TEMPERATURE SELECTION AND GROWTH OF THREE HAWAIIAN REEF FISHES AND THEIR DISTRIBUTIONS IN AN AREA OF HEATED EFFLUENT

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION
OF THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN OCEANOGRAPHY

AUGUST, 1976

By

Patricia A. Medvick

Dissertation Committee:

Jed Hirota, Chairman
John E. Bardach
Brent Gallagher
George S. Losey, Jr.
John M. Miller
William H. Neill

ABSTRACT

The selected temperatures of three species of Hawaiian reef fishes, Acanthurus triostegus sandvicensis (manini), Abudefduf abdominalis (maomao), and Chaetodon multicinctus (butterflyfish), were determined under several experimental regimes in an electronically-controlled selection apparatus, designed by Neill et al. (1972) and Beitinger et al. (1975). A modification of the apparatus was made to stop the selection process during periods of fish inactivity. Experiments were designed to evaluate differences: (1) of median selected temperatures between juveniles and adults, (2) induced by shelter changes, and (3) induced by a change in food ration. The data obtained on selected temperatures included: overall 72 h medians, daytime and nighttime median temperatures, and diel periodicity. Median selected temperatures over a period of 72 h were as follows: C. multicinctus (juvenile to adult), 24.9°C; adult Ab. abdominalis, 25.9°C; juvenile Ab. abdominalis, 30.2°C; adult Ac. triostegus, 29.2°C, juvenile Ac. triostegus, 29.3°C. Juvenile Ab. abdominalis had a significantly ($P \leq .05$) higher median selected temperature than the adults. Juvenile Ac. triostegus selected their temperature over a wider range than adults. C. multicinctus and juvenile Ab. abdominalis selected higher median temperatures during the day than at night. With three different periodicity tests, circadian cycles were present in the selected temperatures for most individuals of all three species. The fishes also thermoregulated with shelters available in only half (i.e., one side) of the experimental tank and at a lowered feeding level (juvenile

Ab. abdominalis). C. multicinctus selected lower temperatures with shelters in the cooler compartment of the apparatus. There was no significant change (P>.05) in median temperatures selected by either juvenile Ac. triostegus or juvenile Ab. abdominalis with shelter changes. Juvenile Ab. abdominalis selected warmer temperatures at lower food levels.

To determine the relationships of growth rates and growth efficiency to the selected temperature and to the temperatures of the thermal plume from the HECO (Hawaiian Electric) power generating station at Kahe Point, Oahu, Hawaii, individually-held juvenile Ab. abdominalis were grown in six different temperature regimes (four constant-temperature and two cyclic-temperature) and at three different food levels. Growth rates of fish fed Artemia ad libitum were highest at the two highest temperatures tested, 29.4 and 32.4°C. At the two lower feeding levels, fastest growth occurred at 26.4°C. Growth rates in cyclic temperature were not significantly different from expected rates calculated from constant temperature results. Ab. abdominalis under 26.4-32.4°C cyclic temperature and low food levels grew at rates similar to fish on the same food levels but at 26.4°C constant temperature.

The spatial distributions of these three species in relation to the water temperature, substrate type, and depth were observed during SCUBA dives along transects in the vicinity of the thermal plume at Kahe in 1974 and 1975. Substrate type was of overriding importance in the occurrence and location of all three species, since they were absent in

sandy regions (i.e., substrates lacking shelter). C. multicinctus were associated with regions of live coral. Juvenile Ac. triostegus (<5 cm) frequently occurred at shallow depths in dead coral regions, while the larger Ac. triostegus occurred with approximately equal frequency in live and dead coral. Ab. abdominalis were associated with rocks or dead coral. Distributional patterns of fish and water temperature showed: (1) juvenile Ac. triostegus at the highest temperatures, (2) Ab. abdominalis and larger Ac. triostegus at intermediate temperatures, and (3) C. multicinctus at the lowest temperatures. When the minimum ambient water temperatures measured in the field were considered, no significant difference was found (except for the larger Ac. triostegus in 1975) between the temperatures at locations of fish sightings and their laboratory-selected median temperatures.