomen were considered to be gravid.

3. Results

According to my results, wing patterns in *L. franciscanus* in Barbados includes just two morphs. All short-winged individuals were apterous. Winged individuals are capable of flying and I found occasional individuals outside the study area on water pools unsuitable for reproduction like cisterns or city fountains.

Of the 428 males and 413 females collected, 3.1% of the males and 3.5% of the females were long-winged (Table 1). Due to the low number of long-winged individuals, no differences were found in the proportions of wing morphs between the rainy (Jul.–Dec.) and the dry (Jan.–May) parts of the year or between the long-day (Apr.–Sep.) and the short-day (Oct.–Mar.) parts. The proportion of long-winged individuals did not correlate significantly with rainfall (Spearman Rank Correlation $r_s = 0.19$). The proportion of gravid females correlated significantly with rainfall ($r_s = 0.474$, $p = 0.05$, $n = 18$), indicating higher breed-

ing activity during rainy periods (Table 1). At the end of the study period, 30 fifth instar and 12 fourth instar larvae from Graeme Hall Swamp were checked for their wing-pads. No larvae with distinct wing pads were found. However, fifth instar larvae with distinct wing-pads were found outside the study area in temporary habitats occupied by winged adults.

4. Discussion

Seasonal changes could not be detected in the wing morph proportions of the *L. franciscanus* population in Graeme Hall Swamp. However, it seems that there is a population level response to seasonal changes in the environment. Reproductive peaks are timed to the late dry season and early rainy season.

Andersen (1993) used a phylogenic approach to analyze the evolution of wing polymorphism in water striders. He suggests that the most ancestral forms of wing patterns in water striders are permanent winglessness (SW) or permanent dimorphism. In permanent dimorphism, all SW adults develop from fifth instar nymphs with reduced wing-pads. According to Andersen (1993), more developed evolutionary stages in water strider wing morphs are seasonal dimorphism and monomorphic long-wingedness (LW). He also suggests that once the short-winged adult morph has been lost it is never regained in the original form where the flightless morph develops from nymphs with reduced wing-pads. Instead, short-winged adults may develop from nymphs with distinct wing-pads.

Observations in this study suggest that *L. franciscanus* in Graeme Hall Swamp belongs to the most ancestral permanent dimorphic class of water strider wing patterns. No seasonality could be found although its environment changes seasonally with respect to rainfall, day length and temperature. Also all short-winged individuals seem to develop from fifth instar nymphs with reduced wing-pads, fitting the prediction of Andersen (1993).

It seems that there is no strong selection toward a winged morph in *L. franciscanus* in Barbados. Maybe migrating winged morphs on a fairly dry island cannot find enough suitable habitats isolated from the permanent swamp to breed. During the rains, the water rises also on the Graeme Hall Swamp providing more space to breed. It is possible that short-winged morphs, as faster breeders (see e.g. Spence 1989), can utilize more efficiently the seasonally appearing new areas in the swamp. If there are any environmental switches to short- or long-wing morphs in this species, it seems that under Barbados conditions they are not active.

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