NOTES AND NEWS

OCCURRENCE OF THE NON-INDIGENOUS GIANT MALAYSIAN PRAWN, *MACROBRACHIUM ROSENBERGII* (DE MAN, 1879) IN SIMMONS BAYOU, MISSISSIPPI, U.S.A.

BY

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INTRODUCTION

The demand for seafood coupled with the decline of fisheries species worldwide due, in part, to overfishing and habitat degradation has resulted in an increase in land-based and offshore aquaculture facilities. Ironically, the growth of aquaculture is often met with mixed blessings because it has the potential to damage riverine and estuarine ecosystems through habitat degradation, waste disposal, nutrient rich effluent, and non-indigenous species and/or pathogen introductions (Courtney & Williams, 1992; Williams & Meffee, 1998; Lodge et al., 2000a; Naylor et al., 2000, 2001). Most species of interest to the aquaculture community have characteristics such as high survival rates, wide tolerance to environmental conditions, high growth rates, and favorable reproductive rates (Naylor et al., 2000) while being an economically viable product. Aquaculture is also one of the leading vectors of aquatic invasive species worldwide (Naylor et al., 2001), with conservative estimates of economic costs of 79 of the more than 6500 non-indigenous species approaching 97 billion dollars in the United States alone (Williams & Meffee, 1998).

One species that has become very popular in the aquaculture industry for the above reasons is the giant Malaysian prawn, *Macrobrachium rosenbergii* (De Man, 1879). During the course of surveys for non-indigenous fish species, we encountered this species in Simmons Bayou, Mississippi, U.S.A. *Macrobrachium*

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rosenbergii is native to southeastern Asia and is found in freshwater lakes and rivers (Raman, 1967). However, many *Macrobrachium* spp. (Harikrishnan & Madhusoodana Kurup, 1998; Bowles et al., 2000) require estuarine conditions for hatching and larval metamorphosis prior to growth that occurs during upstream migrations in rivers and freshwater systems. The postlarval and juvenile stages of this large prawn (males grow to 320 mm total length; Holthuis, 1980) are eurythermal, withstanding water temperatures between 16 and 42°C with optimal growth around 28°C (Chen & Kou, 1996; Herrera et al., 1998). Stressful low dissolved oxygen concentrations do not occur until 2 mg/l with a lethal limit of 0.5 mg/l (Avault, 1986). These environmental characteristics exemplify its maintainability in captivity, making this species a prized commercial product.

As the aquaculture industry develops in our region, there is concern that escaping *M. rosenbergii* will acclimate to the surrounding low salinity wetlands of south Mississippi and become established. Accidental escapes either through poor management practices (e.g., unfiltered effluent) or natural phenomena (e.g., hurricanes) can lead to "biological pollution" with irreversible impacts (Naylor et al., 2001). Furthermore, research has documented that *M. rosenbergii* is a carrier of and resistant to white spot virus (Hameed et al., 2000), allowing *M. rosenbergii* to potentially pose a threat to native prawns and other ecologically (palaemonid) and economically (penaeid) important shrimp species. However, the degree of interaction with native prawns and other palaemonid and penaeid shrimp species is unknown. In this note, we report on the presence of *M. rosenbergii* and the environmental conditions under which it was collected in the hope this information will be useful to monitor the future distribution of *M. rosenbergii* in coastal Mississippi.

METHODS AND MATERIALS

Four fixed stations were sampled from January 2001 through November 2001 in Simmons Bayou, Jackson County (Township 8 S, Range 8 W, Section 2) Mississippi, which connects to Davis Bayou and ultimately, the Mississippi Sound. This bayou receives freshwater input from run-off as well as an aquaculture facility's effluent. The sampling stations were located along a salinity gradient that is more strongly influenced by tide and wind than by freshwater input. Station A (upper most along the gradient) was located in a freshwater stream that flows into Simmons Bayou upstream from an aquaculture facility's effluent. Station B was located in the mouth of the effluent from the aquaculture facility, whereas Station C was located between the facility's effluent and the north branch of Simmons Bayou where freshwater input, effluent, and the bayou water are mixed. Station D was located 1.2 km downstream from the effluent of the aquaculture facility in the north branch of Simmons Bayou.

All stations except those at Station B were sampled primarily with a 1.83 m × 3.15 m seine (3.2 mm Delta mesh netting). Station B was sampled with two kick-sets as the seine was posted at the confluence of the effluent and the freshwater stream (Station A). Once, a 1.83 m × 15.25 m bag seine (3.2 mm Delta mesh) was used to sample Station D. All specimens were fixed in 10% formalin for 7 days, washed overnight in freshwater, and preserved in 70% ethanol. Specimens were identified, counted, sexed (juvenile, male or female), and total length (mm; TL) was measured. All individuals ⩽42.0 mm TL were categorized as juveniles because of the difficulty in accurate sex determination below that size. Post-larval and young penaeid shrimp were identified using Williams (1958), Ringo & Zamora (1968), or Zamora & Trent (1968) and scientific names follow Pérez Farfante & Kensley (1997). All samples are archived in the biological collections housed at the Mississippi Museum of Natural Science (MMNS), Jackson, Mississippi (13 lots of *Macrobrachium rosenbergii*, catalogue # MMNS 1901-1913). Depth (m), water temperature (°C), dissolved oxygen (mg/l; DO), salinity (‰), current flow (m/s), conductivity (μS), and GPS coordinates (Garmin, Model 45) were measured at a fixed reference point for each station. Since the project focused on non-indigenous fishes, our collections of invertebrates, prior to the capture of *M. rosenbergii* were not consistent.

RESULTS

From January to November, water temperature ranged from 10.2 to 29.7°C, salinity ranged from 0 to 13.5‰, DO ranged from 1.1 to 11.5 mg/l, depth ranged from 0.10 to 1.3 m, and current speed ranged from 0 to 5.3 m/s among

TABLE I

Environmental variables ($\bar{x} \pm$ S.E.) for all stations combined by month in Simmons Bayou, Mississippi

Month	Temperature (°C)	Salinity (‰)	Dissolved oxygen (mg/l)	Depth (m)	Current flow (m/s)
January	14.3 ± 1.5	2.8 ± 0.9	9.8 ± 0.7	0.41 ± 0.1	0 ± 0
March	19.9 ± 2.4	0.53 ± 0.2	8.4 ± 0.5	0.15 ± 0.0	2.5 ± 1.0
April	26.0 ± 1.1	2.4 ± 1.4	7.6 ± 0.2	0.56 ± 0.3	0 ± 0
May	27.5 ± 0.6	6.5 ± 2.1	4.5 ± 0.8	0.8 ± 0.2	0 ± 0
June	27.4 ± 0.3	1.0 ± 0.0	7.0 ± 0.3	0.6 ± 0.1	0 ± 0
July	26.6 ± 1.0	0.78 ± 0.78	4.0 ± 0.7	0.3 ± 0.0	0 ± 0
August	28.0 ± 0.5	3.6 ± 0.5	1.4 ± 0.1	0.6 ± 0.1	0 ± 0
September	22.5 ± 0.5	2.8 ± 0.7	3.5 ± 0.5	0.4 ± 0.1	0.5 ± 0.4
October	23.6 ± 1.1	4.8 ± 2.9	5.8 ± 0.9	0.2 ± 0.1	2.1 ± 1.3
November	22.8 ± 0.1	12.0 ± 0.6	2.4 ± 0.1	0.4 ± 0.0	0 ± 0

TABLE II
Comparison of *Macrobrachium rosenbergii* (De Man, 1879) abundance to the abundances of co-occurring species collected in Simmons Bayou by month

Month	*Macrobrachium rosenbergii* (De Man, 1879)	*M. ohione* (Smith, 1874)	*Palaemonetes pugio* Holthuis, 1949	*P. vulgaris* (Say, 1818)	*Litopenaeus setiferus* (Linnaeus, 1767)	*Farfantepenaeus aztecus* (Ives, 1891)
January	0	0	3049	24	0	0
March	0	0	658	1	0	0
April	0	0	577	0	0	0
May	2	0	61	0	0	64
June	8	0	0	0	0	0
July	2	2	0	0	0	0
August	17	0	147	0	0	0
September	5	0	124	0	14	0
October	5	0	2168	0	119	174
November	1	0	840	0	126	7

stations within month. Monthly mean values (± S.E.) for all stations are presented in table I. Between May and November 2001, a total of 40 *Macrobrachium rosenbergii* were collected consisting of 11 juveniles, 4 females, and 25 males (table II; fig. 1A). The TL size range for females was 47.99 to 119.38 mm, whereas TL ranged in males from 42.10 to 96.27 mm. Juvenile *M. rosenbergii* ranged from 22.89 to 41.03 mm TL. Other native shrimp species were collected along with *M. rosenbergii* (table II); the majority of white shrimp, *Litopenaeus setiferus* (Linnaeus, 1767) (96%), and brown shrimp, *Farfantepenaeus aztecus* (Ives, 1891) (100%) were in post-larval and juvenile stages. Interestingly, 98% of *L. setiferus* and 85% of *F. aztecus* were collected at the most saline station (Station D), in comparison to only 27.5% of the *M. rosenbergii*. Forty percent of the *M. rosenbergii* were captured at Station A, whereas <1% of *L. setiferus* and only 7% of *F. aztecus* were captured there. In addition, juvenile *M. rosenbergii* were captured only at Stations A and B between May and August (fig. 1B).

CONCLUSIONS

This is the first reported case of *Macrobrachium rosenbergii* in Mississippi waters. Little can be stated about the range of environmental conditions under which these specimens were collected because of the short duration and small spatial scale of the study. It is clear, however, that salinity plays a role in development of the species within its natural range (Harikrishnan & Madhusoodana Kurup, 1998). Given the range of sizes we collected in low salinity conditions, this species is not

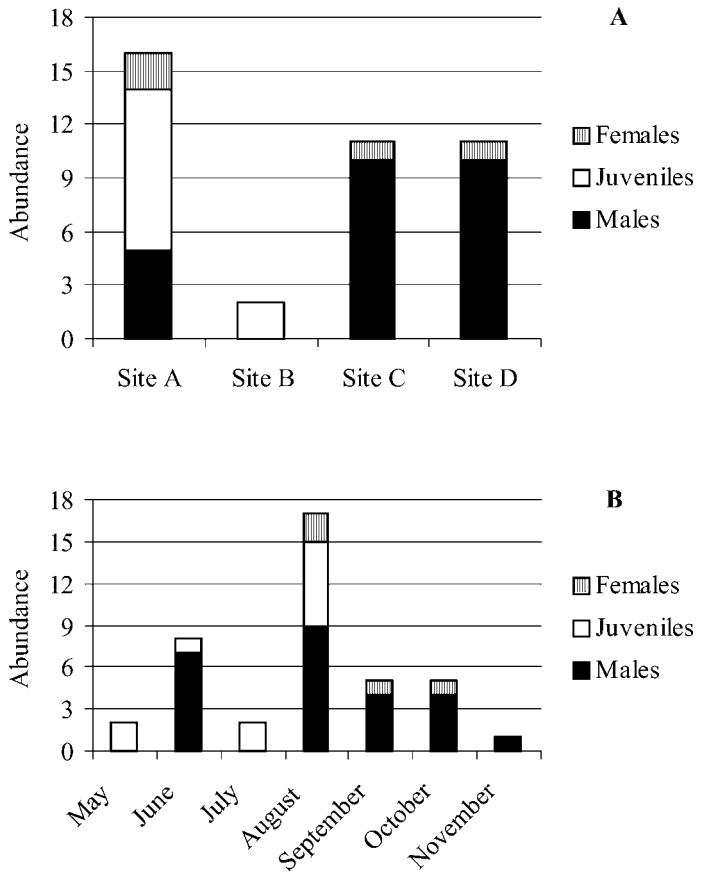

Fig. 1. A, The abundance of *Macrobrachium rosenbergii* (De Man, 1879) for each collection station by gender; B, the abundance of *Macrobrachium rosenbergii* (De Man, 1879) by month and gender in Simmons Bayou, Mississippi.

physiologically challenged in this system. Interestingly, seventeen *M. rosenbergii* were collected on 30 July (listed as August in table I) when DO ranged from 1.1 to 1.8 mg/l. Raman (1967) describes the waters in southeastern Asia as having high and uniform DO levels, but Avault (1986) indicated that these prawns are stressed when DO levels are low (2 mg/l) and DO is lethal when levels approach 0.5 mg/l.

Aquaculture has been established in the U.S. for more than 100 years, but it remains relatively undeveloped in comparison to the rest of the world. While farmed seafood contributes more than 25% by weight to world seafood production, U.S. production is less than 3% of world aquaculture production (USDC, 2000). In Mississippi, there is movement to develop large facilities to culture this prawn throughout the state. The life history characteristics of this species, and their ability to carry and transfer the white spot virus to other ecologically and economically important native shrimps should be considered when permitting such activities

near Mississippi aquatic habitats. The occurrence of juveniles in four consecutive monthly samples indicates multiple escapes/releases and/or spawning in the wild (or some combination of both). Thus, permitted facilities, as well as those entities responsible for regulating and permitting aquaculture activities, should adhere to responsible aquaculture practices such that escapement or accidental release is minimized as has been proposed for non-indigenous crayfish species (Lodge et al., 2000b).

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