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Flow Reduction May Explain Sporadic Occurrence of Craspedacusta sowerbyi (Trachylina) Medusae

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GENERAL NOTES

FLOW REDUCTION MAY EXPLAIN SPORADIC OCCURRENCE OF *CRASPEDACUSTA SOWERBYI* (TRACHYLINA) MEDUSAE.

The unpredictable appearance of medusae of the freshwater hydrozoan, *Craspedacusta sowerbyi,* has resulted in over 100 publications reporting its occurrence in the United States. Although the sessile polyp may be a common but inconspicuous (2-8 mm) inhabitant of stream communities throughout the U.S. and Europe, the appearance of the larger (1-2 cm diameter) sexual medusae in late summer attracts considerable attention. Specific environmental conditions that trigger transformation from the polyp to medusa stage are poorly understood despite several attempts to define them. Factors previously associated with medusa formation are increases in alkalinity, hardness, CO_2, temperature and a decrease in pH (Acker and Muscat, 1976; McCullough, Taylor, and Jones, 1981). Increased zooplankton production also has been related to medusae appearance by Acker and Muscat (1976). They observed that most investigators report similar physiochemical conditions associated with the medusae, but could not account for sporadic formation of this life stage. In a review, Pennak (1956) related that medusae generally appear in standing bodies of water such as man-made impoundments. We suggest that reduction in flow or circulation of water over the polyps is the underlying state factor that stimulates *C. sowerbyi* to form medusae.

Our investigation into the occurrence of medusae was initiated after a large group (over 1,240) was observed in a pool (960 m^2, 1.1 m average depth) of a headwater reach of the Illinois River, Washington County, Arkansas on August 2, 1982. Physical and chemical characteristics of the pool conformed to those generally associated with medusae, although their occurrence in an intermittent headwater stream is previously unreported. The average dissolved oxygen (D.O.) measured at the substrate level was 6.2 ppm, pH (6.3), temperature (29 °C), and conductivity 248 uMHOS cm^{-1}). The D.O. and pH approach the lowest values while temperature and conductivity approach the highest readings measured in a nearby pool where 12 months of data were collected during the same year. Discharge through the pool was measured as 0.5 m^3/sec the first day and declined to no surface flow within one week. The medusae persisted for two weeks after the first sighting while the conditions in the pool remained rather stable. Medusae were observed in the same pool August 16, 1983 shortly after the pool became intermittent.

Some investigators (Lytle, 1960; Hutchinson, 1967) have recognized that medusae are typically associated with standing bodies of water and the hydroid chiefly with running waters, but no causal relationship between medusae formation and flow reduction has been suggested. Our observations suggest that reduction of circulation of water over the polyps may be the ultimate cause of medusae formation in *C. sowerbyi.* The physiochemical conditions which usually accompany production of medusae would normally result from significant flow reductions. The association of increased alkalinity and hardness with medusae formation would be expected in streams and reservoirs during low flow summer months, because evaporative water loss increases the concentration of dissolved solids. Increases of CO_2 and subsequent decreases in pH are common near the substrate in sluggish stream pools and stratified reservoirs in late summer due to the combined effect of increased temperature, lower dissolved oxygen, and more rapid decay of accumulated organic material. It is during these periods of low stream flow and summer reservoir stratification that medusae are produced. The physiochemical conditions may serve as proximate cues to the organism of the more adverse incipient conditions associated with reduced flow and circulation.

The availability of planktonic food to the polyp decreases as flow diminishes because fewer prey are transported within reach of this sessile stage. In contrast, the planktonic food supply in the water column above the substrate remains stable or increases in concentration and can be efficiently utilized by medusae. Increased sedimentation in static waters probably is the most limiting aspect of reduced flow because the 2-8 mm polyp could easily be covered with sediment rendering it non-functional. Such environmental conditions would favor the non-benthic planktivore medusa. This agrees with Acker and Muscat's (1976) observation that no polyps have been reported from areas with heavy sedimentation. Degradation of physiochemical conditions may serve as proximate cues for *C. sowerbyi* of these more adverse incipient conditions (reduction of food supply and sedimentation).

Other advantages accrued by transformation to medusae include the mobility to escape an unfavorable microhabitat, and genetic variability via sexual reproduction to produce offspring which achieve greater mean fitness in their changing environment. However, populations of medusae are usually reported to be unisexual, the eggs are probably not parthenogenic (Payne, 1924), and production of medusae may result in the destruction of the entire polyp (Acker and Muscat, 1976). Decreased frequency of medusae occurrence with increased age of impoundments may indicate depletion of these populations due to unsuccessful recolonization of the area by frequent production of unisexual medusae. Medusa formation by this species should not be considered to be a useless life stage, as Acker and Muscat (1976) have suggested, prior to more extensive research into their reproductive success. Only a few males might be required to fertilize the eggs produced by the apparently unisexual female populations.

We hypothesize that medusa formation is a response to reduced flow that results in spatial and temporal escape from the harsh environmental conditions that ensue.

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