Ecology of aquatic invertebrates in temporary habitats: *Caenestheriella setosa* (Conchostraca, Crustacea) in Delta Marsh, MB, Canada

Brenda J. Hann
Department of Zoology, University of Manitoba
Winnipeg, Manitoba R3T 2N2

Introduction

The Conchostraca, or clam shrimps, are common inhabitants of temporary freshwater ponds and pools, especially in spring and early summer (Bishop 1967a,b; Pennak 1989). They appear to be remarkably adapted to the extreme seasonal variability and diurnal fluctuations in environmental conditions that occurs typically in such ephemeral water bodies (Eriksen 1966; Eriksen and Brown 1980; Bishop 1967a,b). As a group, they have a wide geographic distribution but many species have a restricted local distribution (Mattox 1959; Pennak 1989). Clam shrimps swim by "rowing" movements of the large biramous second antennae (Pennak 1989). They feed on algae, bacteria, protozoans, and detritus (Pennak 1989).

Conchostracans can produce two types of eggs: (1) summer eggs which hatch almost immediately, and (2) winter or "resting" eggs which can withstand heat, cold, and desiccation (Pennak 1989). Resting eggs provide a mechanism for continuity between generations of clam shrimps whose habitat typically dries up or freezes annually. Conditions conducive to hatching of resting eggs in the laboratory may include periods of freezing, drying, or both (Mattox and Velardo 1950, Belk and Belk 1975), and are likely species-specific.

Development of conchostracans is rapid as water temperatures warm in the spring, and proceeds from a nauplius through a series of instars, each separated by ecdysis of the exoskeleton (Herrick and Turner 1895; Plate 48, Fig. 1, 11; Mattox 1939).

Distribution of clam shrimps is puzzling as populations may be abundant in particular ponds in some years but absent in others. Occurrence appears to be serendipidous as ponds adjacent to one another, and seemingly similar in ecological characteristics, may differ in abundance or presence of clam shrimp populations (Horne 1967; Pennak 1989; Hann, pers. obs.).

This report summarizes information relating to the life history and ecology of the clam shrimp *Caenestheriella setosa* in three locations in Delta Marsh.

Study Sites and Sampling Methods

Seasonal sampling took place at three sites. The first site was a roadside pond (0.5 ha), 30-50 cm depth, surrounded by *Typha*, and fishless, located near the Delta Waterfowl and Wetlands Station. The pond was sampled qualitatively using a sweep net, weekly May-July 1982.

The second site was Mist Net Pond, a small (20 m x 3 m) pond on the forested beach ridge between L. Manitoba and Delta Marsh, located at the University Field Station. The pond fills with melt water in spring and is replenished with rainwater; there are no inflows or outflows. The pond rarely dries completely over the summer months. There are no vertebrate predators in the pond, and few invertebrate predators, e.g. dytiscid beetle larvae, *Hydra*. Funnel traps (modified from Whiteside and Williams 1975) were used to sample the pond daily, May-July 1984. Traps were set for 2 sequential 12-hour periods, with numbers pooled to represent a combined 24-hour period. Two sampling stations were established, both near maximum depth of the pond, one toward the north end of the pond, and the second toward the south end. The northern station was shaded while the southern station was exposed to full sunlight throughout the day.

The third site was Crescent Pond (described in Hann 1991). Murkin activity traps (modified from Murkin *et al.* 1983) were used to sample weekly from June-August 1988. Traps were set at several locations in open water and adjacent to the *Typha*-open water interface for 12-hour periods (details in Hann 1996). Crescent Pond was virtually fishless in 1988.

All samples were preserved with 4% formalin prior to counting, and carapace lengths were determined using calipers. Dry weight was determined after drying for 24 hrs at 60°C, then individual specimens were weighed using a Cahn electrobalance.

Results and discussion

Growth

Growth in crustaceans occurs in a step-wise manner coincident with moulting of the exoskeleton (ecdysis). Modal size of each successive instar in a population can be determined from length-frequency histograms. These were constructed for each sampling date in the Delta Waterfowl Station pond and Mist Net Pond. In the Delta Waterfowl Station pond, frequency peaks suggest that 4 instars (modal sizes: 0.75 mm, 1.5 mm, 2.9 mm, 3.5 mm) were found in this population of *C. setosa* (Fig. 1) throughout the spring and early summer. In the Mist Net Pond population, 4 instars occurred (modal sizes: 2.9 mm, 3.8 mm, 5.0 mm, 5.5 mm) (Fig. 2). However, as sampling did not commence in Mist Net Pond until the end of May, it is probable that passage through the earliest instars of *C. setosa* had occurred earlier in May. Thus, at least 6 instars may occur during seasonal development of a population of *C. setosa* in ephemeral ponds in Delta Marsh. Carapace lengths were not determined for the Crescent Pond population, so comparable instar sizes are unavailable.

The bivalved carapace is almost circular and individuals appear as "swimming balls" in the water column. Eriksen and Brown (1980) noted the apparently high energetic costs of such a shape for an actively swimming organism. There was a strong, positive relationship between carapace length and dry weight for individuals of the Mist Net Pond population (Fig. 3). The least squares regression equation describing this relationship was Y = 0.019 X - 0.040, $r^2 = 0.544$.

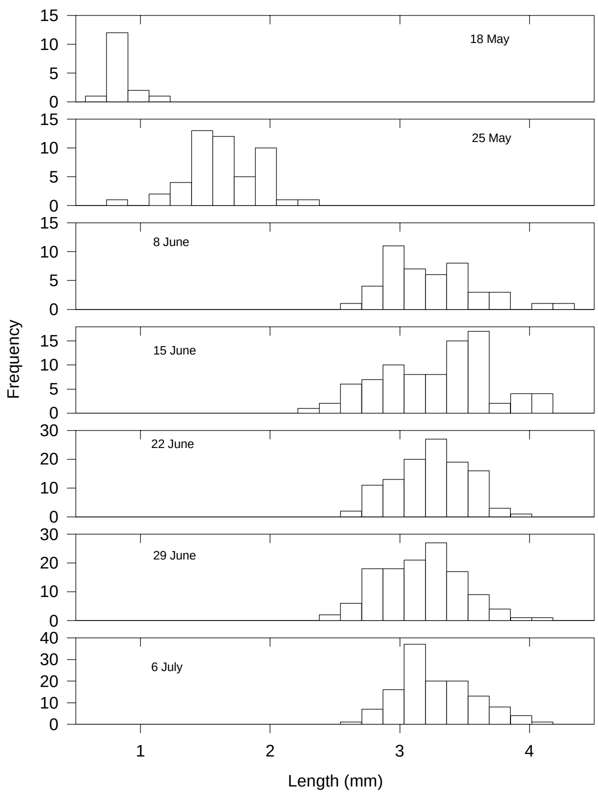

Figure 1. Size-frequency distributions of *C. setosa* in Delta Waterfowl Station pond.

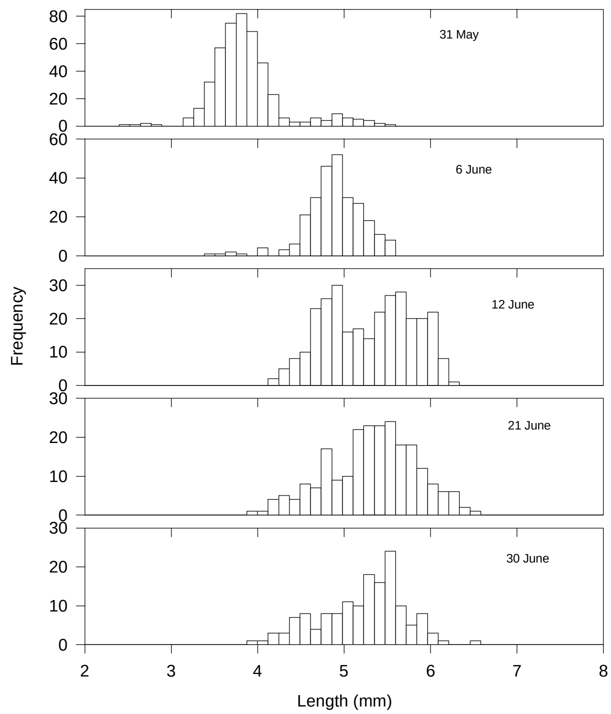

Figure 2. Size-frequency distributions of *C. setosa* in Mist Net Pond, Delta Marsh.

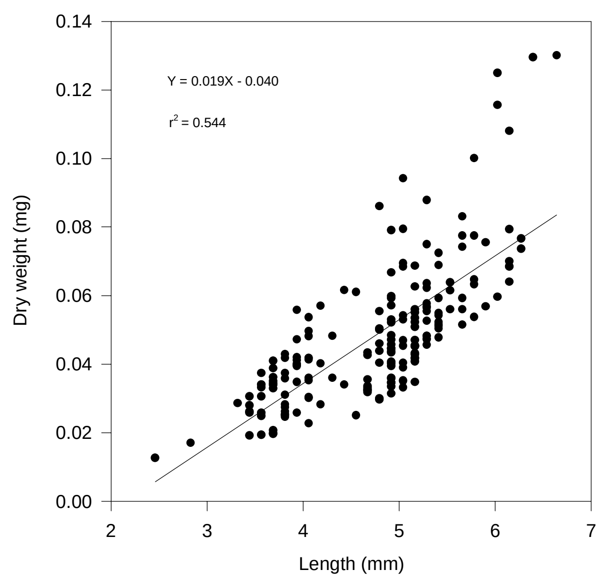

Figure 3. Length-weight relationship for *C. setosa* in Mist Net Pond, Delta Marsh.

Population Dynamics and Ecology

In Mist Net Pond, population numbers were highest from the end of May to mid-June, after which numbers declined rapidly (Fig. 4). None was collected after mid-July. Numbers at the two sampling stations in the pond were similar through June. In late June, a peak in abundance occurred only at the northerly sampling station. *Lemna*, or duckweed, appeared on the pond surface in late May and its entire surface was covered with a 5-10 cm thick layer of *Lemna* by early July. The population decline may have been a consequence of declining amounts of dissolved oxygen, although percentage saturation remained in excess of 10% throughout July (Laberge and Hann 1990; Hann 1997). Female clam shrimps can regulate V_{O2}, enabling them to maintain a constant level of oxygen consumption at extremely low dissolved oxygen concentrations (Eriksen and Brown 1980). Horne (1971) noted that *C. setosa* was "far more tolerant" of low dissolved oxygen concentrations than other phyllopod crustacean inhabitants (e.g. fairy shrimps (Anostraca), tadpole shrimps (Notostraca)) of ephemeral water bodies. Fairy shrimps have been collected from Mist Net Pond soon after ice melts in May, persisting into early June only when water temperatures are lower and dissolved oxygen concentrations are undoubtedly much higher than later in the season (Hann, unpubl. data).

In addition to severely reducing the diffusion of oxygen into pond waters, the thick surface layer of *Lemna* also drastically attenuates light penetration (Goldsborough 1993, Lewis and Bender 1961, Morris and Barker 1977), probably resulting in low phytoplankton biomass. As the gut contents of *C. setosa* have not yet been examined, the importance of phytoplankton in its dietary intake in comparison with bacteria and detritus cannot be determined.

In Crescent Pond, in the open water areas as well as at the *Typha*-open water interface, the population of *C. setosa* was largest during June, particularly in the open water, and declined to small numbers during July and August (Fig. 5). Conchostracans were not collected during intensive sampling of Crescent Pond in 1986 when planktivorous fish (fathead minnows, brook sticklebacks) were present (Hann 1996).

Although sampling in the Delta Waterfowl Station pond was qualitative only, seasonal changes in population abundance paralleled those in both Mist Net Pond and Crescent Pond. The population peaked in June and declined to very small numbers by early July when sampling ceased.

In Delta Marsh, conchostracans occupy ephemeral water bodies or less temporary habitats that are devoid of fish predators. Populations peaked in June, then declined, probably as a consequence of decreased availability of food resources. Zooplankton populations also increase in abundance in June (Hann 1996) and may be more effective filter-feeders of both phytoplankton and bacteria than conchostracans.

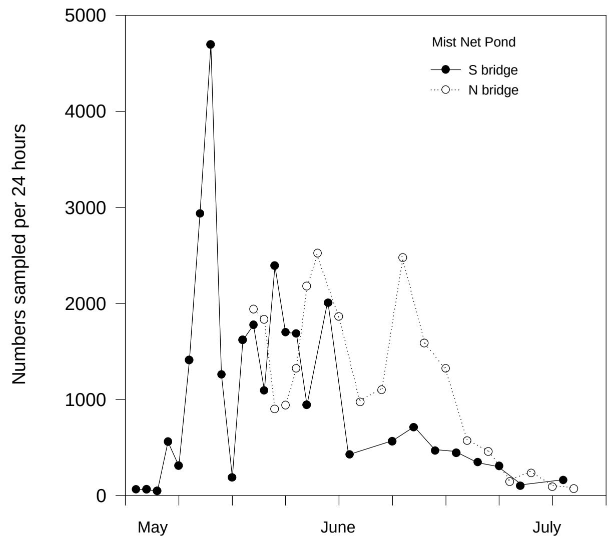

Figure 4. Numbers of *C. setosa* sampled per 24 hours in Mist Net Pond.

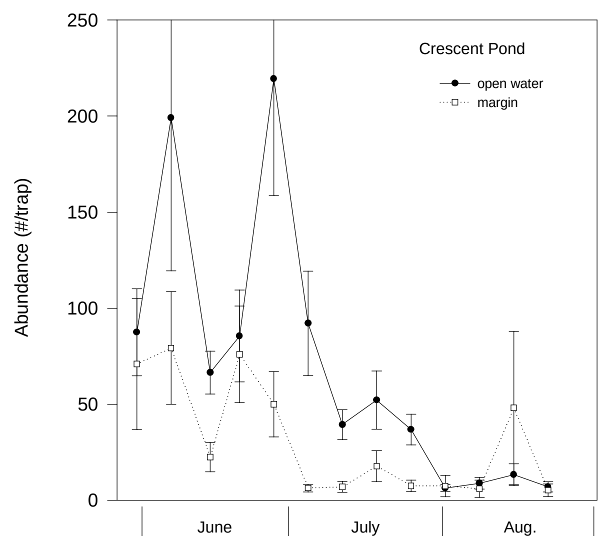

Figure 5. Numbers of *C. setosa* in open water and adjacent to *Typha*-water interface in Crescent Pond, Delta Marsh.

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