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THE PLANKTONIC COPEPODS OF COASTAL SALINE PONDS OF THE CAYMAN ISLANDS WITH SPECIAL REFERENCE TO THE OCCURRENCE OF *MESOCYCLOPS OGUNNUS* ONABAMIRO, AN APPARENTLY INTRODUCED AFRO-ASIAN CYCLOPOID

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ABSTRACT Taxonomic analysis of the copepod specimens collected from 29 Cayman Island ponds revealed the presence of ten species including the nearly ubiquitous cyclopoid *Apocyclops panamensis*. This species was widespread throughout the islands, being collected at 27 of the sampling sites. Another common calanoid, *Mastigodiaptomus nesus*, occurred at nine sites on Grand Cayman and one on Cayman Brac. A cyclopoid of Afro-Asian origin, *Mesocyclops ogunnus*, was collected at two nearly fresh water sites on Grand Cayman and was considered to be a recent introduction. Because of its known adaptability to fluctuating environmental conditions, it is likely that *M. ogunnus* will successfully compete with and probably displace some of the native species and may become a dominant zooplankter on Grand Cayman.

INTRODUCTION

The coastal saline ponds of the Cayman Islands represent a variety of habitats and, like those of most small Caribbean islands, are subject to hypersaline conditions during the dry seasons and flooding during the summer rainy season. Some ponds are also connected via sinks and seeps to brackish, anoxic, anchialine cave systems, and as such are somewhat affected by tidal flow. Coastal ponds provide a feeding habitat for a variety of resident and migratory waterfowl that forage on poeciliid fish and a variety of small benthic invertebrates including insect larvae, snails and crustaceans. In conjunction with a biological assessment conducted in 1996-97 by the Cayman Island National Trust, plankton samples were collected from 29 coastal and inland sites on Grand Cayman and the two sister isles, Little Cayman and Cayman Brac during August 1996 and January and June 1997. The habitats sampled included shallow roadside borrow pits and ponds, tidally influenced mangrove swamps, *Typha* swamps, sedge swamps, seasonal pools on grasslands, and the mouth of an anchialine cave. Salinities at most of the sampled locations varied from hypersaline in the fall and winter to nearly fresh in the summer when inundated during the extensive rainy period. A brief description of localities where copepods were collected is presented in Table 1 along with associated data on salinity (‰), temperature (°C), pH, and dissolved oxygen (D.O., mg/l). The general location of the collecting sites is shown on Figure 1.

MATERIAL AND METHODS

Fifty non-quantitative plankton samples were taken using a plankton net with a mesh size of 0.07 mm at 29 coastal and inland pond localities in the Cayman Islands (Figure 1). All collections were taken from slightly below the surface of the water (0-0.5 m) by hand-towing the net a distance of about 10-15 m. Copepods were examined live soon after collection, and representative specimens were sorted from the sample, fixed with 10% formalin, and later preserved in 70% ethanol. Hydrographic data were collected within the upper 0.25 m at each site using a YSI multi-parameter system (model 85) and a pH pocket meter. Geographic coordinates were recorded with a portable GPS unit. Preserved specimens were examined by the senior author and identified to species with the aid of taxonomic descriptions published by Sewell (1940), Van de Velde (1984), Bowman (1986), Campos-Hernández and Suárez-Morales (1994), and Suárez-Morales et al. (1996).

RESULTS AND DISCUSSION

Taxonomic analysis of the copepod specimens collected from Cayman Island ponds revealed the presence of 10 species. These included the nearly ubiquitous cyclopoid *Apocyclops panamensis* (Marsh 1913), which was widespread throughout the islands at 27 of the sampling sites, and the common calanoid, *Mastigodiaptomus nesus* Bowman, 1986, which occurred at 9 sites on Grand Cayman and one on Cayman Brac. More isolated were the

TABLE 1

Cayman Island Pond station data and copepod occurrence records. GC = Grand Cayman, LC = Little Cayman, CB = Cayman Brac, NT = Not Taken. Key to species: AP = *Apocyclops panamensis*, AC = *Acartia tonsa*, MA = *Macrocyclops albidus*, MN = *Mastigodiaptomus nesus*, ML = *Mesocyclops longisetus*, MO = *Mesocyclops ogunnus*, MJ = *Metis jousseaumei*, TT = *Thermocyclops tenuis*, TE = *Tropocyclops extensus*, TP = *Tropocyclops prasinus cf. aztequei.*

Site	Habitat	Date	Temp. °C	Salinity ‰	D.O. mg/l	pH	Copepod species
Betty Bay Pond, GC 19°17'50"N/81°11'30"W	Slightly brackish, borrow pit, mangrove/woodland fringe, *Chara* mats	1/16/97 6/11/97	29.8 34.4	2.6 5.8	5.9 4.0	9.5 9.6	MN, MO AP
Collier's Pond, GC 19°20'03"N/81°0510'"W	Permanent, shallow brackish, mangrove fringe, *Ruppia* beds	1/16/97 6/11/97	25.8 29.9	2.7 2.6	5.4 1.1	9.8 8.9	AP, MN AP
Governor's Pond, GC 19°16'39"N/81°18'30"W	Small inland *Typha*/*Urochloa mutica* fringe, seasonal, temporary	1/27/97 6/12/97	25.1 31.9	0.4 2.4	3.0 6.9	9.4 8.6	AP, MN, TP MN
Least Grebe Pond, GC 19°16'48"N/81°18'17"W	Small inland *Typha*/sedge fringe, seasonal, temporary	8/28/96 1/27/97 6/12/97	34.6 24.3 30.4	0.8 0.2 1.0	>13.0 1.53 1.05	8.9 9.4 8.4	MN, MO AP, MN, TP AP, MN
Malportas Pond, GC 19°20'35"N/81°12'17"W	Shallow, brackish, mangrove fringe	1/16/97 6/11/97	26.7 33.2	7.4 10.7	5.9 6.8	9.6 10.7	AP, MN AP
Meagre Bay, GC 19°17'38"N/81°13'44"W	Shallow, brackish, mangrove fringe	1/17/97 6/11/97	26.1 28.8	2.6 15.9	10.6 4.1	10.5 10.5	AP, MN AP
Palmetto Pond, GC 19°23'16"N/ 81°21'58"W	Shallow, brackish-hypersaline, mixed mangrove fringe	1/17/97 6/13/97	26.9 27.9	14.5 19.7	4.4 5.1	9.5 9.4	AP, MN AP
Pease Bay, GC 19°17'15"N/81°14'26"W	Shallow, brackish, mangrove fringe, rock outcroppings, *Ruppia* beds	1/16/97 6/12/97	30.0 30.0	1.6 19.5	10.5 1.9	10.1 10.1	AP, MN AP
Point Pond, GC 19°20'58"N/81°13'21"W	Shallow, brackish, temporary, mixed woodland fringe, *Ruppia* beds	1/26/97	32.0	5.8	12.7	11.2	AP, MN
Sea Pond, GC 19°23'14"N/81°22'32"W	Tidally influenced mangrove swamp	1/15/97	29.4	25.9	8.4	9.1	AT
Vulgunner's Pond, GC 19°23'10"N/81°22'59"W	Shallow, hypersaline lagoon, small tidal creek inlet, *Ruppia* beds	1/14/97 6/10/97	33.9 30.9	22.9 26.8	12.1 7.4	9.5 9.8	AP, TE AP, TT, MJ
Bittern Pond, LC 19°39'36"N/80°05'46"W	Marshland, Meagre fern (*Acrostichum*) fringe, *Ruppia* beds	6/3/97	28.9	2.1	6.5	9.1	AP
Booby Pond, LC 19°39'58"N/80°04'15"W	Seasonal, brackish-hypersaline, mixed woodland/mangrove fringe, rock outcroppings, sinkholes and underground seep influence	1/18/97 6/3/97	19.0 27.0	24.3 3.3	5.0 4.4	9.8 8.2	AP AP
Bulldozer Pond, LC 19°39'38"N/80°06'02"W	Marshland, seasonal, shallow, ironshore rock pools	1/20/97 6/4/97	23.0 29.0	21.9 5.0	4.0 3.8	9.3 9.9	AP AP
Coot Pond, LC 19°41'53"N/79°58'18"W	Temporary, seasonal,meadow pond, sedge fringe	6/5/97	31.0	0.1	0.1	7.9	ML, TT
Easterly Pond Complex, LC 19°41'56"N/75°59'14"W	Shallow, brackish, *Ruppia* beds	1/18/97	23.9	11.1	8.4	10.5	AP
Grape Tree Pond, LC 19°41'51"N/80°03'10"W	Shallow, brackish, mangrove/sea grape tree (*Coccoloba*) fringe	1/18/97 6/5/97	24.1 28.1	7.0 1.2	9.4 0.7	9.8 9.0	AP AP
Jackson's Pond, LC 19°41'26"N/80°03'54"W	Permanent, mangrove/mixed woodland fringe	1/19/97	22.1	10.8	13.0	9.9	AP

TABLE 1 (Continued)

Site	Habitat	Date	Temp. °C	Salinity ‰	D.O. mg/l	pH	Copepod species
Lighthouse Pond, LC 19°39'34"M/80°06'32"W	Seasonal hypersaline, connected to underground cave system	1/19/97 6/4/97	23.7 27.7	31.8 1.1	9.6 2.9	10.2 9.2	AP AP
McCoy's Pond, LC 19°40'26"N/80°05'49"W	Shallow, brackish, mangrove fringe	1/19/97 6/4/97	22.9 27.0	12.4 1.1	7.8 4.2	9.8 8.9	AP AP
Salt Rock Cave, LC	Mouth of anchialine cavesystem	6/6/97	NT	NT	NT	8.9	AP, MA
Sandy Point Pond, LC 19°42'05"N/79°57'53"W	Shallow, brackish, eutrophic	1/18/97 6/5/97	25.8 31.4	21. 4 8.7	14.2 8.4	10.2 9.8	AP AP
Tarpon Lake, LC 19°40'41"N/80°02'27"W	Seasonal, brackish-hypersaline, old-growth mangrove swamp	1/18/97 6/3/97	23.4 25.9	8.5 5.2	4.2 4.9	9.8 8.3	AP AP
Westerly Pond -east site, CB 19°41'12"N/79°52'49"W	Narrow brackish inlet from main pond, mangrove fringe	1/21/97 6/8/97	23.0 27.8	11.1 2.8	11.2 1.3	10.5 8.7	AP AP
Westerly Pond -west site, CB 19°41'03"N/79°53'18"W	Shallow hypersaline, mangrove fringe	1/21/97 6/8/97	24.3 27.5	33.8 3.4	4.6 4.4	10.0 9.3	AP, MN AP, ML
Mangrove Wreck Pond, CB 19°41'14"N/79°52'10"W	Brackish, dredged canal adjacent to old growth mangrove swamp	1/21/97 6/7/97	23.4 28.4	16.3 2.8	7.1 6.2	10.3 9.2	AP AP
Red Shrimp Hole, CB 19°41'38"N/79°50'52"W	Marshland, ironshore rock pools, mangrove fringe, sinkhole connection to cave system	6/8/97	27.3	0.6	1.9	8.5	AP
Salt Pond, CB 19°41'16"N/79°51'49"W	Shallow, brackish-hypersaline, man-made levee on one edge	1/21/97 6/8/97	25.5 27.2	28.2 8.1	8.8 5.5	10.5 9.8	AP AP, TT
The Splits, CB 19°41'39"N/79°52'13"W	Interior brackish, karstic bluff formation	1/22/97	23.2	7.2	2.5	9.5	AP

occurrences of the predominantly freshwater cyclopoids, *Macrocyclops albidus* (Jurine, 1820), *Mesocyclops longisetus* (Thiébaud, 1914), *Thermocyclops tenuis* (Marsh, 1909), *Tropocyclops extensus* (Kiefer, 1931), *Tropocyclops prasinus cf. aztequei* Lindberg, 1955, and *Mesocylops ogunnus* Onabamiro, 1957. Two species with greater tolerance for higher salinities, the harpacticoid *Metis jousseaumei* (Richard, 1892) and the calanoid *Acartia tonsa* Dana, 1852, were limited to single occurrences at Vulgunner's Pond and Sea Pond, sites on Grand Cayman with direct marine influence.

Most of these species have been previously recorded from Grand Cayman (Reid 1990), and the overall biogeographic affinities of the local copepod community are clearly tropical. The most noteworthy record is that of *Mesocyclops ogunnus*, an apparently introduced Afro-Asian species, found at Least Grebe, Grand Cayman, and Betty Bay Pond, Grand Cayman, 2 nearly freshwater sites. It can be distinguished from the known American species of *Mesocyclops* by the presence of a row of spines on the maxillular palp, a character shared only with the African *M. salinus* Onabamiro, 1957. Other diagnostic characters of *M. ogunnus* include: pediger 5 with several lateral and a few dorsal spines, seminal receptacle with broad lateral arms and a long curved pore-canal, caudal ramus with naked medial surface and with spines at the bases of the lateral and lateral most terminal caudal setae (Van de Velde 1984, Reid and Pinto-Coelho 1994).

Mesocyclops ogunnus is distributed in Nigeria, Subsaharan Africa, the Near East, South and Southeast Asia, and Brazil. This species inhabits a wide variety of freshwater environments, and is one of the most eurytopic species of *Mesocyclops* in the Afro-Asian region (Van de Velde 1984, Jeje and Fernando 1992, Reid and Pinto-Coelho 1994). This adaptive capacity would explain the success of this species when introduced into a new environment. In the Cayman Island system, *M. ogunnus* is not widely distributed, nor present in a variety of environments. This suggests that the invasion of *M. ogunnus* in the Cayman Islands is quite recent, since, like many other introduced copepods, *M. ogunnus* is a very efficient competitor and can exploit different types of environments (Reid and Pinto-Coelho 1994). Were this species long established in the Caymans, we would expect it to be common and abundant. A more thorough investigation into similar sites throughout the year would

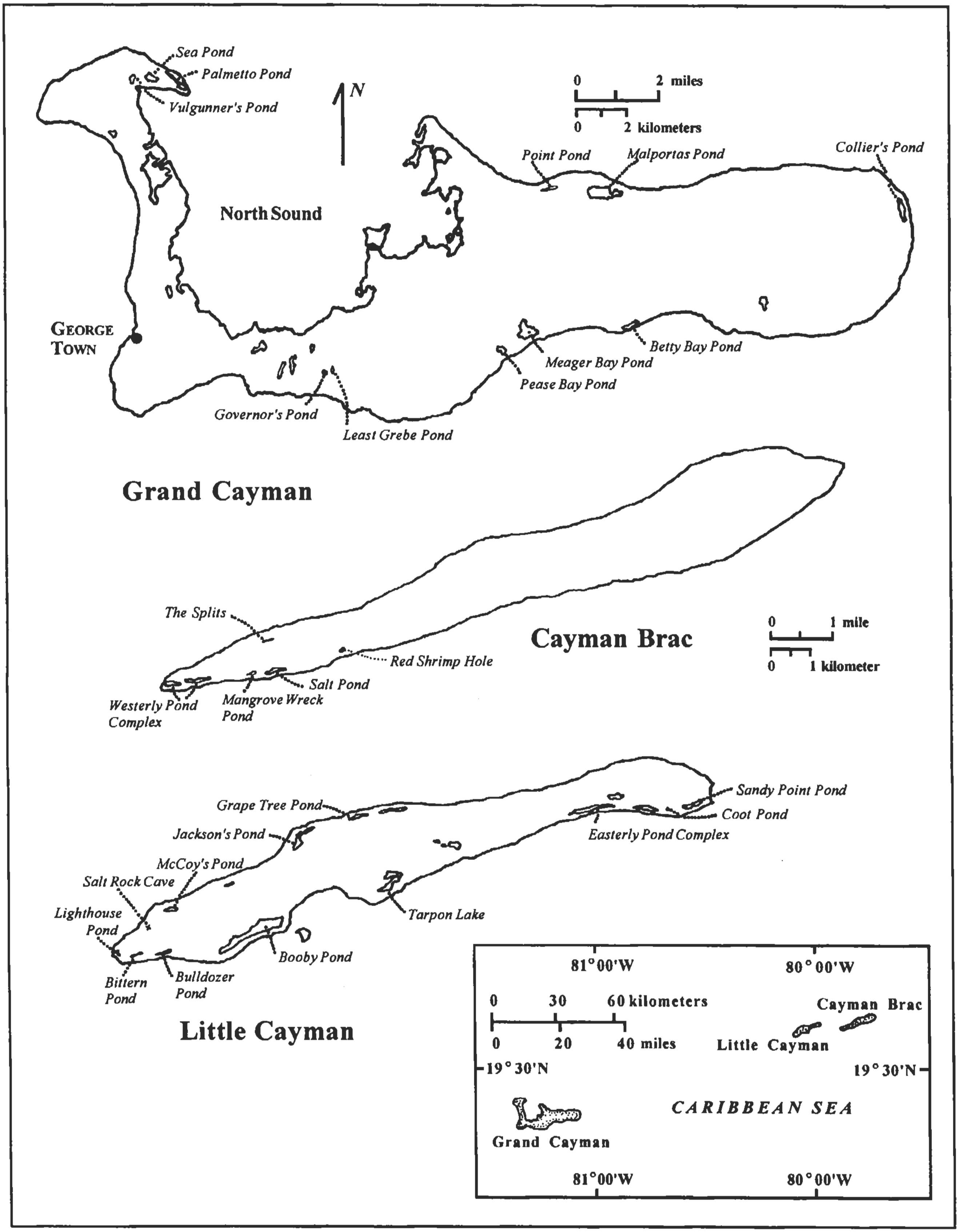

Figure 1. Cayman Islands, British West Indies showing the location of coastal saline ponds where copepods were eollected. Inset shows relative location in the Caribbean Sea and distances between the 3 islands.

likely better define the extent of the *M. ogunnus* invasion into the Cayman Islands. The adaptability of *M. ogunnus* to differing environmental conditions leads us to anticipate that it will successfully compete with and probably displace some of the native species and may become a dominant zooplankter in the area.

It is probable that *M. ogunnus* has been transported along with aquaculture organisms to other parts of the world, since it has been recorded from aquaculture ponds in the Ivory Coast. Aquacultural activities have apparently effected the introduction of several species of copepods. For example, the Asiatic calanoid, *Boeckella triarticulata*, was apparently introduced to Italy together with Chinese carp. *Pseudodiaptomus marinus*, another Asiatic calanoid, was possibly introduced in a similar manner into the United States. *Pseudodiaptomus trihamatus* of the Indo-Pacific may have been introduced to Brazil with the shrimp *Penaeus monodon.* Finally, *Mesocyclops ruttneri*, an East-Asian cyclopoid was perhaps introduced to the Southern U.S. by rice culture (reviewed by Reid and Pinto-Coelho 1994).

The other copepods found in the Cayman Island ponds we sampled (species of *Tropocyclops* and *Apocyclops panamensis*) have different ecological niches and may not be competitors of *M. ogunnus. Apocyclops panamensis*, the most abundant species in the Cayman Island ponds sampled, was introduced to the Ivory Coast from Western Atlantic coasts (Dumont and Maas 1988). The only calanoid found in the Cayman Island ponds is *Mastigodiaptomus nesus*; however, the specimens recorded during this survey lack the characteristic dorsal keel described by Bowman (1986) for this species.

Thermocyclops tenuis had previously been recorded only from Grand Cayman (Reid 1990), and the new records from Little Cayman and Cayman Brac represent a modest range extension for this cyclopoid. Specimens from this area have been deposited at the National Museum of Natural History, Smithsonian Institution (USNM-268059).

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