NOTES

HEART AND GILL VENTILATORY ACTIVITY IN THE LOBSTER, *HOMARUS AMERICANUS*, AT VARIOUS TEMPERATURES

Heart rate and gill ventilatory activity have been suggested as useful measures of the physiological condition of decapod crustaceans and their response to various environmental conditions. Several authors have described altered ventilatory and heart rates in response to such variables as temperature, salinity, and dissolved oxygen (Uglow 1973; Cumberlidge and Uglow 1977; Taylor 1977; Hagerman and Uglow 1979). Price and Uglow (1980) also discussed the applicability of these measures in studies of pollutant stress where they described the effects of copper, cadmium, and zinc on the heart and ventilatory rates of *Crangon crangon*. The mechanics of ventilatory reversals of decapod crustaceans have also been described; for example, the reverse ventilatory pulses (coughs) produced by the American lobster, *Homarus americanus*, during a muscular compression of the branchial chamber probably provide irrigation to the posterior area of the gills or help to clear detritus from gill surfaces (Wilkins and McMahon 1972; Bill and Thurberg 1985). The frequency of the lobster cough response increases after exposure to a variety of waterborne chemicals, and it has been suggested that this response might be a useful measure for detecting aquatic pollutants (Bill and Thurberg 1983, 1985). Before these heart and ventilatory measures can be employed as monitoring tools, however, baseline information should be collected on their seasonal variability under normal, unpolluted conditions, against which to interpret any stress-induced change. This study addresses the relationship between heart, gill-bailer, cough rate, and seasonal water temperature.

Methods

Adult American lobsters (61.4-91.2 cm carapace length) were trawl-collected in Long Island Sound off Milford, CT, and held in running seawater at ambient temperature. Seawater for this building is taken from Milford Harbor, a harbor with good tidal flushing and no industrial development. The pollutant content here is very low; for example, seawater cadmium is <0.5 ppb, mercury <1 ppb, lead <5 ppb, and copper 2-4 ppb. The PCB levels (0.67 ppm, wet weight) in blue mussels, *Mytilus edulis*, from Milford Harbor are typical of levels found in molluscs along the U.S. east coast (Farrington et al. 1983; Greig and Sennefelder 1985). Although no area of Long Island Sound can be considered "pristine", this area has excellent water quality for holding and rearing marine animals as evidenced by a 50-yr laboratory history of marine invertebrate culture. The salinity range is 26-28 ppt with occasional brief low salinity episodes during extreme rains (not during this study, however) and the dissolved oxygen levels remain at or near saturation at the temperatures in this study. The lobsters were fed chopped clams, fish, or crabs daily. Heart, gill-bailer, and cough rates were monitored with 6 mm silver disc electrodes, an impedance converter, and an amplified polygraph recorder, following the methods described in Bill and Thurberg (1985). Measurements were made at 2°, 6°, 10°, 14°, and 18°C over a 1-yr period. Each lobster was allowed to acclimate to temperature for at least 2 weeks before testing. Between 9 and 23 lobsters were monitored at each temperature for a 1-h period. Rates were calculated on a per-minute basis.

Results and Discussion

Crustacean metabolism varies with temperature (Wolvekamp and Waterman 1960; Taylor et al. 1977, 1973). Aiken (1980) observed that elevated temperatures accelerate the metabolic processes in lobsters, although the parameters were not defined. The data presented here confirm this increase in metabolism using three physiological parameters. Figure 1 shows the increasing frequency of heart and gill-bailer rates as the temperature rose from 2° to 18°C. Cough rate also increased with increasing temperatures (Fig. 2). Bill and Thurberg (1983) reported a cough rate of 0.4 coughs/minute at 10°C in this species, a rate similar to that reported in this study at 10°C (0.32 coughs/minute). The data reported here present a full seasonal profile of three important metabolic measures. They provide a

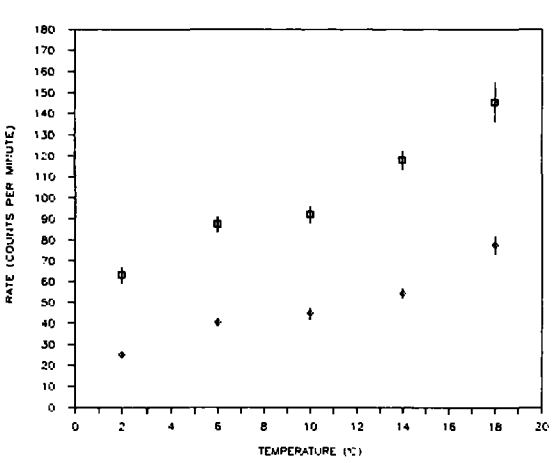

FIGURE 1.—Temperature (°C) versus heart (◇) and gill bailer (□) rate (counts per minute) of the American lobster, *Homarus americanus*, at 2°, 6°, 10°, 14°, and 18°C. Each point is the mean value of 9-23 lobsters and the vertical line is ±1 standard error.

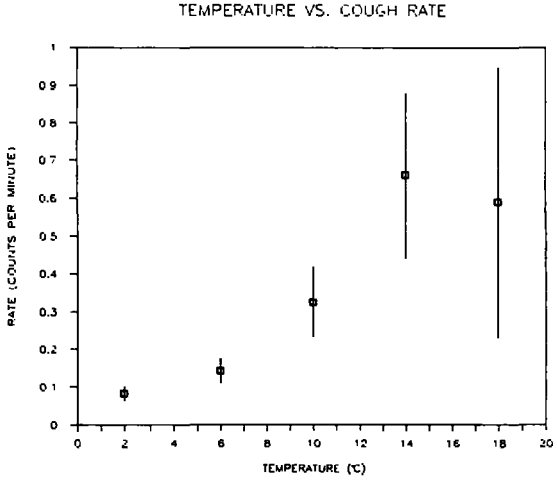

FIGURE 2.—Temperature (°C) versus cough (□) rate (counts per minute) of the American lobster, *Homarus americanus*, at 2°, 6°, 10°, 14°, and 18°C. Each point is the mean value of 9-23 lobsters and the vertical line is ±1 standard error.

comprehensive and easy-to-interpret baseline against which to compare similar measures made on lobsters from areas suspected of pollutant impact.

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