OSMOREGULATION BY FIDDLER CRABS (GENUS *UCA*) FROM THE NORTHERN CARIBBEAN.

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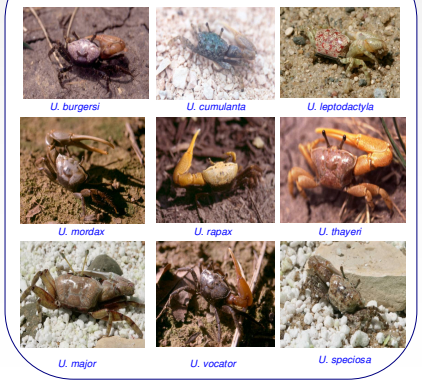
ABSTRACT

The ability to maintain the homeostasis of internal solute and solvent concentrations is well established for several species of *Uca* from North America. However, osmoregulation has been examined in few of their Caribbean relatives. During this investigation, nine *Uca* spp. were collected from four locations in the northern Caribbean: Belize, Bahamas, Jamaica, and USVI. From field studies, any one *Uca* species taken from several sites exhibited considerable variation in tolerance of environmental salinity (mOsm). After 5 d exposure, *Uca* spp. from each location were examined for their osmoregulating ability in solutions ranging from 20 to 3500 mOsm.

Considering *Uca* by subgenus, the [ISO] for *Minuca* ranged from 587 to 768 mOsm while *Leptuca* ranged from 805 to 881 mOsm. Furthermore, the mean [ISO] for each species reflects its preference for an oligo-, meso-, or euhaline habitat. This study broadens our understanding of ecological physiology in Caribbean *Uca* and demonstrates intra- and interspecific differences among tropical fiddler crabs.

Fiddler Crab Species (Genus: *Uca*)



INTRODUCTION

Fiddler crabs (genus *Uca*) are common along the shores of protected lagoons, estuaries and bays around the world (Crane 1975). Their habitats are restricted to thin, intertidal margins close to the sea where they are constantly buffeted by the flow of the ocean. In all tropical and temperate regions, there are between 90 and 100 species. At just about any location, several species inhabit the shore. Three species of *Uca* can be found as far north as Cape Cod, MA. On the other hand, seven (different) species can be collected from an estuary in tropical Belize. Why are there so many crabs at one location? The most-likely answer is that they "partition" the habitat into distinct, separate niches. The more salient features in a fiddler crab's habitat are: 1) temperature, 2) substrate composition, 3) substrate grain size, 4) patterns of tidal inundation and 5) water quality. Biological factors such as vegetation, predators, and mates are also extremely important. Since the availability of salts and water is crucial for their survival, they are linked to the sea and use a variety of physiological and behavioral mechanisms to survive periods away from the ocean. Across the broad geographic distribution of any one species, a fiddler crab may be confronted by a wide range of habitats with very different salinities.

Osmoregulation has been studied in only three species of *Uca* from the Caribbean. The object of this investigation was to collect and compare osmoregulating abilities of nine fiddler crabs from this area. The results of those physiological observations are reported here.

MATERIALS AND METHODS

Between 11- 15 March 2005, *Uca leptodactyla, U. burgersi, U. cumulanta*, and *U. rapax* were collected in Jamaica. Between 3 - 10 January 2006, *U. burgersi, U. rapax* and *U. vocator* were collected from Stan Creek, Belize. *Uca mordax* were collected from Boom Creek. *Uca thayeri* and *U. burgersi* were collected at the mouth of Anderson Lagoon and *U. rapax* were acquired from Tobacco Range Caye. From 11-14 May 2007, Uca were collected in the USVI. In St. Thomas, USVI, *U. burgersi* and *U.rapax* and in St. John, USVI, *U. rapax, U. thayeri,* and *U. leptodactyla.* Between 17-23 July 2007, *U. burgersi, U. major, U. speciosa, and U. leptodactyla* were gathered from Pigeon Creek, San Salvador, Bahamas. Crabs from each location were transported to Iowa by air. In the lab, the ability of each species to tolerate solute concentrations ranging from 25 to 3550 mOsm was determined by placing specimens in bowls with 50-100 mL of various solutions. Following an exposure to the solutions for 5 days, 10 µL of hemolymph was taken from each crab and the osmolality (mOsm/Kg) measured using a Wescor 2250 Vapor Pressure Osmometer. The mOsm of water samples from each location was also estimated. For each measurement, an average for all crabs was calculated as Mean ± SEM. Statistical significance was assessed with a "T" test. Probit analysis was used to estimate LLC_{50} and ULC_{50}.The isosmotic medium concentration [ISO] for each species was calculated from a linear regression of hemolymph with medium mOsm. Since several populations of some *Uca* were collected, both intra- as well as interspecific physiological variation can be estimated.

Results

Field/Lab Studies ☐☐

Species	Location	Habitat mOsm	LLD50	ULD50	[ISO]
Subgenus *Minuca*					
U. mordax	Boon Creek, BE	18	-	1619	**587**
U. burgersi	Pear Tree, JA	34	-	1681	686
	Perseverance, STT	187	86	1739	702
	Sittee River, BE	386	-	1853	699
	Pigeon Creek, SS	1149	-	2566	792
					AVG 718 ± 42
U. vocator	Sittee River, BE	386	-	1993	**718**
U. rapax	Sittee River, BE	386	-	2476	738
	Enight's Pond, STJ	1004	-	3330	725
	Tabacco Range, BE	1027	-	3210	815
	Cobre River, JA	1037	47	2833	779
	Compass Point, STT	2760	26	3373	783
					AVG 768 ± 32
Subgenus *Boboruca*					
U. thayeri	Anderson Creek, BE	924	147	2090	802
	Coral Bay, STJ	1088	85	1906	807
					AVG 805 ± 3
Subgenus *Leptuca*					
U. leptodactyla	Pear Tree, JA	99	82	1805	811
	Fish Bay, STJ	1089	58	1926	808
	Pigeon Creek, SS	1149	77	2857	797
					AVG 805 ± 6
U. cumulanta	Dawkins Lagoon, JA	1037	58	2194	**881**
U. speciosa	Pigeon Creek, SS	1149	-	2958	**822**
Subgenus *Uca*					
U. major	Pigeon Creek, SS	1129	91	2672	**930**

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Gerace Biological Station, San Salvador, Bahamas
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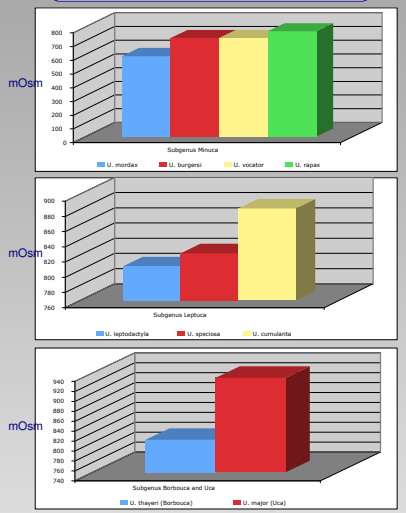
[ISO] Hemolymph mOsm by Subgenus



SUMMARY & CONCLUSIONS

- In general *Uca* are excellent regulators. In nature, they are found in habitats with salinity as low as 18 mOsm and high as 2760 mOsm.
- Members of the *Minuca* subgenus appear to occupy the widest array of habitats when viewed from an osmotic perspective: *U. mordax* 18-386, *U. burgersi* 34-1149, *U. vocator* 122-386 and *U. rapax* 386-2760.
- The three *Leptuca* species occupy different habitats: *U. speciosa* and *U. leptodactyla* prefer high salinity habitats (~1100 mOsm) with coraline sands. *U. cumulanta* also prefers high salinity (1037 mOsm) but with soft, silty mud.
- The *Boboruca*, *U. thayeri* (922-1088 mOsm), is limited to high mOsm in the upper intertidal while the *Uca, U. major* (1050 mOsm), is limited to lower intertidal niches.
- In the laboratory, all *Uca* were found to be excellent hyper- and hypo- osmotic regulators. Collectively, they are able to survive hyperosmotic stress two to three times greater than those they confront in nature. U. *mordax* was able tolerate 0-1600 mOsm, *U. burgersi* 0-2566 mOsm, *U. vocator* 0-2000 mOsm, *U. rapax* 25-3373 mOsm , *U. leptodactyla* 82- 2857 mOsm, *U. cumulanta* 58-2200 mOsm, *U. thayeri* 147-2200 mOsm, *U. speciosa* 67-2958 mOsm, and *U. major* 54-2672 mOsm.
- Among fiddler crabs the mean [ISO] in mOsm appears to reflect preferred habitat osmolality: In *Minuca, U. mordax* [587], *U. burgersi* [718], *U. vocator* [718] and *U. rapax* [768]. The *Boboruca, U. thayeri* [805]. The *Leptuca, U. leptodactyla* [805], *U. speciosa* [822] and *U. cumulanta* [881]. The *Uca, U. major* [930].