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SHORT COMMUNICATION

SELECTED LIFE-HISTORY OBSERVATIONS ON THE CAYMAN GAMBUSIA, *GAMBUSIA XANTHOSOMA* GREENFIELD, 1983 (POECILIIDAE)

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INTRODUCTION

The Cayman gambusia (*Gambusia xanthosoma* Greenfield, 1983) is an uncommon species within the *G. punctata* species group, endemic to North Sound, Grand Cayman Island, BWI. Since the original description (Greenfield 1983) only phylogenetic information has been published and little is known of its habitat, feeding ecology, or reproductive life history (Wildrick and Greenfield 1985, Rauchenberger 1988). Originally described from a brackish-water (30 psu) mosquito control ditch, the species also occurred throughout marine mangrove habitat and inland saline ponds adjacent to North Sound, Grand Cayman Island (see Figure 1). Here we present information on the habitat, diet, reproduction, life history, and parasites of the Cayman gambusia.

MATERIALS AND METHODS

We made collections and recorded environmental data of Cayman gambusia during 4 separate collecting trips: August 1996, January 1997, June 1997, and August 1999 (Figure 1). We recorded water temperature (°C), salinity (psu), pH, sediment type (i.e., detritus, ironshore rock, mud, sand, silt) and submerged structure (i.e., mangrove roots) at the time of sampling. Samples of Cayman gambusia were taken using either a 4.7 m long, 3 mm stretch-mesh seine; a 47 x 25 cm wide, 1 mm mesh kicknet; or a 2.5 m diameter, 1 cm mesh cast net. Presence/absence observations were made in areas inaccessible to sampling gear. Specimens were fixed in 10% Formalin, labeled, and returned to the laboratory where they were transferred to 70% ethanol.

We examined diet, reproductive characteristics, and parasites of preserved specimens from the Little Salt Creek collection made on 25 January 1997, the only collection with gravid specimens. All males were measured to the nearest 0.01 mm standard length (SL) and examined for maturity based on anal-fin morphology (Turner 1941). Males were considered mature if the formation of the gonopodium was complete.

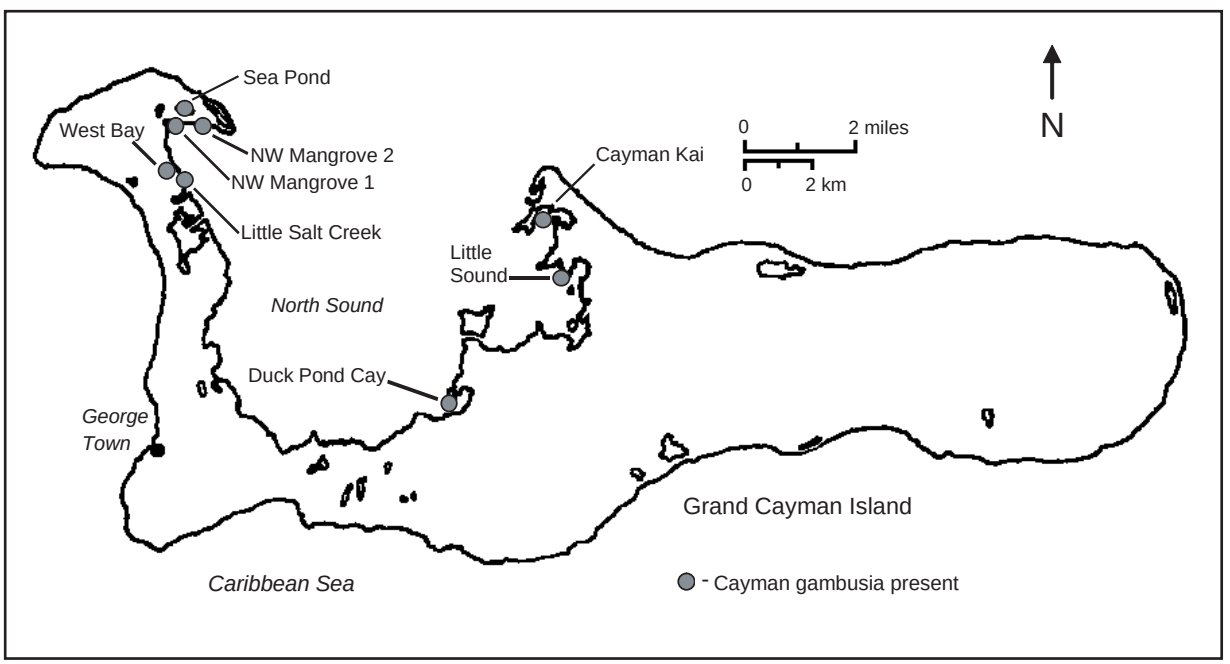

Figure 1. Locations of Cayman gambusia presence at Grand Cayman Island, BWI.

TABLE 1

Environmental variables recorded at the time of sampling for Cayman gambusia from each location between August 1996 and August 1999. n/a = not available.

Location	Date	Salinity (psu)	Temperature (°C)	D.O. (mg/l)	pH	Depth (m)
Cayman Kai	8-14-99	39.2	32.6	3.50	n/a	1.2
Duck Pond Cay	8-10-99	37.5	33.9	5.4	n/a	0.3
Little Salt Creek	1-25-97	36.7	25.6	3.93	n/a	0.5
Little Sound	8-13-99	n/a	n/a	n/a	n/a	1.0
NW Mangrove-1	8-12-99	38.2	32.1	4.5	n/a	0.8
NW Mangrove-2	8-12-99	37.1	31.6	2.36	n/a	0.8
Sea Pond	8-21-96	34.1	28.3	4.60	8.0	1.0
Sea Pond	1-15-97	25.9	29.4	8.42	9.1	1.0
West Bay	6-13-97	30.7	29.6	1.22	8.3	0.5

Developmental stages were determined according to Haynes (1995), wherein ova and embryos were classed into 11 distinct morphological stages. Maturity in females was determined by the presence of a blastodisc (stage 4) or later stage embryo. Embryos of each stage and somatic tissues were dried separately overnight at 60 °C and weighed to the nearest 0.01 mg. Total embryo dry weight was determined by summing the dry weights of all embryos from stages 4 through 11. For each specimen, the mean embryo dry weight was determined by dividing the total embryo dry weight by the number of embryos in the brood. Reproductive allotment (RA), an index of the resources invested by an individual female into the production of a single brood, was estimated according to Reznick and Endler (1982). Digestive tract contents of mature females were identified to the order or class taxonomic level.

Pearson correlations were performed among 4 female reproductive traits and somatic dry weight using SPSS software (SPSS 11.0). Somatic dry weight and all reproductive traits except mean stage were $\log_{10}$ transformed prior to analysis. Significance levels were adjusted for multiple testing using the Sequential Bonferroni correction (Peres-Neto 1999). A strong negative relationship between embryo weight and mean stage of development would indicate lecithotrophy (i.e., mother does not supplement pre-fertilization yolk nutrients during embryo development), whereas a slope of zero or a shallow slope would indicate some matrotrophy (i.e., mother supplements pre-fertilization yolk nutrients during embryo development).

RESULTS AND DISCUSSION

Based on many collections made over the course of 4 extensive surveys of ponds throughout the Cayman islands, Cayman gambusia appears to be confined to the North Sound on the western end of Grand Cayman Island, near mangroves. Specimen collection was difficult due to dense mangrove prop roots and at most locations only presence/absence could be noted. Habitat was either near or within shallow (0.5–1.0 m) fringing mangroves with muddy detritus substratum along the edges of North Sound and in associated mosquito control ditches and connected pond systems. Other fishes co-occurred including 2 poeciliid species, Cayman limia (*Limia caymanensis*) and Caribbean gambusia (*G. puncticulata puncticulata*), and various non-poeciliid species such as tarpon (*Megalops atlanticus*), hardhead silverside (*Atherinomorus stipes*), crested goby (*Lophogobius cyprinoides*), gray snapper (*Lutjanus griseus*), and sheepshead minnow (*Cyprinodon variegatus*). Based on the presence of many piscivorous wading birds (e.g., egrets, herons), avian predation was likely, although differences in the intensity of predation among locations and seasons were not known.

Physico-chemical conditions varied among the 8 collection sites and between seasons (Table 1), probably due to habitats having variable direct or indirect connections to the relatively high salinity of North Sound. The salinity ranged from 25.9 to 39.2 psu, and water temperature ranged from 25.6 to 33.9 °C.

Of the 36 males collected from Little Salt Creek on 25 January 1997, 28 were mature; SL of mature individuals ranged from 18.00 to 31.48 mm ($\bar{x}$ = 25.37 mm). Of the 58 females collected and dissected, 27 were gravid; SL of mature individuals ranged from 21.90 to 38.60 mm ($\bar{x}$ = 28.58 mm). Variation existed among gravid females in mean embryo dry weight (range 1.80–3.92 mg; $\bar{x}$ = 2.70), number of embryos per brood (range 1–11; $\bar{x}$ = 3.89) and RA (range 1.74–13.54; $\bar{x}$ = 8.27) (Table 2).

TABLE 2

Variation in female reproductive traits based on 27 gravid Cayman gambusia specimens from Little Salt Creek on 25 January 1997. $s_{\bar{x}}$ = standard error.

	Minimum	Maximum	Mean ± $s_{\bar{x}}$
Standard length (mm)	21.90	38.60	28.58 ± 0.77
Somatic dry weight (mg)	46.09	322.26	118.48 ± 11.60
Mean stage	4	11	6.74 ± 0.36
Mean embryo dry weight (mg)	1.80	3.92	2.70 ± 0.11
Number of embryos	1	11	3.89 ± 0.47
Total embryo dry weight (mg)	2.73	25.98	10.20 ± 1.21
Reproductive allotment	1.74	13.54	8.27 ± 0.50

None of the gravid females exhibited superfetation, (i.e., the presence of multiple, non-successive developmental embryo stages, Turner 1940). Somatic dry weight was correlated with all 4 reproductive traits: larger females tended to have more and larger embryos at more advanced stages of development (Table 3). However, as a result of doing multiple statistical tests, only total embryo weight remained significantly related to somatic weight (adjusted $P < 0.05$) after Sequential Bonferroni corrections were applied. Total embryo weight was strongly correlated with the number of embryos present, even after correction.

The lack of any detectable correlation between mean embryo weight and mean stage suggested the presence of matrotrophic provisioning (Table 3; $r = 0.1$, $P > 0.25$). However, because of the limited data available, the possibility of spatio-temporal variation in facultative matrotrophy and in the amount of female provisioning still exists (Trexler 1985). Such facultative matrotrophy was observed in Caribbean gambusia (Abney and Rakocinski 2004) and Cayman limia (M.A. Abney, unpublished data).

Diet Observations

In addition to pollen grains and seed pods, 9 taxonomic classes representing 21 orders of prey groups were identified from 27 females (Table 4). The Diptera was represented by the subgroups Brachycera, including some Cyclorrhapha, and multiple species of Nematocera. The Hemiptera was represented by multiple taxa, including the family Naucoridae. Hymenopterans included wasps (Apocrita) and ants (Formicidae). Individual species identified were the ischyrocerid amphipod *Erichthonius* cf. *brasiliensis*, the oniscid ispopod *Littorophiloscia* cf. *culebrae* (Philosciidae) and the tanaid *Hargeria rapax* (Leptocheliidae). Benthic, pelagic, and terrestrial prey were often found within the same specimen suggesting an opportunistic and generalist feeding behavior, typical of gambusiines (Meffe and Snelson 1989).

Parasite Observations

Several helminth parasites were noted from 40 adult female Cayman gambusia (38 preserved, 2 fresh caught) at the Salt Creek site. The widely occurring and relatively non-host specific ectoparasitic monogenean, *Neobenedenia melleni* (MacCallum), was observed attached to the head of a Cayman gambusia collected 27 January 1997 (Bullard et al. 2000).

The body cavity of one Cayman gambusia contained the third stage larva of *Contracecum* sp., a nematode whose adult stage occurs in the digestive tract of piscivorous birds seen during collections. At least 2 different

TABLE 3

Correlations among female reproductive traits based on 27 gravid Cayman gambusia specimens from Little Salt Creek on 25 January 1997. All variables except Mean stage are correlated $\log_{10}$ scale. Bold values indicate significant before sequential Bonferroni correction; asterisks indicate significant after correction for multiple tests.

	Mean stage	Mean embryo dry weight	Number of embryos	Total embryo dry weight
Somatic dry weight	0.284	**0.405**	0.504	**0.628***
Mean stage		-0.148	-0.056	-0.130
Mean embryo dry weight			-0.285	0.043
Number of embryos				**0.941***

TABLE 4

Digestive tract contents of 27 gravid Cayman gambusia collected from Little Salt Creek on 25 January 1997. Number of digestive tracts with prey frequency ranges are given.

	Prey Frequency Range					
Prey Type	**1**	**2–4**	**5–10**	**10–100**	**100–250**	**250–500**
Foraminiferida	2		1	5	5	2
Gastropoda spp.	1	1				
Polychaeta spp.	3			1		
Araneae	2					
Prostigmata	4					
Oribatida	3					
Pseudoscorpiones	2					
"Planktonic" Ostracoda	4	2				
"Harpactacoid" Copepoda	2		1	1		
Amphipoda	2					
Decapoda	1					
Isopoda		2				
Stomatopoda (larvae)	2					
Tanaidacea	2					
Coleoptera	3	1				
Diptera	3	11	1			
Hemiptera	6	2				
Hymenoptera	7	9	3			
Orthoptera	2					
Thysanoptera		1				
Insecta	9					
Osteichthyes	2	1				
Pollen grain	1					
Seed pod	6					

species of digenean parasites, too immature to be identified, were observed in the intestines of Cayman gambusia.

Status

Cayman gambusia is a distinctive poeciliid species that appears to be restricted to the central mangrove area of North Sound, Grand Cayman. Collections made over the course of 4 extensive surveys of ponds throughout the Cayman islands failed to produce this species from any other areas. This unique species of *Gambusia* is of special concern in light of its low prevalence and pressures imposed upon the mangroves of Grand Cayman, by both the threat of development as well as large catastrophic tropical storms that frequent this region.

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