REFERENCES

Enright, Christine A. 1971. A review of research on Type C botulism among water birds. Colorado Cooperative Wildlife Research Unit, Colorado State Univ. Fort Collins, 22 p.

Hunter, Brian F., William E. Clark, Patricia J. Perkins and Phillip M. Coleman. 1970. Applied botulism research including management recommendations—A progress report. Calif. Dep. Fish and Game, Sacramento. 87 p.

Washino, R. K., and Y. Hokama. 1968. Quantitative sampling of aquatic insects in a shallow-water habitat. Ann. Ent. Soc. Amer. 61(3): 785–786.

*Lawrence R. Espinosa and William E. Clark, California Department of Fish and Game, Wildlife Management Branch.* *Accepted December 1971. This study was supported by a grant from the U.S. Bureau of Sport Fisheries and Wildlife and by Federal Aid to Wildlife Restoration Project W-52-R "Wildlife Investigations Laboratory."*

# TOLERANCE OF HIGH SALINITY BY THE PILEWORM, *NEANTHES SUCCINEA*, FROM THE SALTON SEA, CALIFORNIA

The pileworm is an important item in the food chain leading to the orangemouth corvina (*Cynoscion xanthulus*) in the Salton Sea (Walker 1961). A fishery of an estimated 359,000 angler trips annually, with a harvest of 346,000 fish, is supported by this species (Robert C. Hulquist, Calif. Dep. of Fish and Game, pers. comm.). Increasing salinity is threatening the existence of this fishery. Walker (1961) predicted that it will be destroyed by 1980 if remedial actions are not taken to control salinities at a safe level. In 1966, the California Department of Fish and Game began a study to determine the tolerances to high salinities by the various organisms in the food chain as a basis for recommending target levels for a control plan (Hanson 1970). The salinity tolerance of adult pileworms was tested in laboratory experiments during January and February 1968.

Pileworms for the test were obtained by screening bottom samples taken along the shoreline. Test specimens were held in the laboratory for 3 to 5 days in shallow trays containing a mixture of bottom mud and clean sand covered with about an inch of water. Tests were conducted in 1-gallon glass jars containing the mud and sand mixture and 1 inch of Salton Sea water at various test concentrations. These concentrations were obtained by slow evaporation of the water. Ten worms were placed in each jar with no acclimation to hypersalinity. Controls (37‰) were run concurrently and all tests were performed in duplicate or triplicate. Exposure time was 96 hr.

Pileworms tolerated extremely high salinities (Table 1). Survival was 93.3% at 67.5‰. The lowest survival was 68.0% at 62.5‰. However, it appears that in this instance mortality was due to causes other than salinity, since mortalities occurred in all concentrations, including the controls.

Whether the pileworm can tolerate salinities higher than 67.5‰ was not determined, although it appears that they could. The fishery is expected to collapse, however, long before salinities become this high.

TABLE 1. Percentage Survival of *Neanthes succinea* After Exposure to High Salinities for 96 Hr

| Test number | Controls | | 42.5 ‰ | | 45 ‰ | | 50 ‰ | | 55 ‰ | | 60 ‰ | | 62.5 ‰ | | 65 ‰ | | 67.5 ‰ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number tested | Percent survival | Number tested | Percent survival | Number tested | Percent survival | Number tested | Percent survival | Number tested | Percent survival | Number tested | Percent survival | Number tested | Percent survival | Number tested | Percent survival | Number tested | Percent survival |
| 1 | 20 | 100 | 20 | 95.0 | -- | -- | -- | -- | -- | -- | -- | -- | 20 | 75.0 | -- | -- | -- | -- |
| 2 | 30 | 96.7 | -- | -- | 30 | 90.0 | -- | -- | 30 | 93.3 | -- | -- | 30 | 63.3 | -- | -- | -- | -- |
| 3 | 30 | 86.7 | -- | -- | -- | -- | 30 | 96.7 | 30 | 86.7 | -- | -- | -- | -- | 30 | 93.3 | -- | -- |
| 4 | 30 | 96.7 | -- | -- | -- | -- | -- | -- | 30 | 90.0 | 30 | 100 | -- | -- | -- | -- | 30 | 93.3 |
| Totals | 110 | 94.6 | 20 | 95.0 | 30 | 90.0 | 30 | 96.7 | 90 | 90.0 | 30 | 100 | 50 | 68.0 | 30 | 93.3 | 30 | 93.3 |

Moreover, reproduction of the pileworm would probably be adversely affected at lower salinities.

This work was performed as part of Dingell-Johnson Project F-24-R, "Salton Sea Investigation", supported by Federal Aid to Fish Restoration funds.

## REFERENCES

Hanson, Jack A. 1970. Salinity tolerances for Salton Sea fishes. Calif. Dep. Fish and Game, Inland Fish. Admin. Rep. No. 70-2, 8 p.

Walker, Boyd W. (editor) 1961. The ecology of the Salton Sea, California, in relation to the sportfishery. Calif. Dep. Fish and Game, Fish Bull. (113): 1-204.

*Jack A. Hanson, Inland Fisheries Branch, California Department of Fish and Game.* *Accepted October 1971.*

# RANGE EXTENSION OF *PALAEMONETES PALUDOSUS* (GIBBES) IN CALIFORNIA

The freshwater decapod shrimp, *Palaemonetes paludosus*, was introduced into the lower Colorado River in 1958 by the California Department of Fish and Game (Hayden and Ringo 1963) and was raised commercially prior to 1967 at Sargent's Tropical Fish Farm, located on the southeast side of the Salton Sea below the Hot Mineral Spa. The shrimp has not become numerous in the section of the Colorado River where it was introduced, but it is abundant in the Rio Hardy and Colorado rivers, Baja California (St. Amant and Hulquist 1969). The shrimp has recently appeared in waters below Sargent's Fish Farm.

On October 20, 1970, and March 16, 1971, John Day collected shrimp in a drainage ditch northeast of the Salton Sea, Imperial County. The ditch originates in the Hot Mineral Spa, a series of warm springs, and flows into the Salton Sea. The senior author collected 20 adult and juvenile shrimp in the ditch on March 23, 1971. The location of these collections is northeast (upstream) of Highway 111 where the ditch flows over the Liquid Waste Disposal Road. On April 8, 1971, St. Amant and Richard Smith collected additional shrimp in this area. Shrimp were also collected immediately below Highway 111. No shrimp were found between here and the Salton Sea.

An inspection on April 15, 1971, of the water areas in the Hot Mineral Spa vicinity by the senior author and Kurt and Bret St. Amant revealed shrimp in an isolated sump pond at the Sargent's Tropical Fish Farm. This fish farm has been closed since 1967. Two hundred shrimp were collected and numerous sailfin mollies, *Poecilia latipinna*, were also observed in this pond. In 1965 the pond contained a large resident population of *Tilapia mossambica* (St. Amant 1966), but no shrimp were observed at that time. Three shrimp were also found in the concrete box that once received hot water from the Spa. St. Amant collected additional shrimp in the ditch below Highway 111 with minnow traps on April 25, 1971.

The senior author identified the shrimp to be *P. paludosus*. Confirmation of identification was made by U. Chivers, California Academy of Sciences, and Joel W. Hedgpeth, Oregon State University.

In all of the collections the shrimp were associated with aquatic vegetation, *Chara* sp. and filamentous algae.