ABSTRACTS OF PAPERS

Second Annual Albert L. Tester Memorial Symposium
14-15 April 1977

The Albert L. Tester Memorial Symposium is held in honor of Professor Albert Tester who, at the time of his death in 1974, was Senior Professor of Zoology at the University of Hawaii. The faculty and students of the Department of Zoology proposed an annual symposium of student research papers as a means of honoring, in a continuing and active way, Dr. Tester's lively encouragement of student research in a broad range of fields within marine biology. Papers reporting original research on any aspect of biology are solicited from students at the University and these papers are presented at the symposium, which takes place during the spring semester. Income from contributions to the Albert L. Tester Memorial Fund of the University of Hawaii Foundation is used to provide two prizes, one for the best paper on fish or fisheries biology (Dr. Tester's own field of special interest) and one for the best paper in any other area. Papers are judged on quality, originality, and importance of research reported, as well as the quality of the public presentation. Judges at this symposium included several members of the faculty of the Department of Zoology as well as winners of the symposium from the preceding year. In addition, a distinguished scholar from another university is invited to participate in the symposium as a judge and to present the major symposium address. In 1977, Dr. R. G. Northcutt of the Division of Biological Sciences, University of Michigan, participated in the symposium.

Relaxin Levels During Pregnancy and Parturition in the Guinea Pig

SUSAN BOYD

Relaxin is a peptide hormone secreted by the ovaries and possibly the placenta and uterus in the guinea pig. In this species, it is known to be the myometrial inhibiting factor during pregnancy, and in preparation for delivery, relaxin is responsible for the widening of the pubic symphysis.

The purpose of this study is to determine the levels of relaxin present in the last trimester of pregnancy through day 1 of lactation and to correlate these levels with the opening of the pubic symphysis and time of delivery. Blood samples were collected daily from chronically catheterized guinea pigs.

To measure plasma relaxin levels, a radio-immunoassay (RIA) has been set up using purified porcine relaxin and an antiserum raised against this hormone. This assay is capable of measuring guinea pig relaxin as well as porcine relaxin, since inhibition in guinea pig plasma samples parallels the porcine relaxin standard. Levels in the guinea pig during pregnancy and parturition are...
expressed as ng/ml equivalents of porcine relaxin standard (CM-a'). Assays of guinea pig samples are currently being carried out and the results will be discussed.

A Contribution to the Biology of the Spotted Blenny, *Exallias brevis* (Pisces: Blenniidae)

**BRUCE A. CARLSON**

Field observations on the spotted blenny, *Exallias brevis*, were undertaken to meet two objectives: (1) to examine resource utilization and territorial and reproductive behavior and (2) to use this information in a comparative study involving closely related blennies of the genus *Cirripectes*. *Exallias brevis* at Hanauma Bay, Oahu, occur in coral-rich areas from 1 to 15 m deep and were observed to feed exclusively on coral tissue, particularly *Porites lobata*, *P. compressa*, and *Pocillopora meandrina*. Observations in Fiji, Samoa, and Enewetak reveal that *Pocillopora verrucosa*, *Acropora* sp., and *Millepora* sp. also serve as food.

Interspecific aggression was rarely observed, but male-male and female-female intra-specific aggression was frequent, particularly during spawning. Males are recognized by their red coloration, whereas females are overall brown. Males were observed to attack wooden blocks painted red but ignore brown or white blocks presented simultaneously. Preparation of nest sites and parental care of eggs were performed by males. Spawning was observed nearly every day between 10:00 AM and 1:00 PM from February through October. Individual females returned every 4 to 6 days to spawn. A first estimate of female fecundity lies between $2 \times 10^5$ and $3 \times 10^5$ eggs/female/year. Eggs are brilliant yellow when laid, turn silvery in 5 days, and hatch on the seventh day after dark.

The possibility that *Exallias* represents a specialized derivative of a *Cirripectes*-like ancestor is discussed.

The Habituation of Light-Evoked Responses in a Marine Gastropod, *Strombus luhuanus*

**NAPUALANI FLOOD**

Learning involves relatively long-lasting changes in behavior. Classically, habituation is a simple form of learning whereby an animal “learns” to ignore repeated stimuli that are insignificant to its survival. The eye of a marine gastropod, *Strombus luhuanus*, has been shown experimentally on the intact animal to habituate an eyestalk withdrawal response to a photic stimulus regime of varying intensity, duration, and interstimulus interval. Following microdissection, the eye has been subjected to the same regimes used in the behavioral studies for the variation of stimulus intensity and recordings of electrical potentials (electroretinograms) were taken from the eye. Through a comparison of the electrophysiological and behavioral studies, suggestions are put forward relative to the extent the habituation of the withdrawal response is peripherally or centrally mediated.
Continuous Recording of Erythrophore Membrane Potential During Change of Stage in *Ocypode laevis* (Crustacea)

J. H. Hayashi

The erythrophores of the ghost crab, *Ocypode laevis*, appear to be unique in being capable of changing from the stellate to punctate form within 2 min. We have investigated whether this response is coupled to variations in the membrane potential. Intracellular recordings of membrane potential were obtained from the central region of *O. laevis* erythrophores that were in all stages of aggregation. Stable membrane potentials were recorded from 28 cells. The potential was unrelated to stage. The average value was $-59.0 \pm 5.86$ mV; the mode was $-60$ mV. The mode analyzed by stage was also $-60$ mV. Twelve erythrophores were continuously recorded during one or more complete cycles of aggregation in response to erythrophore-concentrating hormone (applied as an eyestalk extract) and subsequent reexpansion during continued saline perfusion. Membrane potential varied by less than 3 mV around its initial value and did so in a random manner. Injection of hyperpolarizing and depolarizing currents of up to $10^{-8}$ A for periods as long as 10 min caused no visible responses. A marked increase in electrode voltage noise, from less than 0.5 mV to as much as 2 mV, upon penetration of chromatophores was consistently observed. Changes of membrane potential are not involved in erythrophore responses to neurophormones nor associated with migration of pigment granules. Membrane potentials do not vary with the state of aggregation of these cells.

Reactions of Yellowfin Tuna to Prey Scents

Walter Ikehara, J. Atema, A. Brittain, J. Bardach, A. Dizon, and K. Holland

Reactions of yellowfin tuna to prey scents in the form of rinses and extracts of prey were investigated. Fish were held in a 7.5-m diameter $\times$ 1-m deep flowthrough tank (swimming pool) into which sensory clues of a chemical nature could be introduced without other sensory inputs.

Rinses of nehu (*Stolephorus purpureus*), anchovy (*Engraulis mordax*), surf smelt (*Hypomesus pretiosus*), squid (*Loligo* sp.), akule (*Trachurus crumenophthalmus*), and opelu (*Decapterus pinnulatus*) were tested. Rinses of several species brought forth strong feeding responses. These manifested themselves in accelerated swimming, change in swimming patterns, circling, attempts at localization of the moving stimulus cloud, as well as the appearance of feeding bars in some cases.

Chemical analyses of the stimuli revealed that (1) only the nonvolatile fraction of the complex chemical mixture was very effective and (2) the amino acids, amino compound fraction, and non-amino fraction were effective, with the latter eliciting much lower and the former perceptibly lower reaction levels than the whole extract.

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4 Department of Zoology and Laboratory of Sensory Sciences. This research was supported in part by the University of Hawaii Foundation.

5 Department of Zoology and Hawaii Institute of Marine Biology.
The Comparative Morphology of Conus Radulae: Observations with Scanning Electron Microscopy

MATTHEW J. JAMES

Scanning electron microscopy (SEM) observations of radulae from 22 species of the venomous marine neogastropod Conus reveal structures that reflect feeding in one of three modes. Piscivorous, vermivorous, and molluscivorous species each possess radular teeth with structures characteristic of their feeding mode. Information gained from the study of radula morphology supports correlations with feeding in one of the three modes in nature. The teeth can be grouped according to the type of prey consumed. The radular teeth of piscivores are of two general types. In the first, two barbs and a posteriorly directed process with a recurved tip are found at the anterior end. In the second, two barbs are found at the anterior end and the shaft is serrated for most of its length. Molluscivores generally possess radular teeth with two anterior barbs and a shaft, which in some species is serrated. The radular teeth of vermivores are characterized by one or two anterior barbs and in most cases a serrated region near the apex. The radular teeth of Conus show considerable variation interspecifically with respect to the anterior extremities (barbs). With respect to the posterior portion, or base, the teeth may be grouped in two categories: those with a simple terminal knob formed by the base being of more or less greater diameter than the shaft and those with a forward projecting cone (basal spur) on the terminal knob. It has been suggested that the tooth might be retained within the proboscis by means of this basal spur when prey is attacked. Piscivorous and molluscivorous radular teeth possess the simple terminal knob. Vermivorous radular teeth predominantly possess a basal spur on the terminal knob, although a few species lack the spur.

The Biology and Fishery of the Hawaiian Endemic Spiny Lobster, Panulirus marginatus, at the Northern and Southern Limits of Its Range

CRAIG D. MACDONALD AND BRUCE E. THOMPSON

Carapace length, sex, molt, and reproductive condition of 1412 spiny lobsters of two species were recorded over a 2-year period at Midway Island from April 1973 to April 1975. Panulirus marginatus represented 98.5 percent and P. penicillatus 1.5 percent of the total spiny lobster catch at Midway Island. These species are equally abundant at Oahu. The information collected at Midway Island is compared with related findings of earlier studies of P. marginatus at Oahu. There are no apparent differences in the length-weight relationship, size at sexual maturity, and egg-carrying capacity of individuals at Midway Island and Oahu. Differences do exist in mean size, molt, and reproductive seasonality, and the relative proportion of females breeding in different size classes. We recommend that a linear carapace measure replace the existing weight measure as the criterion of legal minimum size. Additionally, a reconsideration of the management policies governing this fishery may be in order, since the majority of females throughout this species’ range are apparently being harvested before they reach their maximum reproductive potential.

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6 Biology Program. This research was supported by National Science Foundation grant no. GD-34270 and funds from the Biology Program, University of Hawaii.

7 Department of Zoology.

8 Department of Biological Sciences, University of Southern California.
Molting and Mortality in *Macrobrachium rosenbergii*

**BRAD PEEBLES**

Mortality estimates for *Macrobrachium rosenbergii* grown from postlarvae to adult range from 20 to nearly 50 percent. My observations indicated that certain types of mortality, previously reported as cannibalism by some authors, follow a characteristic pattern and are related to molt state. To explore the relationship between mortality and molt state, a method of fragmenting *M. rosenbergii*'s molt cycle is derived, then a 4 × 3 factorial experiment is conducted testing the relationship of molt state and relative size to injury and mortality. The results indicate that prawns of equal size are susceptible to behaviorally related deaths at two points in the molt cycle, late premolt and early postmolt. The importance of this finding to aquaculture and behavioral research on crustaceans is discussed.

The Role of Phytoplankton in the Diet of the Shipworm *Lyrodus pedicellatus* (Bivalvia: Teredinidae)

**FRANK E. PERRON**

Shipworms have long been studied because of the damage they inflict on wooden marine structures such as dock pilings and ship bottoms. Although it is known that shipworms digest the wood they rasp from their burrows, the present study provides the first direct evidence for ingestion and assimilation of phytoplankton by these mollusks.

Specimens of the shipworm *Lyrodus pedicellatus* were allowed to filter 14C-labeled phytoplankton. Upon removal from the radioactive medium, some specimens were washed and their radioactivity was determined by liquid scintillation. Other specimens were scintillated after being allowed to clear their guts in unlabeled medium. All animals became substantially radioactive and were still radioactive after 7 days. Since less than 4 days are required for food to pass through the guts of *L. pedicellatus*, these animals must have assimilated radioactive phytoplankton. Phytoplankton is probably important to shipworms as a source of nitrogen compounds not easily obtainable from a primarily cellulose diet.

Growth and Survival of Some Hawaiian Corals

**TOM POLACHEK**

Results of a study on the growth and survival of the four commonest branching Hawaiian corals (*Porites compressa*, *Montipora verrucosa*, *Pocillopora damicornis*, *Pocillopora meandrina*) are examined. Growth rates were measured as the change and Ruth D. Turner, Harvard University. It was supported by Office of Naval Research contract N0014-67-A-0298-0027, NR104-687 with Harvard University and National Science Foundation grant no. GA-38895. **11 Department of Zoology.**
in the geometric mean horizontal radius of a colony (Length \times Width/2). This measure of growth was used in order to obtain a comparison of the relative ability of different species to occupy empty space. All colonies were studied undisturbed in their natural habitats and were free from contact with other colonies. The growth rates of all four species were independent of initial size of the colony. Significant differences were found in the growth rates and survivorship of the different species. Implications of these results in terms of competition and reproductive strategies are discussed.

Reproductive Behavior of the Anemonefish *Amphiprion melanopus* on Guam

ROBERT M. ROSS

Nineteen breeding pairs of the anemonefish *Amphiprion melanopus* and their nests were observed continuously on Guam for approximately 1 year. *Amphiprion melanopus* are monogamous and apparently protandrous hermaphrodites. Nest preparation consisted of both anemone biting and substrate biting. Spawning was initiated 2 to 3 hr after sunrise and lasted 1.5 hr. During the incubation period, eggs were mouthed and fanned by the male, but there was no nocturnal egg care. Hatching occurred 1.5 hr after sunset on the seventh or eighth day of incubation.

Spawning activity peaked at approximately the first and third quarters of the moon. As a result, hatching activity peaked near full moon and new moon at the time of day when high spring tides also occurred. Nocturnal hatching on high spring tides is interpreted as a mechanism for reducing predation on newly hatched larvae due to the inactivity of some planktivores at night and the more effective dispersal of hatchlings away from the nest during high tides. There were no seasonal changes in spawning activity. An average of two spawns per lunar month per pair was observed throughout the year, resulting in an estimated annual fecundity of 7200 eggs per breeding pair per year.

The *M. V. Lindenbank* Edible-Oil Spill on Fanning Island

DENNIS J. RUSSELL AND BRUCE A. CARLSON

On 17 August 1975, the drifting 148.7-m long general cargo ship, *M. V. Lindenbank*, came to rest on the western reef flat of Fanning Island. During subsequent rescue operations, 17,797 metric tons of cargo were dumped. Of this cargo, 9497 tons were edible materials, mostly copra and vegetable oils. At no time was any petroleum oil spilled, yet the effects of the vegetable oils on the marine life were almost identical to what has been reported for petroleum oil. Fishes, crustacea, and mollusks were killed and the normally pink-red reef became overgrown with *Enteromorpha* and *Cladophora*. The effect of this material on the Fanning Island reef was profound. It provided a rare opportunity to observe the effects of nontoxic oily substances on an isolated tropical coastline and to compare such effects with toxic crude oil spills.

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12 Department of Zoology.
13 Department of Botany.
14 Department of Zoology. This research was supported in part by the University of Hawaii Sea Grant Program, grant no. 04-6-158-44026, and National Science Foundation grant no. OCE-75-22878.
Physiological Races in *Stylocheilus longicauda* (Gastropod: Opisthobranch)

Dale Sarver

A comparison is made of the growth, longevity, fecundity, and efficiency of two populations of *Stylocheilus longicauda*. One population is from Oahu and one from Enewetak Atoll, where the water is 2 to 5°C warmer than at Oahu. Eggs were obtained from a pair of Hawaiian animals that were kept in 25°C seawater until hatching, raised through a 30-day planktonic larval period, and then allowed to settle on the blue-green algae *Lyngbya*. After 14 days, the juveniles were divided into three groups, placed in seawater at 20, 25, and 30°C and fed algae ad libitum. Juveniles corresponding to the 14-day size of the Hawaiian animals were collected at Enewetak and raised similarly at the same experimental temperatures. When food consumption, growth, longevity, and fecundity were monitored, it was found that in both groups longevity was increased by the cooler temperature but consistent differences occurred in maximum size and fecundity. The experiment was repeated with second-generation Enewetak animals reared from eggs produced by the 25°C experimental animals. Identical temperature effects were noted, indicating a genetic difference between the two populations, presumably brought about by adaptation to different temperature regimes.

The Influence of Food Supplementation upon the Reproductive Strategy and Movement Patterns in the Hawaii Amakihi (*Loxops virens*)

Charles van Riper III

The objectives of this study were to investigate the influence of food availability on (1) territory establishment, shape, and size; (2) nesting success; and (3) postbreeding dispersal in the Hawaii amakihi (*Loxops virens*). From 1970 through 1975, birds were color-banded and their territory boundaries recorded in the Puu Laau area on the southwestern slope of Mauna Kea, Hawaii. On 10 January 1975, supplemental food sources, consisting of 20 percent sugar-water in feeders placed on yellow boards, were supplied in an area that heretofore had not been utilized for nesting. The feeders were placed at three different locations, each an average territorial distance from the other and from all previously known contiguous territorial boundaries. Feeding bouts were recorded through 10 June 1975 utilizing blinds, stopwatches, binoculars, and a tape recorder.

Territory establishment and shape in the amakihi may be directly influenced by food availability; size apparently is not. In the presence of a large food surplus, elongated overlapping territories were established around the periphery, with one major territorial pair centrally located. The food surplus was utilized by territory holders, transient immatures, and introduced white-eyes (*Zosterops japonica*). Of the birds utilizing the food resources, only the major territorial amakihi pair ranked above the white-eye, suggesting potential competition. Nectar may possibly be a limiting factor during the
breeding cycle of the amakihi. It was found that postbreeding dispersal in the amakihi can be suppressed when a continued food supply is made available.

Reasons Why the Palila, a Hawaiian Honeycreeper, Is Rare and Endangered: Analysis of a Breeding Biology

CHARLES VAN RIPER III

The palila (*Psittirostra bailleui*) was studied from 1969 through 1975 on the southwestern slope of Mauna Kea, Hawaii. Birds were color-banded and monitored in 714 days of field work. During this time, a 29-month phenological study of the tree species was also conducted.

The palila is now apparently limited to the mamane-naio ecosystem on Mauna Kea and occupies only 9 percent of its historical range. With the reduction in range has come a decrease in population size, so that it is now believed approximately 1600 individuals remain. The effective breeding population may be smaller, as there is apparently a disparity in the sex ratio. Evidence of infertility and embryonic death may indicate reduced fitness in the population. This may have resulted from the effect low population numbers have had on behavior and genetic conditions in the species.

The primary food source of the palila are pods from the mamane tree, and the bird was found to nest in relation to the period of greatest pod production. An extremely long nestling period is thought to have resulted because the species evolved in the absence of ground predators. This, augmented by nest placement on larger branches, would make the bird highly susceptible to predation.

17 Department of Zoology. This research was supported in part by the grants acknowledged in note 16.