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MASTER

**Thermal Effects on Aquatic Organisms—
An Annotated Bibliography
of the 1977 Literature**

ORNL/EIS-143

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**THERMAL EFFECTS ON AQUATIC ORGANISMS —
AN ANNOTATED BIBLIOGRAPHY OF THE 1977 LITERATURE**

Compiled and edited by

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Ecological Sciences Information Center

Information Center Complex

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- C. C. Coutant, E. F. Huber, and H. A. Pfuderer, *Thermal Effects on Aquatic Organisms - Annotated Bibliography of 1971 Literature*, ORNL/EIS-72/28 (September 1972).
- C. C. Coutant and H. A. Pfuderer, *Thermal Effects on Aquatic Organisms - Annotated Bibliography of 1972 Literature*, ORNL/EIS-73/28 (June 1973).
- C. C. Coutant, H. A. Pfuderer, and B. N. Collier, *Thermal Effects on Aquatic Organisms - Annotated Bibliography of the 1973 Literature*, ORNL/EIS-74/28 (October 1974).
- C. C. Coutant, S. S. Talmage, R. F. Carrier, and B. N. Collier, *Thermal Effects on Aquatic Organisms - Annotated Bibliography of the 1974 Literature*, ORNL/EIS-75/28 (June 1975).
- C. C. Coutant, S. S. Talmage, R. F. Carrier, B. N. Collier, and N. S. Dailey, *Thermal Effects on Aquatic Organisms - Annotated Bibliography of the 1975 Literature*, ORNL/EIS-88 (October 1976).
- H. A. Pfuderer, S. S. Talmage, B. N. Collier, W. Van Winkle, and C. P. Goodyear, *Striped Bass - A Selected, Annotated Bibliography*, ORNL/EIS-75/73 (March 1975).
- J. S. Mattice, H. A. Pfuderer, and B. N. Collier, *Chemistry and Effects of Chlorine in Aquatic Systems - A Selected, Annotated Bibliography*, ORNL/EIS-82 (March 1976).
- S. S. Talmage, *Thermal Effects on Aquatic Organisms - An Annotated Bibliography of the 1976 Literature*, ORNL/EIS-124 (May 1978).

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HIGHLIGHTS

This bibliography, containing 537 references from the 1977 literature, is the seventh in a series of annotated bibliographies on the effects of heat on aquatic organisms. The effects of thermal discharges at power plant sites are emphasized. Laboratory and field studies on temperature tolerance and the effects of temperature changes on reproduction, development, growth, distribution, physiology, and sensitivity to other stresses are included. References in the bibliography are divided into three subject categories: marine systems, freshwater systems, and estuaries. The references are arranged alphabetically by first author. Indexes are provided for author, keywords, subject category, geographic location of the study, taxon, and title (alphabetical listing of keywords-in-context of nontrivial words in the title).

INTRODUCTION

Since 1971 the Ecological Sciences Information Center (ESIC), Information Center Complex, Oak Ridge National Laboratory, in support of the Department of Energy's program of bioenvironmental research, has been compiling a computer-searchable data base on the effects of heated discharges from power plants on aquatic organisms. In 1976 the Electric Power Research Institute became a cosponsor of the project. The scope of the data base includes published literature on power plant site studies and related field and laboratory studies. The entries in the data base are available for searching through ESIC. An annotated bibliography is published annually.

The literature on thermal effects has been reviewed annually for several years in the *Journal of the Water Pollution Control Federation*. The literature indexed in this bibliography forms the basis of the 1977 literature review compiled by S. S. Talmage and C. C. Coutant.

Data bases compiled by ESIC on thermal effects, impingement, entrainment, and chemicals released in cooling waters have been combined and merged with a data base of unpublished literature on power plant effects compiled by the Atomic Industrial Forum. This combined data base on power plant cooling system effects was created for the Electric Power Research Institute and is available for searching through the Atomic Industrial Forum, Washington, D.C.

Citation Form

The bibliographic data are arranged according to the ESIC format. As a result of computer limitation in indicating superscripts and subscripts in the standard manner, certain conventions have been established in the bibliography:

1. For subscripts, $X_{sub t}$ is used for X_t .
2. In chemical compounds and elements, $NaIO3$ is used for $NaIO_3$.
3. In exponential functions, $10(E+3)$ or $\lambda(E-2)$ is used for 10^3 or X^{-2} respectively.
4. For units of measurement such as cubic centimeters or square feet, $X3$ is used for X^3 .

ACKNOWLEDGMENTS

Charles C. Coutant of the Environmental Sciences Division, Oak Ridge National Laboratory (ORNL), provided guidance and support for this project. Opal Russell of the ORNL Central Research Library and Betty Cornett of the Ecological Sciences Information Center acquired the documents. Susan Richardson of the Information Sciences and Operations Department, Information Center Complex, managed the computer production of this document.

<1>

Abell, P.B., and D.T. Burton, Cold Shock: The Effect of Rate of Thermal Decrease on the Survival of Juvenile Atlantic Menhaden (SNEVJOPVIA TYRANUS).

1976. *Assoc. Southeast. Biol. Bull.*, 23, 39; *Sport Fish. Mm.*, 21, 10 (Academy of Natural Sciences of Philadelphia, Benedict Estuarine Research Laboratory, Benedict, MD).

Rapid temperature decreases encountered by fish during the winter from shutdown of industries with heated effluents have resulted in large kills. This study was initiated to assess the response of juvenile Atlantic menhaden (SNEVJOPVIA TYRANUS) acclimated to 15 C and subjected to several rates of thermal decrease down to 5 C. The rates of decrease were 0.0, 1.5, 3.0 and 6.0 hours. In all cases disorientation occurred as the temperature approached 5 C. No significant difference in the median time to death (i.e., time at which 50% mortality occurred at 5 C) was found for fish exposed to the four rates. The average median time to death was 46 hours (range 33-60 hours). The results of this study show that temperature appears to be more important than the rate of decrease when cold shock occurs within 5 hours. (Both)

<2>

Abell, P.B., D.T. Burton, and C.J. Neece, Time course of Thermal Acclimation in Atlantic Silverside (SNEVJOPVIA TYRANUS) Exposed to Cyclic Temperatures.

1977. *Assoc. Southeast. Biol. Bull.*, 24, 30; *Sport Fish. Mm.*, 22, 23 (Academy of Natural Sciences of Philadelphia, Benedict Estuarine Research Laboratory, Benedict, MD).

The time course of thermal acclimation in Atlantic silverside exposed to several fluctuating low temperatures was determined. Malt fish were acclimated for a minimum of two weeks to 15 C. One group was then taken from 15 C to 5 C over a 10-day period (1 C/day) and held at 5 C for 21 days. Three groups were exposed once every 20 hours for 31 days to different fluctuating temperature cycles. Upper limit critical thermal maxima (CTM) were used to assess thermal acclimation after exposure to the cycles for various periods of time up to 31 days. All CTM measurements were made at minimum phase (15 C). The CTM of all cyclic groups decreased significantly between 5 and 10 days when compared to the 15 C acclimated controls. The CTM of all cyclic groups were significantly higher than those of fish held continuously for 21 days at 5 C. This study indicates that Atlantic silverside exposed to cyclic low temperatures adjust to intermediate temperature(s) between the minimum and maximum rather than toward the minimum as has been suggested for fish exposed to cyclic elevated temperatures. (Both)

<3>

Acutano, R.E., and C.B. Vanick, Life History Studies of the Sacramento Perch, ANCHOPLISTES STENDENIUS (Pisces), in California.

1976. *Calif. Fish & Game*, 62, 5-26 (California State University, Department of Biological Sciences, Sacramento, CA).

At Lake Greenhaven, California, sexual dimorphism was observed in Sacramento perch in April at a water temperature of 16 C.

Spawning occurred during May when the water temperature reached 22 C. Young-of-the-year, averaging 16 mm, were first captured on May 26. At Lake Alamo river perch were collected from late May, when the water temperature had reached 26 C, through June. Young-of-the-year, averaging 20 mm in length, were collected in mid-August. (ST)

<4>

Adams, S.H., The Ecology of Unigrams, ESTUARIA SNEVJOPVIA (L.), Fish Communities. II. Functional Analysis.

1976. *Jour. Exp. Mar. Biol. Ecol. (Meth.)*, 22, 293-311 (National Marine Fisheries Service, Atlantic Estuarine Fisheries Center, Beaufort, NC).

Consumption, production, and respiration of fish communities utilizing two oelgrass beds in a shallow estuarine system near Beaufort, North Carolina were estimated for 1971-1972. For evacuation time for the three major fish species were studied in the laboratory. Evacuation time for pinfish decreased from 19.9 to 9.3 hr as temperature increased from 15 to 20 C. Evacuation time for pinfish decreased from 12.6 to 5.8 hr as temperature increased from 20 to 25 C, and evacuation time for silversides decreased from 21.3 to 7.1 hr as temperature increased from 15 to 25 C. Oxygen consumption regression statistics at several ranges of temperatures are tabulated for pinfish. (ST)

<5>

Adams, S.H., P.A. Cunningham, B.D. Gray, and E.D. Ruser, A Critical Evaluation of the Neurobiological Environmental Technical Specifications: Vol. 2: Serry Power Plant Units 1 and 2.

1977. ONSL/WRDC/TN-70, Oak Ridge National Laboratory (Oak Ridge National Laboratory, Oak Ridge, TN).

A comprehensive study of the data collected as part of the environmental Technical Specifications program for Units 1 and 2 of the Serry Nuclear Power Plant was carried out for the Office of Regulatory Research of the U.S. Nuclear Regulatory Commission. Analysis of the monitoring data suggested that the thermal discharges at Serry are having a negative effect on the phytoplankton and zooplankton but are enhancing the benthic and bottom populations in the discharge area. Catch-per-unit-effort of fish was higher in the discharge area than in control areas during cooler months but was lower during warm months. Specific recommendations are made for improving both the present hydrothermal and ecological monitoring programs. (ST)

<6>

Adams, S.H., P.A. Cunningham, B.D. Gray, and E.D. Ruser, A Critical Evaluation of the Neurobiological Environmental Technical Specifications: Vol. 3: Peach Bottom Atomic Power Station Units 1 and 2.

1977. ONSL/WRDC/TN-71, Oak Ridge National Laboratory (Oak Ridge National Laboratory, Oak Ridge, TN).

A comprehensive study of the data collected as part of the environmental Technical Specifications program for Units 1 and 2 of the Peach Bottom Atomic Power Station on the lower Susquehanna River, Pennsylvania for the Office of Regulatory Research of the U.S.

(6) (34)

Nuclear Regulatory Commission is presented. Analysis of the monitoring data showed that catch-per-unit-effort of fish was higher in the discharge plume than in control areas during summer but was the same during winter. (37)

(35)

Meliss, L.H., Effects of Bovine Growth Hormone on Growth of Carp (*CYPRINUS CARPIO*) and the Influences of Temperature and Photoperiod.

1977. Trans. Fish. Res. Bd. Can., 34, 595-595
(University of Minnesota, Department of Zoology, Fisheries, and Wildlife, St. Paul, MN)

Experiments were conducted on year-of-the-year or yearling carp (*CYPRINUS CARPIO*) to determine the influence of temperature and photoperiod on the growth promoting ability of bovine growth hormone, and the dose-response relationship of bovine growth hormone on carp growth. There was relatively greater enhancement of growth due to bovine growth hormone at an above optimum temperature for growth, 35°C, than at the optimum temperature 20°C. This was possibly due to decreased protection or activity of endogenous growth hormone at the higher temperature, resulting in a greater response to the exogenous bovine hormone. Inhibition of endogenous growth may be a major limiting factor to growth at above optimum temperatures. Daylengths of 9 and 16 hr had no effect on the response of the fish to hormone injections. At a temperature of 35°C fish receiving bovine hormone dosages of 12.5, 25, 50, and 100 mg/g per wt responded with increasingly greater growth rates over fish receiving sham injections. Condition factors of fish increased throughout most of the experiment with greater increases among hormone injected fish. (Auth)

(36)

Mairial, R., Influence of Light and Temperature on the Growth Rate of Estuarine Benthic Diatoms in Culture.

1977. Marine Biol. (N. Ser.), 39, 1-9
(University of Groningen, Department of Systematic Botany, Raren, Netherlands)

The highest growth rates of *NAVICULA ARENARIA* as determined by the rate of increase of the chlorophyll-a content occurred at 16 to 20°C while the other three species of estuarine benthic diatoms, *AMPHIPROA PALUDOSA*, *BITISCHIA DISSIPATA*, and *BITISCHIA SIGMA*, had an optimum of 25°C or higher. The small-celled species had higher growth rates at their optimum temperature, but at lower temperatures the growth rates of all four species became very similar. The sinuous fully-quantum irradiance that could effect light-saturated growth at 12 and 20°C ranged from 2.5 to 5.0 E/m²-day. At 12°C, two species had their highest growth rates under an 8 hr daily photoperiod. At 20°C, the three species tested all had highest growth rates under 16 hr daily photoperiod. (HFC)

(37)

Agrawal, S., and A.K. Srivastava, Effects of Cold-Shock on Blood Cells in a Fresh Water Tropical Teleost, *COLISA FASCIATUS*.

1976. Arch. Anat. Microsc. Morphol. Expt., 65, 165-174 (University of Gorakhpur, Department of Zoology, Gorakhpur, India)

Immersion of the adult female freshwater tropical fish, *COLISA FASCIATUS*, in ice water at 2°C for one min immobilized the fish. Recovery took two min after return to warm temperatures. Hematological studies conducted at 1, 15, 27, 40, and 76 min and at 12 to 20 hr revealed significant changes in the abundance of leucocytes and thrombocytes. An increase in the number of leucocytes (leucocytosis) was evident from 15 through 72 min and at 267 min; normal counts were observed at the other observation times. Thrombocytopenia occurred at 15 to 27 min, with normal levels at other recovery time intervals. There was no change in the abundance of erythrocytes in response to the stress. Shock susceptibility was similar during different seasons of the year. (Auth) (37)

(38)

Shetas, P.A., and T. Sorg, The Effect of Salinity and Temperature on Intracellular Osmoregulation and Muscle Free Amino Acids in *FUNDULUS DIAPHYANUS*.

1977. Comp. Biochem. Physiol., 54A, 101-105
(University of Tennessee Center for the Health Sciences, Department of Obstetrics and Gynecology, Memphis, TN; University of North Dakota, Department of Biology, Grand Forks, ND)

FUNDULUS DIAPHYANUS tolerates both freshwater and 30 ppt sea water at 15°C. At 0.5°C only freshwater was tolerated well, and only 50% of the sample population survived in 30 ppt sea water after 2 weeks. At 15°C tissue inorganic ions and free amino acids increased with an increase in ambient salinity. In freshwater adapted fish, tissue K⁺ increased while free amino acids decreased with a decrease in water temperature. The primary amino acids involved with salinity change were alanine, glycine, asinine, proline, and aspartic acid. Tyrosine did not change with salinity and apparently does not function in intracellular osmoregulation. (Auth)

(39)

Akesson, T.B., The Effect of Temperature Changes on the Development of *UECHIS CAUPO* Fisher and McGinitie 1928 (Echiuridae).

1977. Estuarine & Coastal Mar. Sci., 5, 405-453
(Humboldt State University, Department of Biology, Arcata, CA)

The development rates of embryos of the echiurid worm (*UECHIS CAUPO*) were examined under various temperature regimes. The percentage of normally-formed embryos at the 16-cell stage was used as an indicator of favorable conditions. The upper lethal temperature for developing *UECHIS* embryos was 23°C. At 22°C development was rapid but the embryos were normal in appearance. At 8°C cleavage intervals were greatly protracted, and by the 16-cell stage (about 12 hr after fertilization) nearly all of the embryos were abnormal in appearance. Development at 9°C was slow but normal. The zone of thermal tolerance for development in *UECHIS* was estimated to be 9 to 22°C. Embryos subjected to thermal shock programs similar to the conditions produced by the Humboldt Bay Power Plant experienced temporarily accelerated development rates and a 5 to 10 percent increase in the percentage of abnormally-formed individuals. (Auth) (39)

<12>

Albaret, J.J., and P. Corliotto, Biology of *STENALOTA PINGBIA* (Bousfield) in Ivory Coast. I. Description of Reproduction and First Larval Stages.

1976. Pac. Sci. Cent. Tech. Oceanogr., Abidjan, COTE D'IVOIRE, 7, 113-119 (Cent. OCEAN, Laboratory of Hydrobiology, Domete, Ivory Coast)

Seasoning of *STENALOTA PINGBIA* took place from November to June in waters with salinities of 18 to 26 ppt and temperatures of 22.0 to 30.2 C. (ST)

<13>

Allen, P.W., III, Growth, Reproduction and Survival of Some Marine Copepods Subjected to Thermal and Mechanical Stress.

1976. Ph.D. Thesis, University of Florida (University of Florida, Gainesville, FL)

A study was made of the lethal and sublethal effects of power plant entrainment and thermal stress on the copepods of the Crystal River estuary on the west coast of Florida. Temperature, salinity, and temperature-salinity interactions were among the most important factors influencing mortality. Under conditions of low temperature and moderate salinities, mechanical damage was the major lethal entrainment effect for most species, but produced relatively low mortalities compared to those found with other temperature-salinity regimes. Each species had unique response patterns to temperature-salinity effects, as well as to combinations of other variables, but virtually all exhibited rapidly increasing mortalities as temperatures rose above 35 C. Sublethal entrainment effects were negligible until summer conditions caused discharge waters to rise above 35 C. Possible biological and ecological implications of these entrainment and thermal stress studies are discussed. (Auth) (ST)

<14>

Allen, J.A., T. Cook, D.J. Jackson, S. Preston, and L.N. Worth, Observations on the Rate of Production and Mechanical Properties of the Bysus Threads of *MYTILUS EDULIS* L.

1976. Jour. Mar. Biol. Assoc., 52, 279-289 (University Marine Biology Station, Millport, Scotland)

The rate of thread production in *MYTILUS EDULIS* decreased with increasing size of the animal both at high and low salinities. In animals of the same size, fewer threads were produced at low salinity than at high, while more were produced at higher temperatures. (Auth) (ST)

<15>

Allen, J.T., Some Effects of Simultaneous Variation in Salinity and Temperature on Survival of Adult *NEOTYSIS HENICEDIS* from Populations in the Sacramento-San Joaquin Estuary.

1976. Ph.D. Thesis, University of California (University of California, Davis, CA)

A detailed assessment of data analysis procedures applicable to the estimation, with bioassay data, of tolerance response surfaces descriptive of an aquatic species' simultaneous tolerance of environmental and experimental factors is presented. The results of laboratory tests, utilizing

selected data analysis procedures, of the simultaneous temperature-salinity tolerance of adult *NEOTYSIS HENICEDIS* from the Sacramento-San Joaquin estuary for different seasons and years is then presented. The regression models derived for the spring and summer 1972 populations yield point-estimate predictions of the species' optimum salinity which are variously affected by temperature and the concomitant variables. Salinity optimum decreased with increasing temperature. Seasonal and yearly regions of temperature-salinity optimums are given. (ST)

<16>

Allender, B.M., Effects of Emersion and Temperature upon Growth of the Tropical Brown Alga *PADINA JAPONICA*, Using a Tide-Simulation Apparatus.

1977. Marine Biol. (B. Ger.), 40, 55-59 (University of Hawaii, Department of Botany, Honolulu, HI)

A simple tide-simulation apparatus was used to investigate the influence of emersion and temperature (23 to 26 C) on the intertidal growth of *PADINA JAPONICA* Yamada in both the juvenile and adult growth phases. The upper zonation limits are not determined by the sensitivity of any particular growth phase, since all phases show the same emersion tolerance limits. The species grows best when continuously submerged, and growth rates decrease with increasing emersion up to a clear upper zonation boundary. High temperature reduces the emersion tolerance and is therefore an important factor in tropical intertidal zonation. (Auth)

<17>

Ameen, T., and R.M.S. Buda, Effect of High Temperatures on the Larvae and Pupae of *AECYTUS AECYTUS* (L.) (Diptera: Culicidae).

1976. Bangladesh Jour. Zool., 4, 73-84 (University of Dacca, Department of Zoology, Bangladesh)

Effect of high temperatures (36 to 46 C) on the four larval and pupal instars of *AECYTUS AECYTUS* under laboratory conditions were recorded. For ten-minute exposures the LT50 varied from 41.8 to 43.4 C. Larvae became sluggish at high temperatures. After long exposure to sublethal temperatures in the larval and pupal stage, some of the adults failed to emerge, and many of those that emerged had deformed wings. (ST)

<18>

Anderson, C.O., Jr., D.J. Brown, B.A. Katschke, L.M. Elliott, and P.L. Bule, The Effects of the Addition of a Fourth Generating Unit at the Salem Harbor Electric Generating Station on the Marine Ecosystem of Salem Harbor.

1975. Report of the Massachusetts Division of Marine Fisheries to the New England Power Company, 87 p. (Massachusetts Department of Fisheries, Wildlife and Recreational Vehicles, Division of Marine Fisheries)

The study was undertaken to determine the effects of the addition of a fourth generating unit at the Salem Harbor (Mass.) Electric Generating Station. Operation of the fourth unit raised the average delta T of the Station 1.5 C. The thermal plume had a maximum vertical penetration of 6 ft, maximum horizontal penetration of approximately one nautical mile, and a total volume which was

(19) CONT.

not greater than three percent of the total water volume of Salem Harbor at mean low water. Passage of water through the condenser seawater system had no significant effect on water quality. Pre- and post-operational surveys of finfish (see species) showed minor fluctuations in rank of abundance, catch per unit effort, and species diversity. These fluctuations were attributed to natural causes and not to power plant operation. Finfish populations were not adversely affected by impingement. A series of laboratory bioassays was conducted on selected fish species indigenous to the area. TL₅₀'s for heat and cold shock and 144h's for chlorine are presented in table 1. Atlantic silverside was least tolerant to abrupt lowering of temperatures with stress first observed at 8 C and a TL₅₀ of 6 C. The lower TL₅₀ of threespine stickleback was 3 C. Survival percentages of mummichog and winter flounder were greater than 50% at 7 C. Winter flounder, threespine stickleback, and mummichog were least tolerant to higher temperatures with a TL₅₀ of 27 C. TL₅₀'s of fourspine stickleback, Atlantic silverside, and mummichog were 27.5, 31, and 34 C, respectively. No thermal related mortalities have been observed in the area of the plant's discharge. Phytoplankton biomass and viability, as determined by chlorophyll a, C-14 uptake and adenosine triphosphate monitoring, was not significantly altered by passage through the intake-condenser system. It is concluded that the operation of the fourth unit is having no measurable detrimental effect on the balanced indigenous marine populations in Salem Harbor. Recommendations were made relative to plant operation, as well as present and needed future environmental studies. (ST)

(19)

Anderson, G., The Effects of Parasitism on Energy Flow through Laboratory Shrimp Populations.

1977. Marine Biol. (U. Ger.), 62, 239-251 (University of South Carolina, Belle W. Baruch Institute for Marine Biology and Coastal Research, Columbia, SC)

The effects of parasitism by the isopod *PROPOPYTUS PANDALICOLA* on energy flow through the host *PALAEONETES PUGIO* were quantified by comparing secondary production, metabolism, ingestion, and egestion by unparasitized laboratory shrimp populations to the same parameters for parasitized groups during 10 months. The effects of parasitism on host growth and metabolism varied from month to month. Temperature, season, host age, sex, and reproductive condition affected energetics for host-parasite systems. *PROPOPYTUS PANDALICOLA* had little effect on host assimilation efficiency. Ingestion by *P. PUGIO* was observed to be generally temperature-dependent although it was highest in August at 30 C rather than in July at 31 C. An additional peak was observed in October at 23 C. Shrimp growth varied greatly from month to month and showed little temperature dependence. (PFC)

(20)

Anderson, R.A., R.L. Ulrich, and R.L. Reising, Thermal Discharge and Its Effect on Macroinvertebrates and Periphyton in the Wabash and White Rivers, Indiana.

1977. EPA-905-78-001; PB-270 378, National Technical Information Service, Springfield, VA (Environmental Protection Agency, Evansville, IN)

Temperature, macroinvertebrate and periphyton data were collected at the Wabash River, Bremer, Broad, and Metamora power plants on the Wabash River and at the Indianapolis Power and Light Company (IPALCO) and Western Energy Division Petersburg Power Plant (SEPC) on the White River, Indiana. The Wabash River Plant was the most important contributor to increased temperatures within the Wabash River. Temperature increases ranged from 1.6 to 3.9 C as far as 14 miles downstream. The macroinvertebrates collected in the vicinity of the plant in 1976 showed an increase in total population at the 0.5 mi downstream station in comparison to the upstream station. Although there was a decrease in numbers in the discharge canal, species composition was similar at all stations. No significant change in the macroinvertebrate population was observed at the other three plants. There was an increase in abundance of periphyton in the discharge canal and at the 0.5 mi station downstream of the Wabash Plant, with blue-green algae being most abundant. The diatom *COCCONEIS* was greatly reduced in numbers in the discharge canal compared to control stations. Little or no periphyton population increase was noted downstream of the three smaller plants. In the White River high temperatures were recorded as far as 1.25 miles below the lower (0.8 miles below the IPALCO Plant) SEPC plant. The macroinvertebrate population varied significantly from the control station upstream of the IPALCO plant to the farthest downstream station, 1.25 miles below the SEPC plant. A decline in the total population was noted immediately downstream of both plants during most of the sampling periods. Increases occurred 100 yards below the lower plant. Blue-green algae were the most abundant periphyton downstream of both plants. (ST)

(21)

Anderson, R.R., Seasonal Variation in the Population Dynamics of *CARTOPHYLLANUS LATICEPS*.

1976. Parasitology, 71, 201-205 (University of London, King's College, Department of Zoology, London, England)

The seasonality of parasite population size was caused by the combined effects of a temperature-dependent mortality rate and fluctuations in fish host (*ANEMIA SPINOSA*) feeding activity. A mathematical model was formulated to describe the dynamics of the adult parasite within the fish host. Model predictions are compared with observed population data. (ST)

(22)

Antle, S.J., Effects of Temperature on the Darkness Survival of Marine Microplanktonic Algae.

1977. Microb. Ecol., 3, 81-94 (Environment Canada, Pacific Environmental Institute, West Vancouver, British Columbia, Canada)

Thirty-two percent of 37 species of marine microplanktonic algae from 10 taxonomic classes reached the limits of survival with 5 to 6 months of darkness at 2 C. Another similar percentage continued to tolerate darkness for double this period. These darkness tolerance limits were considerably shorter at 20 C for the strains known to be isolated from cold marine regions, whereas the warm-water strains showed the reverse

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temperature effect in surviving significantly longer at 10 or 20 C than at 2 C. The more resistant strains were benthic types, a few of which tolerated three years of darkness. The conclusion that phytoplankton retain darkness-endurance capacity determined by their ecological origin and with no obvious taxonomic correspondence is discussed. (BPC)

<23>

Apstein, J. K., Combined Effect of Temperature and Salinity on the Hatching Rate, Hatching Time and Total Body Length of the Newly Hatched Larvae of the Japanese Red Sea Brown PACSUS.

1976. Rep. (Jap.), 10, 23-30 (Tokyo University of Fisheries, Ecological Laboratory, Hama, Minato-ku, Tokyo, Japan)

Fry of the Japanese red sea brown PACSUS M309 were incubated under 10 different salinity-temperature combinations within the range of 11.00 to 30.00 ppt for salinity and 8 to 23 C for temperature. At all salinities within this range hatching was observed but at temperatures lower than 15 C and higher than 21 C no hatching occurred at any level of salinity. A hatching rate higher than 70% was observed at salinities higher than 27.00 ppt and at temperatures between 19 and 23 C. The hatching time ranged from 10.5 hrs (21 C, 30.00 ppt salinity) to 72 hrs (15 C, 11.00 ppt salinity), decreasing with increases in either salinity or temperature. Optimum conditions for the larval survival appeared to be associated with salinities higher than 27.00 ppt and temperatures between 19 and 23 C, while total larval length at hatching was observed to be greater at high salinities and low temperatures. (Auth)

<24>

Arrington, R. H., and C. G. Sellers, Jr., The Effects of Temperature upon Selected Ventilatory Parameters of Rainbow Trout, (SILNO CHIRUPHY) (Abstract only).

1976. Virginia Jour. Sci., 27, 62 (Abstract only) (Radison College, Department of Biology, Harrisonburg, VA)

Of three temperatures tested, 10, 15, and 20 C, ventilatory activity was highest and oxygen use lowest in rainbow trout, SILNO CHIRUPHY, at 15 C, confirming that changes in amount of oxygen consumed result from alteration of ventilatory activity. Temperature exerts secondary effects upon oxygen utilization. The data suggest a complex lethal chain of events initiated by temperature elevation. (BPC)

<25>

Anderson, T. A., Survival Rate and Oxygen Consumption of Juvenile Wild Carp Maintained under Different Conditions.

1975. Hydrobiol. Jour., 11, 67-68 (Not given)

Experiments were performed to determine the minimum oxygen concentration needed to ensure survival of larvae and fingerlings of wild carp (CYPRINUS CARPIO) and establish the upper limit of salinity and optimum temperature for juveniles. Threshold oxygen concentrations were determined in airtight vessels; temperature preference was performed in a thermal gradient tank. It was found that larvae were less resistant to high salinities and low oxygen concentrations than

fingerlings. Larvae and fingerlings died at salinities above 4 and 8‰, respectively. Fingerling oxygen consumption/time decreased with decreasing oxygen content of the water. Thirty-eight-day old fingerlings preferred a water temperature of 27 C. (BPC)

<26>

Atton, R. J., B. J. A. Brown, and A. C. P. Silver, Heated Water Farms at Inland Power Stations.

1976. Fish Farming Int., 3, 47-50 (C. E. S. L. Freshwater Biology Unit, Sutcliffe-on-Don Power Station, Nottingham, England)

Thermal aquaculture, using heated effluents from power stations, is now being practiced in the UK, USSR, FR, France, Netherlands, East Germany, Poland, and Hungary. Details of species being cultured in each country are tabulated. In all, some 30 power stations, 70 of them inland, are involved. Accounts of the inland stations are reviewed, with particular attention to growth rates achieved. (Auth)

<27>

Atton, J. B., Migratory Behavior of Cottontail Trout Fry with Respect to Temperature, Water Flow, and Food.

1977. M.S. Thesis, University of Idaho (University of Idaho, Moscow, ID)

Migratory behavior of cottontail trout (SILNO CLASHI) fry from Henrys Lake, Idaho, Kings Lake, Washington, and a St. Joe River (Idaho) tributary were compared. The studies were carried out in artificial stream channels and test sections in Beaver Creek, Idaho. Fry from Henrys Lake moved downstream shortly after release in Beaver Creek. Fry from Kings Lake had a strong tendency to move upstream in artificial channels, fry from Henrys Lake had a tendency to move downstream, and wild fry from Beaver Creek had movement patterns midway between fry from Kings Lake and Henrys Lake. None of the movements by any of the three groups appeared to be related to food availability, water flow, or temperature. (Auth)

<28>

Balandin, O. A., and E. G. Repina, Temperature as a Factor Affecting the Accumulation of Radionuclides by Fish.

1977. Gij. Sankt. (USSR), No. 1, 110-115 (Not given)

The objective of the study was to determine quantitative characteristics of the accumulation of some radionuclides in the tissues of commercial pond fishes at optimum temperature (25 C). The experiments were conducted with carp underyearlings placed in 100 l aquaria (50 fish in each) filled with tap water. The temperature was kept at 15, 20 and 25 C. The concentration of Cs-137 and Co-60 applied as carrier-free chlorides was 2×10^5 (B-7) curies/l. On the 60th day the coefficient of radionuclide accumulation in the muscles and bones was found to be 1.5 to 2 times higher at the water temperature of 25 than it was at 15. As the level of radionuclide accumulation by fish is known to be much higher under natural than under laboratory conditions the degree of the temperature effect may prove to be higher under natural than under experimental conditions. In controlling the content of radioactive substances in surface waters it

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<29> 1977.

is necessary to allow for the effect of heat carried by waste water on the degree of radioisotope accumulation by fish. Quantitative indices characterizing this effect need refinement by experimentation under natural conditions. (Auth)

<29>

Panner, A., and M. Hyatt, Induced Spawning of Bluegill Sunfish.

1975. Progressive Fish Culturist, 37, 173-180 (Aquatic Sciences, Inc., Boca Raton, FL)

The effects of elevated temperature, prolonged photoperiod, and applications of gonadotropins on gonadal saturation and spawning of bluegill sunfish were tested. Males and females collected during October and November and subjected to summer conditions (16L/9D at 25 C) showed gonadal development and characteristic pre-spawning behavior. Applications of gonadotropins increased the incidence of mature eggs. Spawning occurred 6 to 13 days after thermal manipulations. Females maintained at 8L/16D and 21 C showed no increase in gonadosomatic index. (ST)

<30>

Barnes, J.K. Effect of Temperature on Development, Survival, Oviposition, and Diapause in Laboratory Populations of SEPEDON FUSCIPENNIS (Diptera: Sciomyzidae).

1974. Environ. Entomol., 4, 1089-1098 (Cornell University, Department of Entomology, Ithaca, NY)

The shortest egg, larval, and pupal developmental periods of the marsh fly occurred at 30 C. Total survival of the immature stages was greatest at 23 C. The intrinsic rate of increase was positive over the range 15 to 33 C and peaked at 30 C. (ST)

<31>

Barnhouse, L.W., J.B. Cannon, S.G. Christensen, A.H. Ersland, J.L. Harris, K.H. Kim, M.C. LaVerne, R.A. McClain, R.D. Murphy, R.J. Reddon, T.H. Row, R.D. Sharp, and W. Van Winkle, A Selective Analysis of Power Plant Operation on the Hudson River with Emphasis on the Bowline Point Generating Station, Volume 1.

1977. ORNL/TR-977/V1, Oak Ridge National Laboratory (Oak Ridge National Laboratory, Oak Ridge, TN)

A comprehensive study of the effects of power plant operation on the Hudson River was conducted. The study included thermal, biological, and air quality effects of existing and planned electrical generating stations. A section on thermal impacts presents a comprehensive mathematical modeling and computer simulation study of the effects of heat rejection from the plants. Included was a study of the effects of impingement, entrainment, and thermal discharges on the Hudson River striped bass population. (ST)

<32>

Bashirullah, A.K., and B. Ahmed, Development of CANALLANUS ADAMSI Bashirullah, 1974 (Nematoda: Canallanidae) in Cyclopoid Copepods.

1976. Can. Jour. Zool., 53, 2055-2060 (Queen's University, Department of Zoology, Kingston, Ontario)

The larval development of CANALLANUS ADAMSI was followed in intermediate hosts, MESOCYCLOPS LEUCOMATI (Claus) and THERMOCYCLOPS CRASSUS (Pischoer), which were kept at 24 and 27 C (average). The nematode molts twice in the bacterium of copepods. The first molt occurred 148 hr after infection at 24 C and the second molt after 249 hr. At 27 C, the first and second molts occurred 72 and 168 hr respectively after the infection. Three larval stages are described. (Auth)

<33>

Bass, R.L., Influences of Temperature and Salinity on Oxygen Consumption of Tissues in the American Oyster (CRASSOSTREA VIRGINICA).

1977. Comp. Biochem. Physiol., 50B, 125-130 (University of Maryland, Department of Biology, Princess Anne, MD)

The O2 of gill, mantle and muscle tissue of oysters acclimated to 5, 15 or 25 C was used to assess responses to alterations in temperature and salinity. For each group of samples, measurements were made at one temperature over the following ranges: gill 5-29 C, mantle 5-27 C, muscle 13-30 C. Cold-acclimated gill tissue showed good acclimatory ability, while mantle tissue showed little and muscle none. Warm-acclimated tissues, gill and mantle showed partial acclimation and muscle none. Upon dilution of the sea water medium, gill and mantle tissues showed increased O2, while muscle tissue exhibited no alteration. No significant alterations in tissue O2 took place in response to increased salinity of the medium. (Auth) (BFC)

<34>

Bass, R.L., and A.G. Heath, Toxicity of Intermittent Chlorination to Bluegill, LEPOMIS MACROCHIRUS: Interaction with Temperature.

1977. Bull. Environ. Contam. Toxicol., 17, 816-823 (Virginia Polytechnic Institute and State University, Department of Biology, Blacksburg, VA)

Bluegill were intermittently exposed to pulses of peak total chlorine residual concentrations of .21, 0.31, 0.41, and 0.52 mg/l at four temperatures (6, 15, 25, and 32 C). At the highest peak total chlorine concentration there was a notable temperature effect on the L50 which decreased from 74 hr at 6 C to about 23 hr at 32 C. There appeared to be little temperature effect on the lethal concentration. The 96 hr L50 was approximately 0.40 to 0.45 mg/l peak total chlorine at all four temperatures. Extending the exposure time to 168 hr did not significantly reduce the L50 except at 6 C where it was lowered to 0.33 mg/l. Although there were no deaths at 0.2 mg/l peak total chlorine, the behavior of the fish exposed at the two highest temperatures indicated that they were under stress. (ST)

<35>

Baudouy, A.H., Experimental Data on the Resurgence of the Virus Causing the Infectious Pancreatic Necrosis in Salmonidae in Water Environment.

1976. Ann. Rech. Vet. (Fr.), 7, 75-82 (Laboratoire Central de Recherches Veterinaires, Maisons-Alfort, France)

The infectivity of infectious pancreatic necrosis virus persisted in water of average mineralization for more than 300 days at 4 C

(35) CONT.

and for 60 days at 14 C. At 4 C it persisted longer in mineralized river water than in water of average mineralization. (ST)

(36)

Payne, S.L., and D.P. Livingstone, Responses of *MYTILUS EDULIS* L. to Low Tension: Acclimation of the Rate of Oxygen Consumption.

1977. Jour. Comp. Physiol., 130, 129-142
(Institute for Marine Environmental Research, Plymouth, England)

MYTILUS EDULIS acclimated its rates of O₂ consumption when maintained at reduced O₂ tensions for periods of more than 3 days. Acclimation was complete down to about 35 mm Hg of oxygen partial pressure; at slightly lower O₂ tensions (31, 29 and 21 mm Hg) acclimation was complete in one experiment and partial in 2 others. The capacity to acclimate O₂ consumption was not affected by a reduction in ration nor by an increase in temperature (10 to 22 C). Mussells that were acclimated to reduced O₂ tension (40-60 mm Hg), and then exposed to an oxygen pressure of more than 20 mm Hg for 2 or 5 hr had depressed rates of O₂ uptake then subsequently "recovered" to 40-60 mm Hg. These results are discussed in the context of biochemical studies of anaerobic metabolism in mussells from the same experiments. (Both)

(37)

Payne, S.L., and C. Scallard, Rates of Nitrogen Excretion by Species of *MYTILUS* (Bivalvia: Tellinacea).

1977. Jour. Mar. Biol. Assn. U.K., 57, 355-369
(Institute for Marine Environmental Research, Plymouth, England)

There is variability with season and with habitat in both the rates of nitrogen excretion by *MYTILUS* and the proportionality between ammonia acids in the excreta, $\text{NH}_4\text{-N}$, as a proportion of total ninhydrin-positive substances, varied between 0 and 63%. Excretion rates were highest in the summer and lowest in the winter. These changes are related to seasonal cycles of gametogenesis and the storage and utilization of body reserves. During the winter, nitrogen excretion rates increased as a result of starvation; in the summer and autumn, rates decreased during starvation. As a result, nitrogen balance was better controlled during starvation in the summer than in the winter. Rates of ammonia excretion increased with rise in temperature between 11 and 21 C ($Q_{10} = 1.75$) and there was no evidence of temperature compensation of the excretion rate in *M. EDULIS*. (Both)

(38)

Becker, C.D., S.G. Sweeney, and H.J. Schneider, Conservative Cold Resistance of Three Columbia River Organisms.

1977. Trans. Amer. Fish. Soc., 106, 170-180
(Battelle Memorial Institute, Pacific Northwest Laboratories, Ecosystems Department, Richland, WA)

Resistance to abrupt and gradual cold shock was determined in bioassays with pumpkinseed (*LEPOMIS gibbosus*), rainbow trout (*Salmo gairdneri*) and a northwestern crayfish (*Pacifastacus lenisculus*) acclimated to higher temperatures at 5 C increments. Test criteria were median tolerance limits (TLM) for 96-hr exposures after abrupt cold shock,

and 50% loss of equilibrium (LE50) for decline rates of 10, 15, 10, 5, and 1 C/hr during gradual cold shock. Cold resistance depended on original acclimation temperature (AT) and varied among species under both test conditions in the order: pumpkinseed < rainbow trout < crayfish. The lower TLM limit for pumpkinseed was 12.3 C at 15 C AT, 9.6 C at 25 C AT, 4.5 C at 20 C AT, and 2.7 C at 15 C AT. Rainbow trout at 20, 15, and 10 C AT survived abrupt exposures to cold down to 1.3, 1.8 and 0.5 C, respectively. Crayfish at 25, 20 and 15 C AT survived exposures down to 2.5, 0.8 and 0.0 C, respectively. The values were slightly above LE50 values for both fish species but well below for crayfish. Partial adaptation significantly lowered LE values at decline rates below 10 C/hr for pumpkinseed, and to a lesser extent for the other two species, thus extending the lower margin of cold resistance. (Both)

(39)

Becker, C.D., S.G. Sweeney, and H.J. Schneider, Predicting Effects of Cold Shock: Modeling the Decline of a Thermal Plume.

1977. PNL-2011 (Battelle Pacific Northwest Laboratories, Ecosystems and Engineering Technology Departments, Richland, WA)

Predicting direct impact of cold shock on aquatic organisms after termination of power plant thermal discharges requires thermal tests that provide quantitative data on the resistance of acclimated species to lower temperatures. Selected examples from the literature on cold shock resistance of freshwater and marine fishes are illustrated to show predictive use. Abrupt cold shock data may be applied to field situations involving either abrupt or gradual temperature declines, but yield conservative estimates under the latter conditions. Gradual cold shock data may be applied where heated plumes gradually dissipate because poikilotherms partially compensate for lowering temperature regimes. A simplified analytical model is presented for estimating thermal declines in terminated plumes originating from offshore submersed discharges where shear current and boundary effects are minimal. When applied to site-specific conditions, the method provides time-temperature distributions for correlation with cold resistance data and, therefore, aids in assessing cold shock impact on aquatic biota. (Both)

(40)

Beitinger, T.L., Thermopreference Behavior of Bluegill (*Lepomis macrochirus*) Subjected to Restrictions in Available Temperature Ranges.

1977. Copeia, No. 3, 534-541 (University of Wisconsin, Limnology Laboratory, Madison, WI)

Juvenile bluegill (*Lepomis macrochirus*) acclimated to 25 C occupied a temperature range of 29.5 to 33.1 C in laboratory preference studies. The midpoint of this range, 31.2 C, is considered an estimate of the final temperature preference for this species. When the temperature preference was unavailable, bluegill spent more than 92% of their time at the temperature nearest the preference. The availability of constant non-preferred temperatures appeared to have little influence on the thermoselection behavior: median percent time spent at the two non-preferred temperatures, 28.0 and 34.0 C, were 9.7% and 1.3%, respectively. In

<37> CONT.

addition, a separate experiment demonstrated that of the two limits of the preferred range, the lower limit is most labile. These findings are related to the thermal ecology of the bluegill. (Auth) (ST)

<38>

Reitinger, T.L., Influence of Abiotic and Biotic Factors on the Stability of Behavioral Thermoregulation in Fishes, Particularly the Bluegill.

1976. Ph.D. Thesis, 251 pp. (University of Wisconsin, Madison, WI)

Experiments were designed to assess the stability or sensitivity of behavioral thermoregulation by fishes under various conditions. In particular, acclimation regimes of temperature and photoperiod were studied as they influenced thermoregulatory ability and thermoselection. Results indicated a high level of stability in thermoregulatory behavior by bluegill. With few exceptions, bluegill had a preferred temperature of about 31 C, circumscribed by lower and upper avoidance temperatures of approximately 29 and 33 C, respectively. Only one experimental manipulation, acclimation of bluegill to 5 C for one month, was totally disruptive to thermoregulatory performance. The majority of experimental manipulations - time of day, photoperiod, fish length, acclimation temperature (21 to 31 C), temperature change rate, and unavailability of preferred temperature - did not influence either thermoregulatory ability or thermoselection. Results from growth studies indicated that bluegill respond to temperature gradient with ecological evidence. Under ad libitum feeding, bluegill at 31 C grew fastest, 2.54 body wt/day; however, rates for fish held at 20 and 25 C were not significantly lower. Growth rates of bluegill maintained at 30 C were much less than those of fish held at the three lower temperatures. These results indicate that the eurythermal bluegill has a rather broad thermal range over which growth occurs at relatively high rates. (Auth) (ST)

<39>

Reitinger, T.L., H.N. Thomas, and S.H. Spigarelli, Relative Roles of Conduction and Convection in Body Temperature Change of Gizzard Shad, DOBSONIA CEPEDIUM.

1977. Comp. Biochem. Physiol., 57A, 275-279 (Argonne National Laboratory, Radiological and Environmental Research Division, Argonne, IL)

The intestinal temperatures of 22 gizzard shad subjected to instantaneous delta T's of + 10 - 9.5 C were monitored while fish were alive and dead. A significant relationship between fish body weight and coefficient of rate of body temperature change was demonstrated by double logarithmic correlation of these variables. The slope (= exponent) relating fish body weight and temperature change equalled 0.64 for live and 0.66 for dead shad. Consistent with results for other fishes, a significant number of live shad heated more rapidly than they cooled. Comparisons of data for live and dead fish indicated that conduction accounted for 80%, and therefore, convection 20% of the total heat transfer in these experiments. (Auth)

<40>

Beljanina, V.M., and A.P. Trankova, Growth and Spectrophotometric Characteristics of the Blue-Green Alga SYNECHOCOCCUS ELONGATUS under Different Temperature and Light Conditions.

1977. Arch. Hydrobiol./ Suppl. (Cov.), 51, 44-46 (L. Kirensky Institute of Physics, Laboratory of Biophysics, Siberian Branch of the U.S.S.R. Academy of Sciences, Novosibirsk, U.S.S.R.)

Optimum temperatures for growth of the blue-green alga SYNECHOCOCCUS ELONGATUS, isolated from a thermal spring, were between 34 and 50 C. (ST)

<41>

Benda, R.S., Growth Response of CLADOPHYTES to a Thermal Effluent.

1976. Indiana Acad. Sci., 85, 76-77 (Aquinas College, Natural Science Division, Grand Rapids, MI)

CLADOPHYTES was present in the discharge area of the Palisades Nuclear Power Plant, Lake Michigan, earlier in the spring and later in the fall months than on surrounding substrates (10 to 11 C). This growth pattern continued until mid-summer when the discharge temperature exceeded 26 C and CLADOPHYTES growth on the discharge structures ceased and died back. Growth on adjoining substrates continued through the summer. (ST)

<42>

Berlin, W.H., L.T. Brown, and L.B. Stone, Verification of a Model for Predicting the Effect of Inconstant Temperature on Embryonic Development of Lake Whitefish (COREGONUS CLUPEIFORMIS).

1977. U.S. Fish and Wildlife Service Tech. Rep. 92 (U.S. Fish and Wildlife Service, Great Lakes Fishery Laboratory, Ann Arbor, MI)

Eggs stripped from lake whitefish spawning in Lake Michigan were incubated in the laboratory at temperatures similar to those on whitefish spawning grounds in Lake Michigan during December-April. Observed times from fertilization to attainment of each of 21 developmental stages were used to test a model that predicts the rate of development at daily fluctuating temperatures. Observed times agreed well with times predicted by the model; the observed time of 135 days from fertilization to hatching was only 5 days less than the predicted time of 140 days. The model was further verified by applying it to unpublished data supplied by the Ontario Ministry of Natural Resources, for eggs from Lake Huron whitefish incubated in the laboratory in untempered Lake Huron water. The model was used to predict the effects of small temperature increases (caused by a hypothetical waste-heat discharge) on the rate of development and time of hatching of lake whitefish eggs. According to this simulation, continuous addition of waste heat sufficient to raise the temperature 1, 2, or 3 C above ambient on the spawning grounds during December-April would advance the time of hatching 8, 16, or 21 days, respectively. Possible effects of this advancement on the reproductive success of whitefish are discussed. (Auth) (ST)

<43>

Whittacharya, S.S., and R.G. Kovalaneni, Salinity and Temperature Tolerance of the

<46> CONT.

Hydrocodens PODOCORYS OCELLATA from Bombay Coastal Waters.

1975. Jour. Biol. Sci., 10, 5-10 (Troperevula Marine Biological Research Station, Bombay, India)

Salinity tolerance, temperature tolerance, and the combined effect of temperature and salinity on survival were studied in the laboratory on the hydrocodens, PODOCORYS OCELLATA from coastal waters of Bombay. Salinity tolerance experiments were carried out at salinities from 35 ppt (100% seawater) to 0 ppt. The sodium could tolerate salinity from 0 to 35H seawater. Salinity acclimation did not increase the salinity tolerance. The upper and lower lethal temperatures were found to be 30 C and 10 C, respectively in full strength seawater. Investigations on the combined effect of temperature and salinity demonstrated that high salinity and lower temperature (22 to 20 C) is favorable to the animal. (Auth)

<47>

Phattacharya, S.S., and R.G. Kovelramani, Salinity and Temperature Tolerance of ACANTHA SPINICARPA.

1976. Indian Jour. Mar. Sci., 5, 120-130 (Sriharth College of Arts & Sciences, Bombay, India)

Salinity tolerance, temperature tolerance and combined effects of temperature and salinity on survival were investigated in the laboratory on the copepod, ACANTHA SPINICARPA obtained from Bombay coastal waters. Salinity tolerance experiments were carried out at salinities from 35 ppt (taken as 100% sea water) to 0 ppt (fresh water). The copepod could tolerate salinity (expressed as percentage composition of sea water) down to 20% sea water when subjected to sudden exposure. Salinity acclimation increased the capacity to tolerate dilutions to as low as 5% sea water. The upper and lower lethal temperatures were 35 and 15 C, respectively, in full strength sea water. Investigation of the combined effects of temperature and salinity demonstrated that the copepod could tolerate the widest range of dilution when the experimental temperatures were close to the field temperatures and widest range of temperature when the experimental salinities were close to field salinities. Distribution of A. SPINICARPA, on the basis of the above findings, was discussed. (Auth)

<48>

Pillard, R., and R. Breton, Temperature Susceptibility of Various Reproductive Stages in Rainbow Trout.

1977. Cah. Lab. Hydrobiol. Brestois (Fr.), 5, 5-20 (Laboratoire de Physiologie des Poissons, IZMA, Jouy-en-Josas, France)

Thermal requirements for rainbow trout reproduction were determined under controlled environment and by in vitro experimentation with gametes. Good growth occurred at all tested temperatures (8-18 C), but was significantly higher at 10 C for salmon and females. Only decreasing photoperiods (16L-8D to 8L-16D) were favorable. Spermatation was initiated at 10 C, but total volume of sperm collected was lower at 10 C than at 18 C, suggesting the inhibitory effect of elevated temperature on spermatation. In females kept under thermal regimes of 10 and 20 C after ovulation, ova

fertilizability was maintained during 70 h; after 110 h, it was the same at 10 C but dropped at 20 C. In vitro experimentation showed that sperm and ova susceptibility to elevated temperature depends on dilution rate and parental origin (great individual variability in the quality of gametes). The temperature should not exceed 10 to 15 C during insemination. (Auth)

<49>

Pillard, R., and C. Gillet, Temperature Effects on Fecundation and Survival of Gametes in Rainbow Trout (SALMO GAIARDUS).

1975. Bull. Fr. Piscic., No. 259, 53-65 (Institut National de la Recherche Scientifique, Laboratoire de Physiologie des Poissons, Jouy-en-Josas, France)

Temperature susceptibility of rainbow trout gametes was defined following in vitro experimentation. Brood stock reared at 10 to 12 C were handstripped and gametes were diluted and submitted to various temperatures (1 to 20 C for ova and 0 to 30 C for sperm) for 20 or 60 min before insemination. Effects of various temperatures at the time of artificial insemination were also investigated. When spermatozoa were diluted in the diluent for insemination, fertilizing ability was better maintained at 0 and 5 C than at 10 and 15 C. If spermatozoa were kept immobile fertilizing ability was significantly decreased at 20 C and sometimes at 15 C. Following 60 min exposure to the experimental temperature, fertilization of ova was maximally maintained only at 1 and 5 C. At the time of insemination, the most favorable temperatures were between 5 and 15 C. At 1 C, 20 C, and high r., the percentage of fertilization was reduced especially when the rate of dilution was high. (Auth)

<50>

Bisson, F.A., and G.E. Davis, Production of Juvenile Chinook Salmon, ONCORHYNCHUS Tshawytscha, in a Heated Model Stream.

1976. Fish. Bull., 74, 763-770 (Oregon State University, Department of Fisheries and Wildlife, Corvallis, OR)

Two large model streams, one heated approximately 4 C above ambient and one unheated, were used to examine the effects of constantly elevated temperature on production of juvenile chinook salmon under conditions similar to natural streams. Salmon were introduced into each stream as either eyed eggs or fry and allowed to remain for one year. Salmon production in the control stream exceeded that in the heated stream. In 1972, total production in the control stream was twofold greater and, in 1973, it was approximately 10% greater than in the heated stream. Elevated temperature resulted in reduced growth rates of the fish, especially as food became less abundant, and at times also resulted in lower biomass of food organisms, either because the temperature increase directly affected survival and growth of benthic invertebrates or because increased sedimentation associated with heavier growth of filamentous algae made riffle substrate less suitable for certain species. Beneficial effects of increased temperature appeared to include protection from infestation by a trematode parasite (PAROPHISTEUS SALMOCOLA) and, possibly, increased tendencies of some invertebrates to enter the drift. (Auth) (57)

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<52>

Slabov, S.J.E., and A.L. Whitfield, Large Scale Mortality of Fish at St. Lucia.

1976. S. African Jour. Sci., 72, 210 (University of Natal, Zoology Department, Pietermaritzburg, South Africa)

It is reported that at least 100,000 fish died in the St. Lucia Lake system between May and July 1976. Examination of dead fish showed skin lesions and hemorrhaging over large areas of the body. The areas of hemorrhaging were in many cases covered with a fungal growth. The deaths coincided with a period of very low salinities in the St. Lucia system, values falling from between 17.3 and 6.8 ppt down to 3.5 and 1.2 ppt. The surface and bottom water temperatures were unusually low (12 C). It is suggested that the large mortality at St. Lucia was due to either a lethal combination of low salinities and low temperatures leading to osmoregulatory failure, or if the fish survived these conditions, to fungal infection of the skin lesions which usually follow osmoregulatory stress. (Auth)

<52>

Polov, A., Study of the Influence of Temperature on Survival and Biology of Some Molluscs of Sediment Substrate, for Thermal Pollution.

1976. Ph.D. Thesis, Université d'Aix-Marseille, 109 pp. (Université d'Aix-Marseille-2, UFR des Sciences de la Ter et de l'Environnement, France)

Experiments are recorded with gastropods and bivalves collected on the Mediterranean coast of France. Lethal temperatures (LT 50) and temperatures inhibiting burrowing (TI 50) are determined: the two curves evolve in a parallel way, they diminish as a function of time. The species responses are proportional to the temperature variations, but differ with each species as well as for a double thermal stress and the influence of age. The species resistance is a function of the bathymetric level where they live, the more resistant being those of superficial levels. Studying the reproduction of gastropods leads to the conclusion that the reproduction processes stop before the lethal temperature for embryo is reached. The author concludes that temperatures less than the LT 50 may represent acceptable conditions. (Auth)

<53>

Pogoda, R.G., The Relative Abundances of Filter-Feeding Behavior of Zooplankton: Clues to Coexistence in the Pelagic Environment.

1977. Ph.D. Thesis, 250 pp. (State University of New York at Albany, NY)

The summer variation in filtering rate per unit biomass in *DAPHNIA GALEATA*, *DIAPHANUSOMA LEUCHESTERI*, *TRICHAETA*, and *DIPTERUS NIGRUS* was dependent on the variation in the temperature and particulate organic carbon (POC) level of the food-suspensions. In *DAPHNIA*, the rate showed a linear dependence on temperature (19 to 26 C) and was inhibited at 26 C. A curvilinear response between 20 and 26 C was assumed for *DIAPHANUSOMA*. Food concentration was shown to be below the incipient-limiting level of both species. The rate of *DIPTERUS* showed a linear dependence on temperature (20 to 26 C) but a closer analysis revealed that POC levels below 0.4 microg C/ml influenced filtering rate. When temperature was statistically controlled, the rate declined with POC level. This suggests that at lower

food levels, *DIPTERUS* but not the two cladocerans responded to food scarcity. (BPC)

<54>

Buge, C., and C. Paves, Effects of a Thermal Acclimatization Associated with Sudden Changes of the Temperature on the in vivo Intestinal Absorption of Glycerol by Trout.

1977. Cah. Lab. Hydrobiol. Montfermeil (Fr.), 5, 49-58 (Institut de Recherches Pêche, Laboratoire Maritime de Physiologie, Toulon-sur-Mer, France)

Trout were acclimatized for three months at 5, 10, 18, and 23 C. The weight of the animals acclimatized at extreme temperatures was more dispersed than that of the other fishes. The action of sudden thermal changes on the intestinal absorption of glycerol by these trout was studied using a perfusion method. At the lower perfusion temperatures the absorption of trouts acclimatized at 5 C and 23 C was less high than at the other acclimatization temperatures. When these results are related to the weight of the intestines, differences have been found only between 5 C and the other temperatures. The thermal coefficients are higher at extreme temperatures of acclimatization when measured at low temperature. They are noticeably the same at an acclimatization of 10 C, and are therefore rather low. (Auth)

<55>

Bohl, H., Gill Worn Disease (Dactylomyxosis), the Most Fearful Parasitosis in Carp Fry.

1975. In The Role of Parasites in the Production of Freshwater Fish, Papers of the Munich Seminar of Biology of Fish, December 5-7, 1973. G. Fischer, Stuttgart, Germany: Fisch. Umwelt, No. 1, 67-80 (Bayer Biologische Versuchsanst., Teichwirtschaft. Abt., Wiblingen, Göttingen)

DACTYLOMYXUS VASTATUS causes a high rate of mortality in pond-reared carp fry. Development is temperature dependent; at water temperatures up to 20 C development from the egg to a sexually mature adult takes place within 10 days. (ST)

<56>

Dennis, J.B., The Physiological Ecology of Larval Sunfishes and Perch: Temperature Tolerance and Growth Rates Under Hatchery Conditions.

1976. M.A. Thesis, State University College (State University College, Buffalo, NY)

Critical Thermal Maxima (CTM) and growth rates of larval sunfishes (*Lepomis microlophus*) and perch (*Perca fluviatilis*) were determined under hatchery conditions. Two groups of fish were maintained at ambient water temperatures with natural photoperiod. Weekly water samples were collected to monitor the troughs. Parameters measured were dissolved oxygen, pH, and ammonia which were within normal limits. Perch had higher temperature tolerance and developed faster than sunfishes. CTM of larval sunfishes (30.9 to 36.0 C) were significantly different from those of sunfishes (29.9 to 35.6 C). Both species exhibited a sharp decrease in CTM during swim-up, followed by a slow recovery period indicated by a gradual increase in CTM values. Both species steadily increased in length during development. Weight remained stable through swim-up, decreased with absorption of the yolk sac and then increased as the fry began

[56] 1971.

to grow. The results obtained in this study indicate that both age and past thermal history had a significant effect on the temperature tolerance of sockeye and arctic fry. (Auth)

[57]

Bout, S.P., A.V. Betscher, and J.C. Stevens. Mortality, Saltwater Adaptation and Reproduction of Fish During Gas Super Saturation.

1976. EPA-600/3-76-050, U.S. Environmental Protection Agency (Environmental Research Laboratory-Baloth, Western Toxicology Station, Corvallis, OR)

Mortality of sockeye salmon, largemouth bass and rainbow trout at comparable gas supersaturation levels (gas-bubble disease) was determined at temperatures between 10 and 20 C. Sockeye salmon and largemouth bass adults and juveniles revealed markedly different response patterns to supersaturation when tested at 10 and 20 C. Adult sockeye were considerably more tolerant to 120 and 125% saturations when they were acclimated slowly from 10 C and tested at 10 C. Sockeye salmon and rainbow trout parr showed a variable response; increased test temperatures increased tolerance in one case and decreased tolerance in two cases. Both juvenile and adult largemouth bass showed a decrease in tolerance with increased test temperature, possibly because of rapid temperature acclimation and supersaturation. Short temperature acclimation times may have influenced the results. (ST)

[58]

Bruton, B., and R. Billard, Effects of Photoperiod and Temperature on Plasma Gonadotropin and Spermatogenesis in the Rainbow Trout *Salmo gairdneri* Richardson.

1977. Ann. Biol. Anim. Biochim. Biophys., 17, 331-340 (Institut National de la Recherche Agronomique, Laboratoire de Physiologie des Poissons, Jouy-en-Josas, France)

Two-year old male rainbow trout were exposed to 16L:16D, 16L:8D, and gradually decreasing from 16L to 8L photoperiods at 8 or 16 C. Control fish were exposed to natural photoperiod and temperature. Control fish showed no advancement of spermatogenesis, whereas those exposed to decreasing photoperiod at 8 or 16 C showed complete induction of spermatogenesis. Cooler temperature favored production of spermatogenesis and spermatocytes; warmer temperature stimulated formation of spermatids and spermatozoa. In trout exposed to constant short or constant long photoperiods spermatogenic response was weak at both temperatures. Plasma gonadotropin levels increased in groups kept under decreasing photoperiod at both temperatures, with the magnitude of rise greater at 16 C. The data suggest that the optimum photothermal combination for gonadotropin release and induction of spermatogenesis is a gradually decreasing photoperiod at 16 C. (Auth) (ST)

[59]

Brett, J.R., Feeding Metabolic Rates of Young Sockeye Salmon, *Oncorhynchus nerka*, in Relation to Satiation Level and Temperature.

1976. Trans. Am. Fish. Soc., 105, 675, 45 pp. (Fisheries & Marine Service,

Pacific Biological Station, Nanaimo, British Columbia, Canada)

A direct relation between rate of oxygen consumption and size of daily ration was observed for fingerling sockeye salmon, *Oncorhynchus nerka*, at 10, at 15, and at 20 C, with a maximum change induced at 20 C. A predictive model was developed from these data and published records of standard metabolism in the form of isopleths of daily metabolic rate in relation to temperature and ration. The predicted rates were compared with published studies on hatchery-reared chinook salmon, and with other studies on fish where feeding metabolic rates have been recorded and, in general, support the observations and concepts developed for sockeye salmon. (STC)

[60]

Bretthauer, R., Laboratory Experiments to Determine the Limits of Tolerance of Placental to Some Abiotic Factors.

1975. Verh. Intl. Ver. Limnol. (Ger.), 19, 2041-2050 (Not given)

The ecological limits of tolerance of *Ochromonas sociabilis* non. prov. Pringsheim (Chlorophyta, Chlorellales) to various pH values and temperatures were investigated in culture experiments. This species prefers acidic pH values and could be cultured for more than 2 weeks at values between 6 and 8. Maximal growth was observed at pH 6. The lower limit of temperature tolerance is the freezing point of the nutrient medium. The upper limit is at 35 C. The highest population density was observed at 30 C. The basic findings were confirmed by experiments in which various pH-temperature combinations were investigated. (Auth)

[61]

Brittain, J.E., Experimental Studies on Symbiotic Growth in *Leptophlebia versipennis* (L.) (Ephemeroptera).

1976. Freshwater Biol., 6, 445-449 (University College of North Wales, Department of Zoology, Bangor, Wales)

The mayfly, *Leptophlebia versipennis*, was reared at field temperatures in the laboratory. A major change in growth rate occurred when temperatures were falling rapidly from 10 to 15 C to around 5 C. The growth rate was also lower during the later part of July and August when maximum temperatures often exceeded 20 C and minimum temperatures were generally over 15 C. Growth rates in the field and laboratory were similar. The optimum temperature range for growth appeared to be about 10 to 15 C, but may vary with developmental stage. (ST)

[62]

Brook, D.A., Comparison of Community Similarity Indices.

1977. Jour. Water Poll. Control Fed., 49, 2000-2004 (University of Texas, Austin, TX)

Community similarity indices were computed to aid evaluation of power plant thermal effluent effect on the zooplankton of Lake Lyndon B. Johnson, Texas. Analysis of variance and regression techniques applied to pooled similarity indices are discussed. Pielou's and Pearson's index and a percentage-based index were compared in

<42> 1947.

Direct application to field data and in parallel statistical treatments. There were qualitative and quantitative differences in the manner in which the two indices represented the system. The first appears to be sensitive to variation of rare forms and thus more affected by sample error. It is also relatively insensitive to changes in transient taxa. The use of the second index plus complementary statistics on zooplankton total abundance may be a better methodology for impact analyses involving comparisons between communities. (Auth)

<43>

Procter, R.P., J.L. Norris, and R.J. Hensworth, Mass Mortalities of Molt Salmon, *Salmo salar*, in the St. Lawrence, 1976.

1977. Jour. Appl. Ecol., 14, 409-417 (WISST, Department of Applied Biology, Cardiff, Wales)

The physical, biological and chemical conditions leading to a mass mortality of adult salmon (*Salmo salar* L.) in the lower reaches of the St. Lawrence (Quebec) are described. As a result of sunny and low flow conditions during late June 1976, water temperatures increased to a maximum of 27.6 C and accelerated the decay of substantial plant stands, the growth of which had been enhanced by the prevailing conditions; this resulted in severe deoxygenation of the water. It is concluded that the low oxygen concentration in the water at this time was the principal factor in causing mass mortalities of fish and was probably accentuated by high water temperatures. (Auth)

<44>

Probst, R.S., and G.L. Seeport, The Effects of Intermittent Chlorination on Rainbow Trout and Yellow Perch.

1977. Trans. Amer. Fish. Soc., 106, 278-284 (University of Wisconsin-Milwaukee, Department of Zoology and Center for Great Lake Studies, Milwaukee, WI)

Rainbow trout, *Salmo gairdneri*, and yellow perch, *Perca flavescens*, were exposed to residual chlorine for single 30-minute and triple 5-minute doses. Tests were conducted at 10, 15, and 20 C with both species plus 25 and 30 C for the perch. Single exposure 30-minute LC50 values for the perch ranged from 0.70 mg/liter at 30 C to 0.0 mg/liter at 10 C. Triple 5-minute exposure LC50 values for the perch were 22.6 and 9.0 mg/liter at 10 and 20 C, respectively. Rainbow trout 10-minute LC50 values were 0.99 and 0.90 mg/liter at 10 and 15 C, respectively. Two groups of trout tested at 20 C yielded 10-minute LC50 values of 0.60 and 0.03 mg/liter. Triple exposure 5-minute LC50 values for the trout were 2.07 mg/liter at 10 C and 1.05 mg/liter at 20 C. Mortality occurred immediately after exposure to chlorine in the 30-minute perch tests at 10 and 15 C, but was delayed 2 to 12 hours at the higher temperatures. This pattern was reversed in the 5-minute triple exposure tests. Rainbow trout exhibited rapid mortality in all tests except the 10 C triple exposure series where mortality was delayed 12 to 78 hours. For both species, concentrations resulting in no mortality were approximately one-half the LC50 value. (Auth)

<45>

Brungs, W.A., and B.P. Jones, Temperature

Criteria for Freshwater Fish: Protocol and Procedures.

1977. EPA-600/3-77-061, Environmental Protection Agency, Duluth, MN (Environmental Research Laboratory, Duluth, MN)

The history, procedures, and derivation of temperature criteria to protect freshwater fish are discussed and numerical criteria for 30 species are summarized. Data for survival, reproduction, growth, temperature selection and upper and lower temperature tolerances from both field and laboratory studies are tabulated. The insufficiency of data for some important species is noted. (ST)

<46>

Barr, B.M., and R.A. Morris, Spawning Behaviors of the Shorthead Redhorse, *Moxostoma valenciennesi*, in Big Rock Creek, Illinois.

1977. Trans. Amer. Fish. Soc., 106, 60-62 (Illinois Natural History Survey, Urbana, IL)

Shorthead redhorse were observed spawning on May 17 and 18, 1976 in Big Rock Creek, Illinois, at 16 C in a manner similar to that described for other redhorse species. Spawning behavior and reproductive characteristics are described for the species. (Auth)

<47>

Burton, D.T., C.J. Moore, L.L. Yansant, and J.H. Dayton, Lethal Limits of Sheepshead Minnow Eggs (*Cyprinodon variegatus*) Exposed to Various Rates of Thermal Elevation.

1976. Ann. Southeast. Biol. Bull., 22, 40 (Academy of Natural Sciences of Philadelphia, Benedict Estuarine Research Laboratory, Benedict, MD)

The thermal tolerance of *CYPRINODON VARIEGATUS* eggs exposed to seven constant temperature increases was established for eggs spawned at 25 C. Temperatures were increased from 25 C at the rates of 0.75, 0.50, 0.75, 1.00, 1.50, 1.75 and 2.00 C/minute until cardiac failure occurred. Mean mortality temperatures at the slower heating rates of 0.25 and 0.50 C/minute were significantly lower than those at the faster rates of 0.75, 1.00, 1.50, 1.75 and 2.00 C/minute. No significant difference was found between the mean mortality temperatures at the slower rates or at the faster rates. The mean lethal temperature at the two slower heating rates was 35.3 C in contrast to 37.0 C at the faster rates of thermal elevation. A significant difference was also found between the mean time to death at each rate with the exception of the means at 1.75 and 2.00 C/minute. These findings suggest that acute heat death is a function of the rate of temperature change and/or time spent at a lethal temperature. (Auth)

<48>

Bumacher, G.P., The Age and Growth of the Largemouth Bass *Micropterus salmoides* (Linnaeus), in a Thermally Loaded Reservoir.

1971. M.S. Thesis, University of Missouri (University of Missouri, Columbia, MO)

A one-year study was undertaken to determine the effects of heated effluent from a 475,000 kw fossil-fuel plant on the growth of largemouth bass in the receiving reservoir.

(68) CONT.

Warren discharge temperature was 37 C; temperature of the heater was elevated 0.5 to 11.5 C above that of the control arm. Winter and summer checks in the scales of bass note the analysis of age and growth difficult. No differences were found between the body-scale and length-weight relationships of bass from the two arms. Condition factors did not differ for bass from the two arms and were low when compared to those from other reservoirs. The heated water had the following measurable effects upon the largemouth bass: (1) annulus formation occurred up to one month earlier in the heater arm than in the control arm; (2) an extended growing season and a greater annual growth increment occurred in the heater arm; (3) bass congregated in the heater arm during the winter and provided an excellent winter sport fishery. During the study period, the heated water discharge had no apparent deleterious effects on adult largemouth bass. (Auth) (57)

(69)

Porch, R.A., and R.J. Linpe, Establishment of an Asymptomatic Carrier State Infection of Enteric Redmouth Disease in Rainbow Trout (*Salmo gairdneri*).

1975. Jour. Fish. Res. Bd. Can., 32, 2029-2032 (University of Idaho, Department of Bacteriology and Biochemistry, Moscow, ID)

The dynamics of establishment, pathogenesis, and continued maintenance of Enteric Redmouth (ERM) disease in rainbow (*Salmo gairdneri*) were examined. Groups were infected by oral and ocular routes and subsampled at weekly intervals. Both modes of infection were standardized to obtain 10 (100) levels of infection with an average of 30 bacteria constituting and 10% damage when administered parenterally. The clinical course of the disease was monitored up to 102 days postinfection. A clinically asymptomatic carrier state infection was established in the lower intestine of 25% of survivors 65 days postinfection at 10.5 C. Thereafter, regular intestinal shedding of the pathogen, causing recurrent infection and mortality within the population, occurred on a cyclic basis of 30 to 60-day intervals. Clinical recovery, establishment of the asymptomatic condition, and periodicity of intestinal shedding and the clinical course of the disease to convalescence were described. (Auth)

(70)

Cade, G.P., The Entrainment of Larval Fishes at Two Nuclear Power Plants on the Missouri River in Nebraska.

1977. Ph.D. Thesis, University of Nebraska (University of Nebraska, Lincoln, NE)

High observed mortality of ichthyoplankton above the intakes of the power plants was due to rapid sampling velocities at which collections were routinely made. When the effects of this sampling mortality were removed from consideration through linear regression techniques, significant entrainment mortalities were demonstrated. The same adjustments applied to samples collected at the 1 C isotherm of the thermal plume, however, resulted in significantly greater mortalities on only one date. Thus the immediate detrimental effects of entrainment within the plume were less critical to larval fish than the hazards of

condenser passage. (57)

(71)

Cain, J.B., Environmental Regulation of Gametogenesis in *Scenedesmus obliquus*.

1975. Ph.D. Thesis, University of Connecticut (University of Connecticut, Storrs, CT)

Temperatures of 30 C and higher inhibited zoete formation of *Scenedesmus obliquus* and were detrimental to survival of gametes formed at lower temperatures. A minimum of 20 to 24 hr exposure to favorable nitrogen levels and 15 C temperature was required before cells in culture reach a point of no return for zoete formation. Nitrogen concentration in the media determined the number of cells in the culture which would form gametes, but did not affect the rate of zoete production or time of onset of gametogenesis. (57)

(72)

Cairns, J., Jr., W.P. Calhoun, R.J. McGinniss, and P. Straka, Aquatic Organisms Response to Severe Stress Following Acutely Sublethal Toxicant Exposure.

1976. Water Resources Bull., 12, 1231-1243 (Virginia Polytechnic Institute and State University, Department of Biology, Blacksburg, VA)

Snails, *Corbicula fluminea* (Muhlenb.), were exposed to acutely sublethal concentrations of p-nitrophenol and the lampricide, 3-trifluoromethyl-4-nitrophenol (TFN), and then to acutely lethal thermal shocks. The same species were also exposed to acutely sublethal concentrations of zinc followed by exposure to acutely lethal concentrations of p-nitrophenol; and to acutely sublethal concentrations of TFN followed by exposure to acutely lethal concentrations of zinc. Brown trout, *Salmo trutta*, were exposed to acutely sublethal concentrations of TFN and then to an acutely lethal thermal shock. Results of these experiments indicate that prior exposure to acutely sublethal toxicant concentrations may reduce survival time for a subsequent exposure to acutely lethal concentrations of a second toxicant (e.g., snails exposed to zinc(2) then p-nitrophenol), but neither prior or concomitant exposure to acutely sublethal toxicant concentrations insures that the median survival time for a lethal exposure will be significantly altered (e.g., snails exposed to 0.2 x 96-hour LC50 for TFN then zinc(2)). However, some acutely sublethal concentrations of a toxicant may significantly alter survival time of snails to a lethal concentration of a different toxicant (e.g., exposure to 0.4 x 96-hour LC50 TFN then a lethal dose of zinc(2)). The brown trout exposed to an acutely sublethal concentration of TFN and then an acutely lethal thermal shock did have significantly altered survival patterns. (Auth)

(73)

Calow, P., The Joint Effect of Temperature and Starvation on the Metabolism of Triclad.

1977. Oikos, 29, 87-92 (University of Glasgow, Zoology Department, Scotland)

Size changes, measured photographically as plan area, were followed in eight species of triclad during complete starvation. The area-time curves so obtained were negative exponentials. In common with simple

<73> 1977.

Physico-chemical reactions the relationship between reaction rate, expressed as the coefficient of exponential degrowth, and the reciprocal of ambient temperature (in degrees Kelvin) was linear. There was a direct relationship between the rate of degrowth, its sensitivity to temperature and the distribution of each species. (Auth)

<74>

Cassidy, J.V., S.A. Lawrence, and J.L. Davidson. Combined Toxicity of Free Chlorine, Chloramine and Temperature to Stage I Larvae of the American Lobster *NOVIGORUS AMERICANUS*.

1975. Water Res. (G.B.), 10, 1091-1099 (Woods Hole Oceanographic Institution, Woods Hole, MA)

The differential effects of free chlorine and chloramine on stage I larvae of the American Lobster *NOVIGORUS AMERICANUS* were investigated in continuous flow bioassay units. Applied chloramine was more toxic than corresponding concentrations of applied free chlorine to lobster larvae with estimated LC50 values at 25 C of 16.30 mg/l applied free chlorine and 2.07 mg/l applied chloramine. The synergistic effect of temperature on the toxicity of both free chlorine and chloramine was also demonstrated. Exposure to applied free chlorine at 20 C resulted in no significant mortality of test organisms, whereas exposure at 30 C resulted in an estimated LC50 value of 2.50 mg/l. Applied chloramine was considerably more toxic with an estimated LC50 value at 20 C of 0.08 mg/l and at 30 C of 0.56 mg/l. (ST)

<75>

Carpenter, J.B., and C.G. Peterson. Variation in Selected Meristic Series in the Golden Shiner, *NOTEMIGONUS CRYSOLEUCUS* (Mitchill), in the New Brunswick-New Scotia Border Region.

1977. Canadian Field-Naturalist, 91, 70-77 (Mount Allison University, Biology Department, Sackville, New Brunswick, Canada)

Populations of *NOTEMIGONUS CRYSOLEUCUS* inhabiting five lakes of varying limnological characteristics near the New Brunswick - Nova Scotia border did not show differences in the number of dorsal or pelvic fin rays or in the number of scale rows above the lateral line. One lake in the series, Layton's Lake, supported a population with a significantly lower number of lateral line scales. Population differences in number of anal fin rays could not be related to temperature differences or to differences in other limnological variables and are postulated to result from genetic differences among the populations. (Auth)

<76>

Carr, T.N., Culturing and Transplanting Hatchery-Spawed Quahogs (Abstract Only).

1975. Proc. Natl. Shellfish. Assn., 65, 1 (New Brunswick Shellfish Academy, Division of Marine Fisheries, Buzzards Bay, MA)

Between May and October, 1973, 5.5 million quahogs, averaging 2.0 cm along their anterior-posterior axis, were placed in trays suspended in the water column. By November, the mean survival rate was 52% and the mean size of quahogs delivered in May and June was 6.0 cm. Quahogs subjected to freezing water temperatures and ice during the winter of 1973-74, had a survival rate of 99%. Other

hatchery-spawed quahogs with a size range of 0-20 cm were transplanted onto natural bottom. Recovery and survival of shell stock planted at a water temperature of 4C was greater than that planted at 20C. (Auth)

<77>

Cassidy, J.V., and P.S. Lake. The Acute Toxicity of Cadmium for the Fish *GALAXIAS MACULATUS* and Changes in Acute Toxicity with Season and Temperature.

1975. Bull. Aust. Soc. Limnol., 6, 27-32 (Trevallion, Lancaster, Tasmania)

The 96 h median lethal concentration (96 h LC 50s) of cadmium using cadmium sulphate for the fish *GALAXIAS MACULATUS* were determined. The 96 h LC 50s ranged from a maximum value of 10.3 ppm of Cd in July, 1973, to a minimum value of 1.3 ppm of Cd in November. Continuous flow and static toxicity tests carried out in July gave 96 h LC 50 values of 5.4 ppm and 10.3 ppm respectively. The 96 h LC 50 value for fish acclimated to 21 C was 5.7 times lower than that for fish acclimated to 15 C. It is suggested that the prime cause for variation of the 96 h LC 50 values for fish freshly collected from the field is the seasonal variation in stream temperature. (Auth)

<78>

Chap, P., A Study of Populations of a Sexable Rotifer in the River Loire.

1977. Cah. Lab. Hydrobiol. Roumouss (Fr.), No. 6, 60 pp. (Laboratoire d'Ecologie Aquatique de l'Ecole Normale Supérieure, Paris, France)

The sexable, colonial rotifer *SINANTHESINA SOCIALIS* (Linnaeus) has been found in great numbers in the river Loire (France) for some years. Measurements show that this species can grow at between 10 and 30 C, the optimum temperature being about 27 to 28 C. The sexual cycle is characterized by the existence of "amphoteris" females capable of emitting apparently anisic eggs after having produced male eggs. The occurrence of asexual reproduction appears to be significantly related to short photoperiods and high population densities. At sufficiently high temperatures (over 10 C), hatching rates of up to 80 per cent of the resting eggs have been attained. In summer, birth rates decrease with increasing temperature and population density, and are probably limited by the amount of food available (diatoms). In autumn, birth rates increase with temperature and population density, the main limiting factor being temperature. Below the heat effluent from the nuclear plant at Chinon, the season of presence of *SINANTHESINA* is longer than upstream from the plant, and population densities are higher. Secondary productivity, however, which is probably limited by food availability, does not reach greater values. Although thermal pollution lengthens the growth season for *SINANTHESINA SOCIALIS*, the exceptional densities of this rotifer are the consequence of river eutrophication. (Auth) (M)

<79>

Chen, T.N., Cage Culture of Channel Catfish in a Reused Effluent from a Power Plant, Thomas Hill Reservoir.

1976. Ph.D. Thesis, University of Missouri (University of Missouri, Columbia, MO)

(79) (57).

Channel catfish were cultured in floating cages in an 88 acre arm of a power plant cooling reservoir. Control fish were cultured in another arm subject to annual temperature regimes. In the heated water, fish were subjected to an average high temperature of 33°C in August and a low of 6.1°C in January. In the control arm, average temperature extremes were 28.9°C in July and 2.8°C in January. During summer, growth of control fish exceeded growth of all fish in the heated water by 1.9 g. Best growth in the heated effluent was obtained in a cage with a mean temperature of 32.7°C. During a nine month over-winter experiment, there was a significant difference in growth between fish in the heated water and the controls, with the fish in the heated water showing greater growth. The elevated temperature effect was most influential during early spring and summer. Minimum weight of fish maintained in the heated water for two years was 861.9 g; maximum weight was 2215 g and the mean was 872.7 g. Survival was 93%. There was no apparent relationship between survival and stocking densities. In the laboratory the best growth and food conversion factor was obtained by fish raised at 30°C. (Auth) (57)

(80)

Cheng, F., Bionenergetics of Utah Chub and Rainbow Trout.

1975. Ph.D. Thesis, 69 pp. (University of Idaho, Moscow, ID)

Feeding, assimilation, and growth of Utah chub (*CILA ATROPIS*) and rainbow trout (*Salmo gairdneri*) were determined at four food rations (basal, 2/3 maximum, 1/3 maximum and zero ration) and at various temperatures. Maximum food consumption rates of Utah chub at 9.0, 12.0, 15.0, and 20.0°C were 62.7, 101.1, 100.6, and 279.9 cal/kcal fish/day, respectively. Maximum food consumption rates of rainbow trout at 10.0, 12.0, 15.0, and at regulated temperature fluctuations of 10.0 to 15.0 were 60.0, 73.6, 60.1, and 75.8 cal/kcal fish/day. Rainbow trout raised at 12.0 and 15.0 to 15.0°C consumed more of the available food than the trout raised in 10.0 and 15.0°C. Utah chub assimilated about 62 to 79% of Oregon moist pellet feed. Food assimilation by chub was positively related to temperature and inversely related to food ration. Rainbow trout assimilated about 97% of fish flesh regardless of the variations in temperature and food ration. At any given food ration, growth of Utah chub was maximum at 20°C and least at 9°C. Growth rate of rainbow trout was affected primarily by the amount of food intake and not by temperature. (Auth) (57)

(81)

Chen, J., L. Morrow, and A. Schlosser. A Long Term Exposure to Effluents of the Fort Calhoun Nuclear Power Station: Effects Upon Survival and Development of Age 0 *ITALUS* *PERCUTANUS*.

1976. Proc. Amer. Acad. Sci. Affil. Soc., 86, 11 (Abstract only) (Omaha Public Power District, Omaha, NE)

To evaluate the feasibility of studying the long-term exposure of fish to effluents from power plants, floating boxes of catfish were suspended in the Missouri River above and below the Fort Calhoun Nuclear Power Plant. The experiment lasted three months, August to

November. Food was provided as needed.

Twenty-eight of 53 upstream fish survived and 27 of 50 downstream fish survived. At termination the mean weight of upstream fish (21.9 g) was significantly lower than that of downstream fish (35.1 g). The mean length for upstream fish (11.0 cm) was significantly shorter than that of downstream fish (12.8 cm). (57)

(82)

Cherry, D.S., R.L. McKen, J. Collins, Jr., and J.E. Stauffer. Preferred, Avoided, and Lethal Temperatures of Fish During Rising Temperature Conditions.

1977. Jour. Fish. Res. Bd. Can., 34, 239-246 (Virginia Polytechnic Institute and State University, Biology Department and Center for Environmental Studies, Blacksburg, VA; University of Maryland, Appalachian Environmental Laboratory, Frostburg, MD)

Selected temperatures increased for 15 fish species in a laboratory gradient when acclimated to 3°C increments from 12 to 27°C. Temperature preferences exceeded acclimation temperatures between 12 to 27°C for all except the teleost shiner (*NOTROPIS TELEOSTIUS*), yellow perch (*PERCA FLAVESCENS*), rainbow trout (*SALMO GAIARDNERI*), brown trout (*SALMO TRUTTA*), and brook trout (*Salvelinus fontinalis*). At 10, 13, or 16°C acclimation, preferred temperatures were less than the acclimation temperature. The highest temperature preferences occurred at acclimations of 27, 30, or 33°C. Bluegill (*Lepomis macrochirus*), spotted bass (*Micropetrus punctulatus*), rock bass (*Ambloplites rupestris*), and the spotfin shiner (*Notropis spilopterus*) consistently selected the highest temperatures while the lowest temperatures were preferred by the siluoids. Final temperature preferences were usually greater than 20°C for most centrarchids, above 24°C for most cyprinids, and less than 17°C for siluoids. Avoidance temperatures increased as acclimation temperature increased. Upper avoidance temperatures tested at high acclimation temperatures (30 to 36°C) either equalled or exceeded the 7-day upper lethal temperature limit of the species by 1 to 2°C, while avoidance were below this upper lethal limit when tested at the acclimation temperature closest to the species' final temperature preference. Seven-day upper lethal temperature limits, following acclimation to the highest temperature at which no mortality occurred, were: spotfin shiner, bluegill, spotted bass, and rock bass, 36°C; smallmouth bass, 35°C; redbreast shiner and northern hogchoker, 33°C; bluntnose shiner, 32°C; stoneroller, 31°C; teleost shiner, 30°C; yellow perch, 28°C; rainbow trout, 25°C; brook trout, 20°C; and brown trout, 23°C. (Auth) (57)

(83)

Cherry, D.S., and R.E. Guthrie. Effects of *FLAVOBACTERIUM LUTESCENS* Growth on Populations of *ESCHERICHIA COLI* and *STREPTOCOCCUS PISCICOLA* in Water Following Thermal Loading.

1975. Microbial Ecol., 2, 106-193 (Virginia Polytechnic Institute and State University, Center for Environmental Studies, Blacksburg, VA; Clemson University, Department of Microbiology, Clemson, SC)

FLAVOBACTERIUM LUTESCENS, a major bacterial species in populations of aerobic, heterotrophic bacteria in aquaculture systems, is present in lower numbers in the

<41> 1977.

presence of municipal sewage and higher concentrations of organic wastes. In water from nonpolluted systems in laboratory tests, at 'separate' bacterial populations after thermal addition and was a major component with thermal addition in polluted water. Numbers of *ESCHERICHIA COLI* and *STREPTOCOCCUS FAECALIS* decreased in proportion to the thermally-induced increase in *P. LUTESCENS*. Results were similar in tests of water from three aquatic systems of differing nutrient content. *P. LUTESCENS* predominance was reduced with greater amounts of organic material. The results suggest a non-chemical method for restoration of natural aquatic bacterial populations and reduction of undesirable microbial populations in water supplies. (Auth) (BPC)

<42>

Cherry, D.S., S.P. Larrick, K.L. Dickson, R.C. Roehn, and V. Cairns, Jr., Significance of Hypochlorous Acid in Free Residual Chlorine to the Avoidance Response of Spotted Bass (*SPOTTED BASS PUNCTATUS*) and Rosyface Shiner (*ROSYFACE SHINER PUNCTATUS*).

1977. Jour. Fish. Res. Bd. Can., 34, 1365-1372 (Virginia Polytechnic Institute and State University, Biology Department and Center for Environmental Studies, Blacksburg, VA; Virginia Polytechnic Institute and State University, Environmental Science and Engineering Program, Civil Engineering Department, Blacksburg, VA)

The spotted bass (*SPOTTED BASS PUNCTATUS*) and rosyface shiner (*ROSYFACE SHINER PUNCTATUS*), when exposed to successively doubling doses of total residual chlorine (TRC) from 0.025 to 0.20 mg/l, generally avoided higher concentrations when acclimated and tested at five temperatures from 6 to 30 C. Both species avoided 0.05 mg/l TRC when acclimated and tested at 6 C and avoided 0.20 mg/l TRC at 24 and 30 C. Variations in avoidance of the free residual chlorine (FRC) ranged from 0.017 to 0.091 mg/l (0.05 to 0.20 mg/l TRC) between 6 and 30 C. After the initial avoidance response, the rosyface shiner continued to avoid the remaining higher residual levels, while spotted bass showed less avoidance or none at all. The same behavioral responses occurred when each species was exposed to a single concentration (0.05 or 0.10 mg/l TRC) for three successive 10-min observations. The avoidance response was most closely associated with the calculated hypochlorous acid (HOCl) fraction of the TRC, which declined (relative to the percent of TRC) as the pH and acclimation temperature increased. Avoidance to HOCl occurred between 0.012 mg/l (6 C) and 0.031 mg/l (30 C) when TRC was between 0.05 and 0.20 mg/l respectively. Avoidances did not occur at the 12 and 18 C acclimation temperatures until the HOCl content surpassed the 0.10 and 0.20 mg/l TRC doses surpassed the initial HOCl threshold level (0.012-0.013 mg/l) calculated for 0.05 mg/l TRC at 6 C. The HOCl content may be the most important constituent within the TRC to influence the avoidance response of fish in unpolluted aquatic systems. (Auth)

<45>

Chervinski, J., and Y. Lahav, The Effect of Exposure to Low Temperature on Fingerlings of Local *TILAPIA* (*TILAPIA AUREA*) (Steindachner) and Imported *TILAPIA* (*TILAPIA VULCANI*) (Trevan) and *TILAPIA NILOTICA* (Linne) in Israel.

1976. Nasilgeh, 28, 25-29 (Fish and Aquaculture

Research Station, 203, Israel)

Results of preliminary experiments on *TILAPIA AUREA*, *T. VULCANI*, *T. NILOTICA* and *T. NILOTICA* (female) x *T. AUREA* (male) hybrids, are reported. *T. AUREA* and *T. BOSSMANNICA* are more tolerant to low temperatures in 5% seawater than in freshwater. *T. AUREA* is tolerant to lower temps than either *T. NILOTICA* or *T. VULCANI*. The hybrid offspring are similar to *T. AUREA* in their tolerance. The acclimatization temperature affects the lower temperature tolerance. (Auth)

<46>

Childress, J.J., Effects of Pressure, Temperature and Oxygen on the Oxygen-Consumption Rate of the Midwater Copepod *GAMMARUS PRINCEPS*.

1977. Marine Biol. (R. Ger.), 39, 19-24 (University of California, Marine Science Institute, Santa Barbara, CA)

G. PRINCEPS is shown to be a diurnal vertical migrator which spends its days below 400 m in the oxygen minimum layer and migrates to shallower depths (200 to 300 m) at night. Oxygen consumption was measured at 3.5, 7 and 10 C and 1, 14, 28, 41, 121 and 181 atm of hydrostatic pressure (1 atm corresponds to about 10 m of depth). The Q10 of the oxygen consumption is shown to be higher at lower temps and higher pressures. Hydrostatic pressure is shown to have significant effects on the oxygen-consumption rate at pressures as low as 28 atm. At all temperature and pressure combinations, *G. PRINCEPS* displays a very low metabolic rate compared to shallow-living copepods. The critical oxygen partial pressure for this species is shown to be about 10 to 13 mm HgO2 at 10, 7 and 5.5 C. Based on these data, a predicted relation between depth and oxygen consumption by this species off California, USA, is presented. This shows a higher oxygen-consumption rate at nighttime depths and a much lower, partially anaerobic metabolism at daytime depths. (Auth)

<47>

Chittleborough, R.G., Breeding of *PARALICHTHES LEUCIPES* CYGNUS George under Natural and Controlled Conditions.

1976. Aust. Jour. Mar. Freshwater Res., 27, 499-516 (CSIRO, Division of Fisheries and Oceanography, Western Regional Laboratory, North Beach, Western Australia)

The incubation period of eggs of the western rock lobster varied inversely with water temperature, being longest at 19 C (68 days) and shortening towards an asymptote at 25 C (19 days). When held at a constant temperature of 25 C and given abundant food, adult females bred continuously, averaging six spawnings and three molts each year. (ST)

<48>

Christensen, H.O., P. Naasen, and P. Frandsen, The Influence of Temperature on the Infectivity of *FASCIOLOPSIS* *HEPATICA* Miracidia to *LYNCEUS TRUNCATULA*.

1976. Jour. Parasitol., 62, 698-701 (Royal Veterinary & Agricultural University, Parasitology Research Group, Copenhagen, Denmark)

The minimum temperature for host-finding capacity (small localization, attachment, and penetration) by *FASCIOLOPSIS* *HEPATICA* miracidia was 5 to 6 C and the optimum temperature was

<98> -047-

between 15 and 26 C. Lack of host-finding below the minimum temperature could be reversed by raising the temperature. A clear inverse relationship was observed between the environmental temperature and the duration of the host-finding capacity of the miracidia in infecting the snails. At 8, 16, and 24 C, the capacity ceased after 24, 20 to 24, and 13 to 20 hours, respectively. (BPC)

<99>

Christiansen, H.E., J.D. Costlow, and R.J. Moore, Effects of the Juvenile Hormone Miotic 22-515 (Altosid) on Larval Development of the Crab *MYTHROPODOPUS HARRISII* in Various Salinities and Cyclic Temperatures.

1977. Marine Biol. (W. Ger.), 39, 269-279 (University of Oslo, Zoological Museum, Oslo, Norway; Duke University Marine Laboratory, Beaufort, NC; North Carolina State University, Department of Statistics, Raleigh, NC)

Effects of 0.01, 0.1, and 1.0 ppm methoprene (Altosid: 22-515), a juvenile hormone mimic which shows high activity against some economically important insect pests, especially Diptera, were tested on larvae of the crab *MYTHROPODOPUS HARRISII* (Gould) (Decapoda: Xanthidae) from hatching to the first crab stage under optimum and stress conditions of a number of salinities and cyclic temperatures. Three cycles of temperature (20 to 25 C, 25 to 30 C, and 30 to 35 C) and five salinities (5.0 ppt, 12.5 ppt, 20.0 ppt, 27.5 ppt and 35.0 ppt) were used. There was a significant reduction in survival of zoeal larvae with increasing concentrations of methoprene in nearly all combinations of salinity and temperature. The first zoeal stage was the most sensitive of the larval stages to methoprene as well as to salinity and temperature stress. Except at 0.1 ppm in 27.5 ppt salinity, survival of the megalopa was not significantly reduced in 0.01 or 0.1 ppm methoprene in any salinity or temperature; although the percentage of abnormal megalopa increased under stress conditions. (Auth)(77)

<97>

Chung, K.S., Heat Resistance of Crustaceans and Fishes Taken From an Intake Canal of an Estuarine Power Plant and Their Predicted Survival in the Discharge Canal.

1977. Ph.D. Thesis, Texas A&M University (Texas A&M University, College Station, TX)

Heat resistance times of 10 species of crustaceans representing 5 families and 65 fishes from 32 families were determined during June 1974 through September 1975 to estimate percentage survival in the discharge canal system of the P.M. Robinson Generating Station, Baycliff, Texas. Animals were taken directly from the intake canal and placed at experimental temperatures. Individual resistance times increased with an increase in intake canal temperature and with a decrease in test temperature. Most aquatic animals captured at similar temperatures were less resistant to heat death in April to mid-June than in late August and September. Few species showed a relationship between individual resistance time and total length. Summer discharge canal temperatures above and below the cooling towers were around 40 and under 35 C, respectively. Three-h L050 temperatures of most organisms were equal to or greater than 35 C and 0.5-h L0100 temperatures of most species were lower than

40 C during the summer (June-September). (Auth)(77)

<91>

Cloern, J.E., Population Dynamics of *CRYPTONHAS OVATA*: A Laboratory, Field, and Computer Simulation Study.

1976. Ph.D. Thesis, Washington State University (Washington State University, Pullman, WA)

A four-part study of the physiology and population dynamics of *CRYPTONHAS OVATA*, a common phytoplankton in southern Kootenay Lake, British Columbia, is reported. Over the temperature range, 8 to 20 C, maximum specific growth rate increased exponentially with temperatures. At 26 C both the maximum specific growth rate and the light intensity required for optimum growth were depressed, thus suggesting a temperature inhibition. Phosphate, nitrate, and ammonium uptakes were measured over the temperature range of 8 to 26 C and at different light intensities. Field and laboratory data were integrated into a mathematical model designed to simulate the population dynamics of *CRYPTONHAS OVATA* in southern Lake Kootenay. (ST)

<92>

Cloutman, D.G., and D.A. Becker, Some Ecological Aspects of *ENGASILUS CENTRARCHIDARUM* Wright (Crustacea: Copepoda) on Largemouth and Spotted Bass in Lake Fort Smith, Arkansas.

1977. Jour. Parasitol., 63, 372-376 (University of Arkansas, Department of Zoology, Fayetteville, AR)

Certain ecological aspects of *ENGASILUS CENTRARCHIDARUM* on largemouth and spotted bass from Lake Fort Smith, Arkansas, were studied during July 1970 through 1971. There were no significant differences in *E. CENTRARCHIDARUM* intensities between host sexes. *E. CENTRARCHIDARUM* tended to increase in abundance with the age of the hosts through the first 3 years, then declined in older hosts. Maximum abundance and egg production occurred during the summer months. Optimum temperatures for abundance and egg production ranged from 24 to 29 C. There was no evidence of antagonism among *E. CENTRARCHIDARUM* and other concomitant species of gill parasites. (Auth)

<93>

Coles, S.L., and P.L. Jokiel, Effects of Temperature on Photosynthesis and Respiration in Mesotrophic Corals.

1977. Marine Biol. (W. Ger.), 43, 209-216 (Hawaii Institute of Marine Biology, Kaneohe, HI)

Measurements of photosynthesis and respiration rates of the reef corals *POCILLOPODA DANICORNIS*, *NOPTIPODA VERBUCOSA*, *POBITES COMPRESSA* and *PONGIA SCUTARIA* under controlled temperatures showed that coral metabolism is closely adapted to ambient temperature conditions. Tropical corals measured at Eniwetok, Marshall Islands, showed greater primary production compared to maintenance requirements at elevated temperatures than did subtropical varieties of the same species in Hawaii. Photosynthesis:respiration (P/R) ratios were significantly and negatively related with temperature between 18 and 31 C for all Hawaiian corals, whereas at Eniwetok this ratio generally showed a curvilinear

<93>

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relationship for this temperature range. Extrapolations of P:B regressions on temperatures to a value of 2.0 (estimated as a minimum required for long-term functional anisotropy) coincide for Hawaiian specimens with published upper lethal temperatures. For Eniwetok specimens at temperatures above 25 °C, extrapolations suggested that lethal temperatures are 2 to 5 degrees C higher than for Hawaiian corals. Interspecific differences in P:B temperature regressions for Hawaiian corals correlating with upper lethal temperature tolerances were described. (PFF)

<94>

Colasante, R.T., Behavior of Muskellunge Fry During Yolk Absorption and Swim-Up.

1977. N.Y. Fish & Game Jour., 24, 94 (New York State Department of Environmental Conservation, Delmar, NY)

Time lapse for initial signs of swim-up of developing muskellunge fry until all fry were swimming was 72 hr at 16.6 °C and 48 hr at 20 °C. (ST)

<95>

Collett, L.C., Respiratory Physiology of Two Turbiniid Gastropod Molluscs in Relation to their Ecology.

1976. Ph.D. Thesis (University of New South Wales, Australia)

The causes of distributional differences between two similar, closely related, turbiniid gastropods (*MINELLA TORQUATA* and *STENINELLA UNDULATA*) inhabiting slightly different zones of the rocky shore and having different biogeographic distributions in temperate Australian waters was investigated. A higher weight specific rate of oxygen consumption was observed for *MINELLA* at temperatures between 15 to 30 °C, with a maximum reached at about 25 °C. The responses of excised tentacular tissue and heartbeat rate were similar except that no rate maximum was observed over the temperature range employed. Any need for a change in the rate of oxygen supply to the tissues (due to temperature change, wave action, activity, etc.) was found to be met by an alteration in cardiac output. (PFC)

<96>

Collins, M.T., Aquatic Recirculating Systems and the Effect of Environment on the Immune Response of Channel Catfish (*ICTALURUS PUNCTATUS*).

1976. Ph.D. Thesis, University of Georgia (University of Georgia, Athens, GA)

As part of the study, channel catfish were maintained in recirculating systems under conditions of low (15.4 °C) and fluctuating (15.4 to 26.9 °C/24 hr) temperature, low and high nitrate, and crowding and starvation. Within two weeks of introducing the catfish, total bacterial counts stabilized at 10 (B₆) organisms/ml. Fish were immunized with a formalin-killed bacterium and antibody titers were monitored weekly for 10 weeks. Only those fish maintained in low or fluctuating temperature regimes demonstrated significant immuno-depression. The other environmental conditions studied, which are commonly encountered in intensive fish culture operations, did not compromise the humoral immune response. (ST)

<97>

Colura, R.L., Induced Spawning of the Spotted Seatrout, *Cynoscion nebulosus* (Cuvier).

1976. In Proceedings 5th Annual Workshop World Mariculture Society held at Charleston, SC, (pp. 319-330) (Texas Parks and Wildlife Department, Marine Fisheries Research Station, Palacios, TX)

Induced spawning of spotted seatrout (*CYNOSCION NEBULOSUS*) during their natural spawning season was accomplished by injecting human chorionic gonadotropin. Thirteen of 31 injected females produced viable eggs. Ovulation occurred 26 to 32 hr after injection. Viable eggs resulted only when average initial ova diameters were 0.462 mm or greater. Eggs incubated at 23.5 °C hatched in 22 hr but larvae failed to survive to metamorphosis. Eggs incubated at 28 °C hatched in 15 hr. Larvae held at 28 °C completed metamorphosis after 10 days, at which time an average length of 8 mm had been reached. (Anth)

<98>

Cordero, F.A., Jr., Taxonomy, Distribution and Seasonal Occurrence of the Genus *GALAXAURA* in the Vicinity of the Seto Marine Biological Laboratory.

1976. Publ. Seto Mar. Biol. Lab., 23, 237-256 (Kyoto University, Seto Marine Biological Laboratory, Kyoto, Japan)

Ten species of *GALAXAURA*, a red alga, were collected near the Seto Marine Biological Laboratory from around Takashima Islet in Kanayama Bay to Nataka-jima Island in Tanabe Bay. The most commonly occurring and seemingly most environmentally tolerant was *G. OBLOBOGATA* while *G. PAPILLATA* and *G. PALCATA* were rare. All began to appear in the lower intertidal to the shallow sublittoral zone in autumn, growing well from spring to early summer of the following year, and disappear in late summer when the water temperature reaches 28 °C or more. Some factors affecting the growth and distribution of the genus in the area are briefly discussed. (BFC)

<99>

Cottrell, B., The Immune Response of Plaice *Pleuronectes platessa* to Tissue Parasites (Abstract only).

1976. Parasitology, 73, 3 (Middlesex Hospital Medical School, Department of Immunology, London, England)

An evaluation was made of the humoral immune response of plaice to three tissue parasites. Natural and experimental infections with the metacercariae of *CHRISTOCOTYLE LINGAE* and *HNIPIDOCOTYLE JONESTONII* induced a temperature-dependent precipitin response in the plaice. Physico-chemical characterization of these antibodies indicated they were IgM with a molecular weight of 900,000. Plaice infected with the hemoflagellate *TRYPANOSOMA PLATYSSAE* had elevated levels of serum beta₂-globulins, and this may be associated with antibody secretion to the parasite. A pronounced seasonal variation in the numbers of *T. PLATYSSAE* infected fish pointed to a temperature-controlled immunity to these trypanosomes. (Anth)

<103>

Contant, C.C., Cold Shock to Aquatic Organisms: Guidance for Power-Plant Siting, Design, and Operation.

1977. Nuclear Safety, 18, 329-342 (Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN)

Problems of cold-shock damages to aquatic organisms have arisen at some condenser cooling-water discharges of thermal power stations when the warm-water releases have suddenly terminated. The basis for such damage lies in the exposure of resilient organisms to a rapid decrease in temperature and a sustained exposure to low temperature that induces abnormal behavioral or physiological performance and often leads to death. Although some spectacular fish kills from cold shock have occurred, the present knowledge of the hydraulic and biological processes involved can provide guidance for the siting, design, and operation of power-plant cooling systems to minimize the likelihood of significant cold-shock effects. Preventing cold-shock damages is one consideration in minimizing overall environmental impacts of power-plant cooling and in balancing plant costs with environmental benefits. (Auth)

<104>

Contant, C.C., Compilation of Temperature Preference Data.

1976; 1977. CNRP-760499: Jour. Fish. Res. Bd. Can., 34, 739-745: Environmental Sciences Division Publication No. 998, Oak Ridge National Laboratory (Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN)

The report briefly summarizes current information from field and laboratory studies on temperature selection by fishes, with a tabulation of final temperature preferences and upper and lower avoidance temperatures. (Auth)

<107>

Contant, C.C., and S.S. Talmage, Thermal Effects.

1977. Jour. Water Poll. Control Fed., 49, 1369-1425 (Oak Ridge National Laboratory, Oak Ridge, TN)

The 1976 literature on thermal effects on aquatic organisms was reviewed under the categories: reviews; site studies; producers; consumer reproduction, development, activity, morphology, distribution, thermal tolerance, sensitivity to combined stresses, temperature selection and avoidance, and predator-prey relations; decomposers; diseases and parasites; and beneficial uses. (ST)

<103>

Craddock, D.R., Impact of Cooling Waters on the Aquatic Resources of the Pacific Northwest.

1976. Marine Fish. Rev., 38, 27-34 (National Marine Fisheries Service, Northwest Fisheries Center, Seattle, WA)

The present and predicted future sources and volumes of cooling waters returned to the marine environment in the Pacific Northwest are described. The physical and subsequent biological effects are reviewed. It is concluded that the impact of thermal effluent on the marine resources of this area is

presently small, as the bulk of electric power is from hydropower generation. (ST)

<104>

Craig, J.P., Seasonal Changes in the Day and Night Activity of Adult Perch, *PERCA FLUVIATILIS* L.

1977. Jour. Fish Biol., 11, 161-166 (Freshwater Biological Association, Ferry House, Far Sawrey, Ambleside, Cumbria, England)

PERCA FLUVIATILIS L. were caught by gill nets every 3 hr over a 24-hr period monthly from February 1975 until January 1976. The numbers caught increased with rise in temperature. The monthly catch (in 24 hr) was related to water temperature. The temperature was based on a mean value for the depths at which the nets were operating. The highest number of fish were caught in August (450) at a temperature of 19.5°C and the lowest in January at a temperature of 6.1°C. During the winter months perch migrated into deeper water although some fish were still caught in shallow water (1 to 6 m). Perch were active at very low light intensities. However changes in visual surface irradiance (400 to 700 nm) and water clarity caused inverse changes in activity. Only June did not conform to this pattern and it was presumed that spawning behavior was of primary importance. It is suggested that increase in eutrophication with its effect on water clarity enables fish to become more active during the day in the summer months. They are thus able to utilize food sources to a maximum at an optimum period for feeding and growth. (Auth) (ST)

<105>

Crawshaw, L.I., Physiological and Behavioral Reactions of Fishes to Temperature Change.

1976; 1977. CNRP-760499: Jour. Fish. Res. Bd. Can., 34, 730-734 (John B. Pierce Foundation and Yale University School of Medicine, New Haven, CT)

Teleost fishes possess a central nervous system thermoregulatory mechanism remarkably similar to that of other vertebrates. Inputs from peripheral and anterior brainstem thermosensitive elements are integrated to effect appropriate thermoregulatory responses. The integrated output signal from the thermoregulatory center also appears to provide an input to the respiratory system. Short-term deviations from a given temperature alter respiratory requirements, produce acid-base imbalance, and cause disturbances in fluid-electrolyte regulation. Acclimation to a given temperature involves changes that counteract these disturbances. (Auth)

<106>

Crawshaw, L.I., Effect of Rapid Temperature Change on Mean Body Temperature and Gill Ventilation in Carp.

1976. Amer. Jour. Physiol., 231, E37-E41 (Yale University School of Medicine, New Haven, CT)

During the first minutes of cooling after transfer of carp, *CYPRINUS CARPIO*, either from 25°C water to a calorimeter at 15°C or from 15°C to 25°C, mean body temperature (T_b) changed rapidly, while dorsal muscle temperature (T_{dm}) changed only slightly. T_{dm} changed faster during heating than during cooling. Changing temperature of inspired water (T_{insp}) and body surface (T_{bs}) both

<105> CONT.

effected rate-sensitive changes in gill ventilation (VG), although Tinsp was more effective. Decreases in Tinsp or Tbs produced decreases in VG while increases in Tinsp or Tbs had an opposite effect. The observation that the fish respiratory system is sensitive to the rate of change of external temperature provides evidence for the existence of peripheral thermal input to the systems regulating respiration in teleost fish. (JPC)

<107>

Collinsev, J.L., and S.D. Turner, Larval Development of the Deep-Water Wood Boring Bivalve, *MYOPHAGA ATLANTICA* Picharis (Mollusca, Bivalvia, Pholadidae).

1974. *Phelia*, 15, 149-161 (Harvard University, Bureau of Comparative Zoology, Cambridge, MA)

Adult *MYOPHAGA ATLANTICA* obtained from lobster pots sat at a depth of 100 m released in the laboratory when the water temperature was raised from 8 to 9 C. Spawns were rarely observed but spawned eggs developed, suggesting internal fertilization. Larvae reared at 9 and 14 C and 31 ppt salinity were free swimming in 20 to 40 hours and 20 to 24 hours respectively. Swimming larvae held in tall culture vessels congregated in a horizontal band where the temperature was 11 to 13 C. (ST)

<109>

Francis, V.A., S.P. Stieber, and P.A. Cavanaugh, Summer Temperature Tolerance of Selected Species of Mississippi River Acclimated Young of the Year Fish.

1977. *Comp. Biochem. Physiol.*, 56A, 81-85 (University of Wisconsin-Eau Claire, Department of Biology, Eau Claire, WI)

The temperature tolerance was determined for eight species of young of the year fish taken from the Mississippi River during periods of high summer temperature. Under the experimental conditions described, LD50 values were determined as follows: *Dorosoma cepedianum*, 28.5 C; *Lepomis macrochirus*, 28.5 C; *Esox lucius*, 30.8 C; *Aplodinotus grunniens*, 32.8 C; *Morone chrysops*, 33.5 C; *Carpionus carpio*, 35.2 C; *Micropogonias undulatus*, 35.6 C; and *Ictalurus nebulosus*, 35.7 C. (Auth)

<110>

Mabrowski, R.R., How to Calculate the Optimal Density of Food for Fish Larvae.

1976. *Environ. Biol. Fish.*, 1, 87-89 (Academy of Agriculture and Technology, Institute of Ichthyobiology and Fisheries, Olsztyn-Kortowo, Poland)

The feeding minimum at 4 to 12 C for whitefish larvae, *Coregonus lavaretus*, was 50-70 plankton individuals/l, when the weight of plankton was 0.004 mg per individual/l. The feeding optimum at 13.5 C was 200-260 plankton individuals/l and was twice as high for larvae starved for 15 days. A drop in water temperature caused a decrease in the feeding optimum. At 8.5 C, therefore, the optimum was 155 individuals/l. (JPC)

<113>

Davies, P.R., and S.G. Massey, Energy Conversion Efficiency in Fish: The Influence of Food Intake

and Temperature on K-Values at Ratios Close to Maintenance.

1977. *Jour. Comp. Physiol.*, 116B, 191-202 (University of Nottingham, Dept. of Zoology, Nottingham, England)

Data relating to growth in goldfish at ration levels very close to maintenance were used to calculate maintenance rations and food conversion efficiencies (K) in energetic terms. The relationship between maintenance metabolism and temperature was logarithmic, with a Q10 of 2.2 (12-28 C). A significant positive relationship was apparent between the natural logarithm of K and ration on which the influence of temperature is equivocal. The meaning of this in relation to the findings of other workers is discussed. (Auth)

<117>

Davis, B.J., Distribution and Temperature Adaptation in the Teleost Fish Genus *GIBBERINIA*.

1977. *Marine Biol. (U. Ger.)*, 42, 315-326 (San Francisco State University, Department of Biology, San Francisco, CA)

Along the California coast there are three intertidal species of the genus *GIBBERINIA* (*G. elegans*, *G. neta*, *G. montezumensis*). These species have distinct but overlapping distributions. Collections were made seasonally from three areas. Each collection was divided into two groups - a critical thermal maximum and minimum were determined for one group and the other group was tested after a 3 week acclimation period. The three species showed genetically different adaptation abilities and these were correlated with species differences in latitudinal distributions. The species that experienced the widest seasonal temperature range proved capable of anticipatory adjustment to temperature while the two experiencing small seasonal changes showed only reactive adjustments. The species with the widest distribution showed the greatest ability to adapt to temperature extremes. After 1 week acclimation all three species demonstrated different mechanisms for heat and cold adaptation. (Auth)

<112>

Davison, J., *HYDRA HYMANAE*: Regulation of the Life Cycle by Time and Temperature.

1976. *Science*, 190, 618-620 (University of Vermont, Department of Zoology, Burlington, VT)

HYDRA HYMANAE, a hermaphroditic freshwater coelenterate, reproduced asexually at 24 C and sexually at 15 C. The appearance of gonads began 12 days after transfer from 24 to 15 C and was complete 35 days after the temperature transition. Testes appeared before eggs. Fifty percent of the mature embryos maintained at 15 C hatched by day 61, but they had a low level of survival. Fifty percent of the mature embryos pretreated for from 5 to 25 days at 4 C hatched by about day 85, and these had a high level of survival. Embryos maintained at 4 C for longer periods (55 to 85 days) accumulated in a prehatching state and hatched with a high degree of synchrony approximately 7.5 days after return to 15 C. Populations derived from newly hatched polyps were refractory to sex induction for approximately 120 days. The system is well adapted to ensure a regular alternation of reproductive modes in the natural environment. (Auth)

<113>

Dawes, C.J., R. Boon, and J. LaClaire, Photosynthetic Responses of the Red Alga, *HYPERA HYALINUS* (Wulfen) Linoceous (Gigartinales).

1976. Bull. Marine Sci., 26, 467-473 (University of South Florida, Tampa, FL; University of California, Berkeley, CA)

HYPERA HYALINUS was collected during the summer and winter from a protected estuary and an exposed shore on the west coast of Florida. The plants showed broad tolerances to light intensity, temperature, and salinity. Analysis of variance indicated significant differences in tolerance to light intensity and salinity, but not temperature between plants from the two sites and seasons. Results of experiments using forty-eight combinations of light-intensity, temperature, and salinity suggested significant differences in synergistic effect between plants from the two sites. The majority of plants, except summer specimens from the coastal site, had maximum rates of apparent photosynthesis at 20 to 32 C. (Auth) (ST)

<114>

de Niechojowski, J.D., Characteristics and Distribution of Postlarvae of *ACONOPSIS CHILOENSIS* (Jenyns, 1842) Jordan and Evermann, 1898 and *TRIPLETION CUNNINGHAMI* Salt, 1898 in Atlantic Waters of Argentina (Pisces).

1977. Physic. Riv. Soc. Argent. Cienc. Nat. (Arg.), 38A, 309-317 (Inst. Biol. Mar., Mar del Plata, Argentina)

Morphological characteristics of postlarvae, 4 to 20 mm in length of *ACONOPSIS CHILOENSIS* and of postlarvae, 3 to 27 mm of *TRIPLETION CUNNINGHAMI* are given. The range of temperatures at which the postlarvae were collected was 6.7 to 12.9 C for *A. CHILOENSIS* and 11.7 to 13.2 C for *T. CUNNINGHAMI*; the range of salinities was 32.40 to 33.62 ppt and 33.26 to 33.32 ppt respectively. The results obtained indicate that the spawning of both species occurs at least between October to November and January to February. (Auth) (M)

<115>

de Jockheere, J., and H. van de Voorde, The Distribution of *HAEMOPHYSALIS FOWLERI* in Man-Made Thermal Waters.

1977. Amer. Jour. Trop. Med. Hyg., 26, 10-15 (Ghent University Leuven, School of Public Health, Leuven, Belgium)

The discharges of 16 thermal polluting factories were examined for the occurrence of *HAEMOPHYSALIS FOWLERI*, the causative agent of primary amoebic meningoencephalitis. Seven of these waters were shown to harbor this amoeba. Of 22 *H. FOWLERI* isolates, three were highly virulent for mice when inoculated intranasally. The three pathogenic strains were isolated from three different places during summer. More *H. FOWLERI* were found during summer than in winter, which could be attributed to the lower temperature during winter. The distribution seems to be bound to the cooling waters of older factories and is not restricted to one type of factory. There are strong indications that the isolation of nonpathogenic seropositive strains from water is an indication for the occurrence of pathogenic *H. FOWLERI*. (Auth)

<116>

de March, B.G.E., The Effects of Photoperiod and Temperature on the Induction and Termination of Reproductive Resting Stage in the Freshwater Amphipod *HYALELLA AZTECA* (Saussure).

1977. Can. Jour. Zool., 55, 1595-1600 (Department of Fisheries and Environment, Fisheries and Marine Service, Freshwater Institute, Winnipeg, Manitoba, Canada)

Three experiments, one on the induction of reproductive resting stage and two on its termination, were performed to determine the effects of various combinations of temperature and photoperiod on the induction and termination of reproduction in *HYALELLA AZTECA*. These showed that only photoperiod determined whether reproduction was continued or discontinued but that temperature influenced the rate of all changes. Induction of reproduction, tested over the temperature range of 12 to 25 C, occurred faster at higher temperatures. It is believed that although photoperiod is the main cue in the induction and termination of reproduction, active reproduction takes place when environmental temperatures are 20 to 26 C, since optimum reproduction and growth rates occur in this range. The adaptive advantage and the biogeographic variability of the photoperiodic response are discussed. (Auth) (ST)

<117>

de Vlaming, V., and G. Paquette, Photoperiod and Temperature Effects on Gonadal Regression in the Golden Shiner, *NOTEMIGONUS CRYSOLEUCAS*.

1977. Copeia, No. 4, 793-797 (Marquette University, Department of Biology, Milwaukee, WI)

The study was undertaken to determine whether high summer temperatures as well as decreasing daylength are involved in gonadal regression of golden shiners. A 15L:9D photoperiod and temperature of 27 C resulted in testicular regression during February and ovarian regression during November, January and February. Thus high temperatures acted independently of short photoperiods to induce gonadal regression. Gonadal regression in wild populations of *NOTEMIGONUS* in southern Wisconsin occurs during mid to late summer when daylength begins to decrease and temperatures are high. The results suggested that both decreasing daylengths and high temperatures occurring at this time of year are involved in gonadal involution. (ST)

<118>

Devik, O. (Ed.), Harvesting Polluted Waters - Waste Heat and Nutrient-Loaded Effluents in the Aquaculture.

1976. Plenum Press, New York, 324 pp. (Not given)

Twenty papers review what is currently known of these subject areas. The first contains papers dealing mainly with algae and phytoplankton production and is entitled Controlled Primary Production in Marine Systems: Potentials of Select Species/Control of Unwanted Grazers. Large Scale Culturing Systems includes the use of coastal waters for aquaculture, the entrainment of large water masses, and dialysis culture in integrated aquaculture. Contributions concerning Food Chains and Their Use: Mussels, Mollusks, Bivalves, Fish and Fish Fry make up the third section. The book's purpose was to focus on problems involved in the use of waste heat and

<114> 1977.
nutrient-loaded effluents for aquaculture
rather than to provide final solutions. (BPC)

<113>
Dillon, T. V., Effects of Acute Changes in
Temperature and Salinity on Pulsation Rates in
Ephyrae of the Scyphozoon *AURELIA ANITA*.

1977. Marine Biol. (W. Ger.), 42, 31-35 (Texas
A&M University, Department of Biology, College
Station, TX)

The response of *AURELIA ANITA* ephyrae to
abrupt temperature and salinity differentials
is expressed as changes in bell pulsation
rates. Acute temperature rate-response of
Texas (USA) ephyrae reflect a reduced
temperature sensitivity over a broad range
(10 to 35 C), with a Q10 value of 0.97
between 20 and 25 C. The initial
relationship between salinity changes and
pulsation rate is linear and direct. This
pattern is disrupted after 20 hr, with those
ephyrae experiencing a salinity decrease
pulsing significantly faster than those
experiencing no change or an increase in
salinity. This response to low salinities
dissipates after 2 days. Holding osmotic
pressure constant and disrupting ionic
ratios has more of an immediate and
persistent effect than solely decreasing
salinity. (Auth)

<122>
Dorson, J. J., and J. C. Young, Temperature and
Photoperiod Regulation of Rheotactic Behavior in
Prespawning Common Shiners, *NOTROPIS CORPUSCULUS*.

1977. Jour. Fish. Res. Bd. Can., 34, 381-386
(University of Waterloo, Department of Biology,
Waterloo, Ontario, Canada)

The upstream orientation and frequency of
upstream movement of prespawning common
shiners, *NOTROPIS CORPUSCULUS*, in response to a
water current simulated by moving a striped
background past the fish were observed at
three temperatures (10, 15, 20 C) and two
photoperiods (12L:12D and 16L:8D). The
greatest frequency of upstream movement was
induced by a combination of spring day
lengths and warm water temperatures. Further
increases in the frequency of upstream
movement followed immediate 5 C increases in
water temperature. Neither temperature nor
photoperiod had a major effect on the
frequency of upstream orientation. The
significance of environmental regulation of
rheotaxis as a mechanism of upstream
migration is discussed. (Auth)

<121>
Doenges, J., and R. Goetzelsmann, Echinostome
Pedias: Effect of Pretreatment with Cold on
Transplantation to Uninfected Snails.

1975. Exptl. Parasitol., 38, 228-232 (University
of Wurzburg, Institute of Zoology, Wurzburg,
Germany)

Transplantation of *ECHINOPARYPHIUM ACONIATUM*
from infected snails, *LYNUREA STAGNALIS*, to
uninfected snails was more successful in
snails acclimated to 13 C than in those held
at 23 C. (ST)

<122>
Doi, T., Some Aspects of Feeding Ecology of the
Sea Stars, genus, *ASTROPECTEN*.

1976. Publ. Anahusa Mar. Biol. Lab. (Jap.), 4,
1-19 (Kyushu University, Anahusa Marine
Biological Laboratory, Japan)

The feeding of sea stars, *ASTROPECTEN* sp.,
observed along the coast of Japan, generally
increased with increasing water temperature.
But feeding rates at the same temperature
differed depending on whether temperature was
increasing or decreasing. Both *A. SCOPABIUS*
and *A. LATESPICOSUS* showed the highest
feeding rate in midsummer and very low
feeding rates in winter. For *A.*
POLYACANTHUS, the feeding rate was depressed
in summer. Mean monthly seawater temperature
varied between 13.0 C in January and 26.0 C
in August. (ST)

<123>
Dorcelo, J., Comparative Ecophysiology of
Gammarids (Crustacea: Amphipoda) from Marine,
Brackish- and Fresh-Water Habitats Exposed to the
Influence of Salinity-Temperature Combinations:
IV. Blood Sodium Regulation.

1977. Netherlands Jour. Sea Research, 11,
189-199 (University of Amsterdam, Laboratory of
Aquatic Ecology, Amsterdam, The Netherlands)

Blood sodium regulation as a function of
salinity and temperature was determined for
natures of gammarid species from marine
littoral (*CHAETOGAMMARUS MARINUS*),
oligohaline (*GAMMARUS TIGRINUS*) and
freshwater (*G. FOSSARUM*) environments in
order to get quantitative data on their
regulatory characteristics in relation to the
salt regime in which they occur in nature.
Literature records of Crustacea show that the
curves describing the regulation of sodium
and total osmococoncentration in relation to
those in the environment have the same shape.
The three species are hyperosmotic over the
whole salinity range, tested at 5, 15, and 25
C, except for *G. FOSSARUM* in supramarinal,
potentially lethal salinities. They show
hyperregulation at homeostatic levels that
decrease from coastal to brackish water to
freshwater origin. The influence of
temperature on the level of regulation has no
ecological implications for the populations
of the three species studied. In its osmotic
regulation *G. TIGRINUS* resembles *G. MARINUS*
more than *G. FOSSARUM*, which may be linked
with its great salt tolerance. Small males
of *G. MARINUS* have a higher blood sodium
content as compared with big ones. (Auth)

<124>
Dov, R. L., Relationship of Sea Surface
Temperature to American and European Lobster
Landings.

1977. Jour. Conseil, CIEH (Den.), 37, 186-191
(Department of Marine Resources, Augusta, ME)

Analyses of sea surface temperatures and
lobster landings data in which there are
highly significant correlation coefficients
between (1) temperature at Boothbay Harbor,
Maine, and Torshov, Norway, from 1905 to
1974; (2) Maine landings of American lobsters
and total European lobster landings from 1950
to 1972; (3) Boothbay Harbor temperatures and
total European lobster landings during the
same period, support the assumption that the
cyclic increase and decline in landings of
both species can be attributed to the same
factors: corresponding cyclic increases and
declines in temperature and, as has been
demonstrated for northern New England and the
Canadian Maritimes, evidence of over fishing.
(Auth)

<125>

Dries, W., and D. Melung, New Results on the Rearing of *CARCINUS MAENAS* in the Laboratory.

1974. *Marine Biol. (U. Ger.)*, 38, 17-24 (Zool. Abt. Inst. Meeresk., Kiel, West Germany)

The shore crab *CARCINUS MAENAS* was reared in the laboratory from egg deposition to sexual maturity. Special enclosures were developed for cultivation of the larvae. Food and temperature proved the most important exogenous factors for rearing success. Fresh *APTYCHA SALINA* nauplii were the only food suitable for all larval stages. The rearing temperatures which proved most successful during larval development were embryonic development, 10 C; zoea stages, 15 C; and megalopa stage, 17.5 C. The larvae hatched preferably in darkness when reared under short-day conditions. (Auth)

<126>

Dunn, J.P., Dynamics of External Brooding in the Sea Anemone *EPICATIS EPICATIS PROLIFERA*.

1977. *Marine Biol. (U. Ger.)*, 39, 41-49 (University of California, Department of Zoology, Berkeley, CA)

The protection of sea anemones brooding on the Coast of Sonoma County, California, was inversely proportional to seawater temperature (9 to 13 C) and directly related to size. (ST)

<127>

Dunson, W.A., Tolerance to High Temperature and Salinity by Tadpoles of the Philippine Frog, *RANA CAUCALYBURA*.

1977. *Copeia*, No. 2, 375-378 (Pennsylvania State University, Department of Biology, University Park, PA)

The observation of tadpoles (*RANA CAUCALYBURA*) in shallow tidal pools at 42 C near midday represented an increase of about 3 C over the previously recorded highest pool temperature for tadpole survival. Temperature tolerance tests conducted in the laboratory showed that tadpoles acclimated at 35 C could survive longer than 40 hours at 42 C. A test of tadpole survival in 0, 20, 40, 60, 80, and 100% sea water at 25 C for 5 days showed 0, 0, 0, 5, 33, and 100% dead respectively. Thus survival was more than 50% up through 80% sea water. Resistance to high temperatures is probably a trait shared by many tropical and desert anurans, but the physiological adaptations for salinity tolerance are exceptional among amphibians. (ST)

<128>

Eble, A.V., Freshwater Aquaculture of the Tropical Prawn, *MACROBRACHIUM ROSENBERGII*, and the Rainbow Trout, *SALMO GAIJARDII* using Thermal Effluent Discharges from an Electric Generating Station.

1976. *Proc. Natl. Shellfish. Assn.*, 66, 100-101 (Trenton State College, Trenton, NJ)

The possibilities of growing the freshwater prawn, *MACROBRACHIUM ROSENBERGII*, and the rainbow trout, *SALMO GAIJARDII*, to commercial sizes in aquaculture systems utilizing waste-heat water discharges from the Mercer Generating Station, Trenton, NJ, were investigated. In laboratory tanks prawns grew from 10 mm to 22 mm in one month at 28

C. Thermal effluent water from the generating station was passed through heat exchangers to boost temperatures to optimal levels. In mid-June prawns were stocked in outdoor ponds at a density of 1/ft². Pond temperatures averaged 25 to 30 C and flow rates were 100 gallons/min. After three and one-half months survival rate was 90.2%; average growth rate was 0.6 in/month. Average growth of trout fingerlings stocked in an outdoor pond was 0.6 in/month over a five-month period. No mortalities occurred after animals recovered from the trauma of stocking. (ST)

<129>

Eble, A.V., Integration of Thermal and Food Processing Residuals into a System for Commercial Culture of Freshwater Shrimp (Power Plant Waste Heat Utilization in Aquaculture), Final Report, Volume II.

1977. Final Report of the Public Service Electric and Gas Company to the National Science Foundation, 165 p. (Trenton State College, Trenton, NJ)

Research conducted at the Mercer Generating Station, Trenton, NJ, demonstrated that the tropical freshwater prawn (*MACROBRACHIUM ROSENBERGII*), rainbow trout (*SALMO GAIJARDII*), and the American eel (*ANGUILLA ROSTRATA*) can be successfully cultured using waste-heat effluents. Prawns grown in outdoor ponds and raceways showed an average growth rate of 1.3 cm/month and 3.7 g/month, May to October. By using an artificial substrate of draped netting and thus utilizing the entire water column, prawn densities were increased by a factor of four over traditional culture systems. Postlarval prawns were grown in indoor heated nurseries in early spring. They were placed in outdoor ponds in mid-May at a size of 5 to 6 cm and harvested in late October at 11 to 12 cm. Eighteen cm rainbow trout were stocked in raceways in early November and harvested as young adults (28 cm, 260 g) in early May. Eels stocked at 25 cm and 40 g in early July more than doubled their weight in four months. Methods of overcoming the problems of chlorination and extreme temperature and dissolved oxygen conditions are described. (ST)

<130>

Edelstein, T., C.J. Bird, and J. McLachlan, Studies on *GRACILABIA*. 2. Growth under Greenhouse Conditions.

1976. *Can. Jour. Bot.*, 54, 2275-2290 (National Research Council of Canada, Atlantic Regional Laboratory, Halifax, Nova Scotia, Canada)

GRACILABIA sp. was cultured in tanks of running seawater under different conditions. The highest yield, an increase in weight of 423%, was obtained over a four-week incubation period at 20 C with a 12-hr photoperiod. Under natural light maximum growth occurred at 25 C. Maximum growth occurred in undiluted seawater. (ST)

<131>

Eisen, S., Incidence of *LEISHMANA CYPRINACEA* among Goldfish of North Pond, Kelleys Island, Ohio.

1977. *Ohio Jour. Sci.*, 77, 88 (Indiana University, Zoology Department, Bloomington, IN)

The mean number of parasitic copepods (*LEISHMANA CYPRINACEA*) per goldfish increased

<131> C597.
between July 18 and August 12 (water temperature 22 to 30 C). With the onset of colder temperatures, the incidence of the adult parasites declined until they disappeared in October (water temperature 11 to 15 C). (57)

<132>
Fisler, P., Acute Toxicities of Selected Heavy Metals to the Softshell Clam, *MYA ARENARIA*.

1977. Bull. Environ. Contam. Toxicol., 17, 177-185 (U.S. Environmental Protection Agency, Environmental Research Laboratory, Narragansett, RI)

Static acute toxicity bioassays with adult softshell clams and salts of copper, cadmium, zinc, lead, manganese, and nickel were conducted at 30 ppt salinity and 22 C. Concentrations fatal to 50% in 168 hours, in mg/l (ppm) metal added at start, were 0.03% for Cu, 0.15% for Cd, 1.5% for Zn, 0.80 for Pb, 170.0 for Mn, and >50.0 for Ni. Additional tests were conducted with Zn(2+) and Cu(2+) at 30 ppt during fall (17-5 C) and winter (8 C); clams displayed increasing survival with decreasing temperature. For Cu, LC-50 (376 hr) values at 17 C and 8 C were 0.086 and >1.00 mg/l, respectively; for Zn these were 2.65 and >25.0, respectively. (auth)

<133>
Fisler, P., Toxicity Evaluation of a Complex Metal Mixture to the Softshell Clam *MYA ARENARIA*.

1977. Marine Biol. (U. Ger.), 43, 265-276 (U.S. Environmental Protection Agency, Environmental Research Laboratory, Narragansett, RI)

Adults of the softshell clam, *MYA ARENARIA* were subjected to a flowing seawater solution containing a mixture of salts of manganese, zinc, lead, nickel, copper, and cadmium. Final calculated concentrations, in mg/l of the toxicant solution were 7200 Mn, 2500 Zn, 70 Pb, 50 Ni, 50 Cu and 1 Cd. *MYA ARENARIA* were also subjected to a 20% solution, i.e., 1440 Mn, 500 Zn, 14 Pb, 10 Ni, 10 Cu, and 0.2 mg/l Cd. In a study conducted for 112 days at 0 to 10 C all clams exposed to a 100% solution died between the 8th and 10th week; soft parts of survivors at 6 weeks contained about 19 times more Pb, 15 times more Zn, 12 times more Cu, 10 times more Mn, 3 times more Ni and 0.1 times more Cd than controls. Clams exposed to a 20% solution survived the 112 day study; at that time these contained about 5 times more Cu, 4 times more Mn, 3 times more Zn and about 2 times more Pb than controls. In a second study conducted for 16 days at 16 to 22 C all *MYA ARENARIA* subjected to the 100% solution died between 6 and 14 days; survivors from this group at 7 days contained about 25 times more Pb, 13 times more Cu, 11 times more Zn, 7 times more Mn, and 3 times more Ni than controls. Mortality in the 20% group was slightly higher than controls during the 16 day study; at 14 days survivors from this group contained about 12 times more Mn, 7 times more Pb, 7 times more Zn, 4 times more Cu, and 3 times more Ni than controls. The significance of these findings are discussed in terms of potential environmental perturbations, especially local dredging practices. (auth) (70)

<134>
Ellis, P., and J. Dagusan, Alimentation and Growth of Elvers (*ANGUILLA ANGUILLA*) Reared

Experimentally with Various Temperatures in the Laboratory.

1976. Ann. Betr. Aliment, 30, 95-116 (University of Rennes, Laboratory Zoology Generale & Ecophysiologie, Rennes, France)

Bels were raised in the laboratory at temperatures of 10 to 25 C. Best rapid growth with minimal mortality was at 25 C. Below 10 C growth was inhibited. Between 10 and 25 C activity increased with increasing temperature. (57)

<135>
Elliott, J.B., The Growth Rate of Brown Trout (*Salmo trutta* L.) Fed on Reduced Rations.

1975. Jour. Animal Ecol., 44, 823-842 (Freshwater Biological Association, Windermere Laboratory, Ambleside, England)

Brown trout (live weight 5 to 201 g) were fed on various ration sizes ranging from zero to maximum rations at twelve different water temperatures (range 3.8 to 19.5 C). The optimum temperature for growth decreased progressively with decreasing ration from about 13 C at maximum ration to about 8 C at a ration size just above the maintenance ration. As the weight of the trout increased, the effect of temperature on growth rate at each ration size was progressively reduced. The rate of weight loss in starving fish remained fairly constant at temperatures below about 13 C, but rapidly increased at higher temperatures. Both the weight of the trout and the water temperature affected the maintenance and maximum rations, and an equation was developed to estimate the 'scope for growth' between the maintenance and maximum rations. An equation was developed to describe the relationship between ration size and the growth rate expressed as a percentage of maximum growth rate. This equation was applicable to trout feeding on a variety of food organisms in both the stream and the laboratory, and at both constant and fluctuating temperatures between 3.8 and 19.5 C. The efficiency of food utilization was examined and an equation was developed to estimate the optimum ration, i.e., the most efficient ration which produces the greatest growth for the least intake of food. The limitations of the 'K-line' equation are discussed in detail. (auth)

<136>
Elliott, J.B., Energy Losses in the Waste Products of Brown Trout (*Salmo trutta* L.).

1976. Jour. Animal Ecol., 45, 541-580 (Freshwater Biological Association, Windermere Laboratory, Ambleside, England)

Energy losses in the waste products of brown trout (live weight 10 to 302 g) were measured for single fish fed on various ration sizes ranging from zero to maximum rations at different water temperatures (range 3.8 to 20.4 C). The proportion of the daily energy intake lost in the feces decreased as temperature increased and the ration level decreased. Absorption efficiency increased with a decreasing level of energy intake and increasing temperature, but the temperature effect was less marked above about 15 C. The proportion of the energy intake lost in the excretory products, ammonia and urea, increased as temperature increased and the ration level decreased. The proportion of the energy intake lost in both feces and

<136> C777.

excretory products was less variable than its two components, and energy available for growth and metabolism increased as the ration level decreased, slightly increased with increasing temperature at low temperatures and then slightly decreased with increasing temperature at high temperatures. The energy losses in the waste products of trout deprived of food increased with both body weight and temperature. An equation was developed to estimate these losses for trout in the weight range 10 to 30 g at temperatures between 3.0 C and 19.5 C. Equations were developed to estimate the proportion of the daily energy intake lost in the feces, lost in the excretory product, absorbed by the trout, and available for growth and metabolism. These equations provide satisfactory estimates of the first three for a wide variety of food organisms, consistently underestimate energy lost in the feces and overestimate energy lost in the excretory products for some food organisms, but provide good estimates of energy available for growth and metabolism for all the food organisms used in this study. They are applicable to trout in the weight range 10-300 g at temperatures between 3.0 C and 20.0 C. (Auth)

<137>

Eng-Willnot, D.L., W.S. Hitchcock, and E.F. Martin. Effect of Temperature on the Proliferation of *CYTHODIUM BREV* and *CONPROSPHAEZIA APOINIA*.

1977. Marine Biol. (W. Ger.), 41, 71-77 (University of South Florida, Department of Chemistry, Tampa, FL)

The effect of temperature on the growth and proliferation of two marine microorganisms, the toxic dinoflagellate *CYTHODIUM BREV*, and a potential bio-control organism, the blue-green alga *CONPROSPHAEZIA APOINIA*, was determined by culturing the organisms in thermal gradients established by heating and cooling the opposite ends of an aluminum bar that had been adapted to hold culture tubes. Gradients were linear and stable for the duration of each trial. There was no relationship between variations in light and growth of the organisms. *CYTHODIUM BREV* showed optimum growth at 22 C, and proliferated over a range of temperatures (17 to 30 C). Below 17 C cultures of *C. BREV* declined in growth, and at 0 C the organisms died within 5 hr. Above 31 C there was rapid decline in viability of cells, and at 33.5 C the organism died within 24 hr. *CONPROSPHAEZIA APOINIA* showed optimum growth between 24 and 29 C, with a maximum at 27 C. Growth at temperatures greater than 31 C was minimal, but the organism survived. Limitation may be due to repression of the bio-synthesis of an iron-transport compound. (Auth)

<138>

Eng, L.L., Biology and Population Dynamics of the Asiatic Clam, *CORDICULA HAMILTONI* (Philippi, 1861) in the Delta-Mendota Canal, San Joaquin Valley, California.

1977. Ph.D. Thesis, University of California (University of California, Davis, CA)

Growth of the Asiatic clam, *CORDICULA HAMILTONI*, in the Delta-Mendota Canal varied from slightly to markedly less than that reported for other areas. Growth occurs at 10 C and above. (ST)

<139>

Eriksson, S., Seasonal and Temperature Occurrences of Benthic Copepods on the Swedish West Coast.

1976. 2008, 4, 155-160 (Uppsala University, Institute of Zoology, Uppsala, Sweden)

Seasonal and temperature occurrences of copepods were investigated from 1966 to 1971 in the northeast Kattegatt (on the west coast of Sweden). Optimum temperature ranges were: *PSEUDOCALANUS ELONGATUS*, 4 to 17 C; *PASACALANUS PASTUS*, 10 to 19 C; *CENTROPAGES HARTWYS*, 3 to 19 C; *C. TYPICUS*, 12 to 16 C; *TEMORA LONGICORNIS*, 0 to 20 C; *ACARTIA LONGIRENIS*, -1 to 16 C; *A. CLASII*, 5 to 20 C; and *OTIROHA SIBILLIS*, 6 to 16 C. *PSEUDOCALANUS ELONGATUS* was classified as a spring to autumn species, *A. LONGIRENIS* as a winter and spring species, *C. HARTWYS* as an early summer species, *C. TYPICUS* as an autumn species, and the others as summer and autumn species. (30) (ST)

<140>

Erskine, D.J., Heat Transfer and Thermoregulation in the Largemouth Blackbass, *MICROPTERUS SALMOIDES*.

1976. B.A. Thesis, 46 pp. (State University College at Buffalo, NY)

An energy budget equation based on energy budget theory for terrestrial organisms indicated that convection and a combined conduction-convection process were major avenues of heat exchange between a largemouth bass, *MICROPTERUS SALMOIDES*, and its aquatic environment. Results using solid aluminum castings to determine heat transfer coefficients for the fish at water velocities covering the free and forced convection ranges indicated that direct transfer of heat from the body surface was the major mechanism of heat exchange. (BFC)

<141>

Erskine, D.J., and J.L. Spotila, Heat-Energy-Budget Analysis and Heat Transfer in the Largemouth Blackbass (*MICROPTERUS SALMOIDES*).

1977. Physiol. Zool., 50, 157-169 (State University of New York College at Buffalo, Department of Biology, Buffalo, NY)

Heat-transfer coefficients varied directly with water velocity when a heat-energy-budget equation was developed to describe the heat-energy exchange between the largemouth bass, *MICROPTERUS SALMOIDES*, and its aquatic environment. The coefficients were approximately 2X similar coefficients determined for terrestrial organisms. Rapid heat transfer occurs between a fish and the surrounding water because of a reduced boundary-layer thickness in water and the high heat capacity of this fluid. In still or moving water, the major avenue of heat exchange for fresh-water fish is the direct transfer of heat from/to the body surface to/from the water. The physical interactions between fish and water preclude the development of thermoregulatory adaptations such as changes in the thickness of insulation and circulatory modifications in all but the largest fish. (BFC)

<142>

Esch, G.B., G.C. Campbell, R.E. Connors, and J.B.

<142>

<142> C772.

Wright, Recruitment of Helminth Parasites by Bluegills, *LEPOMIS MACROCHIRUS* Using a Modified Live-Box Technique.

1974. Trans. Amer. Fish. Soc., 103, 486-493
Wake Forest University, Department of Biology,
Winston-Salem, NC; U.S. Wildlife Biological
Station, Hickory Corners, MI

A modification of the live-box technique was used in studying the recruitment of helminth parasites by bluegills, *LEPOMIS MACROCHIRUS*, during the summer of 1973-74 in Gull Lake, Michigan. Simultaneously, an approximately even number of *L. MACROCHIRUS* were captured by hook and line and the parasite fauna compared with that of tethered bluegills. The results showed that the nature of the parasite faunas in the two groups of fish is similar. Results of tether experiments indicated that the acanthocephalan, *PROTODRACONUS PTEROCOLLI*, was recruited at a higher rate early in the summer, then declined while *LEPTORHYNCHUS TRICATUS* was initially recruited slowly, then increased as *P. PTEROCOLLI* was declining. (Auth) (ST)

<143>

Sch, T.P., T.C. Hazen, R.V. Dinock, Jr., and J.W. Gibbons, Thermal Effluent and the Epitheliology of the Ciliate *EPISTYLIS* and the Bacterium *AEROMONAS* in Association with Centrarchid Fish.

1974. Trans. Amer. Microsc. Soc., 93, 627-631
Wake Forest University, Department of Biology,
Winston-Salem, NC

Over 11,500 sunfish were collected from Par Pond, Savannah River Plant, SC, and examined for external lesions associated with infection by *AEROMONAS HYDROPHILA* and *EPISTYLIS* sp. Largemouth bass (*MICROPTERUS SALMOIDES*) were most heavily infected, followed by bluegill (*LEPOMIS MACROCHIRUS*), warmouth (*LEPOMIS GILLOUS*) and redear sunfish (*LEPOMIS RUBRITIS*). Direct correlations were found between thermal loading, body condition of over 2,000 largemouth bass, and incidence of infection. (ST)

<144>

Fishbeiner, B.L., Effects of Intensified Fishing, Species Changes, and Spring Water Temperatures on Yellow Perch, *PERCA FLAVESCENS*, in Saginaw Bay.

1977. Jour. Fish. Res. Bd. Can., 34, 1830-1836
Michigan Department of Natural Resources, Alpena
Great Lakes Fisheries Station, Alpena, MI

The paper primarily discusses the effects of intensified fishing and size limit removal on yellow perch, *PERCA FLAVESCENS*, in Saginaw Bay during the 1960's. In addition a brief history of the yellow perch stocks from 1924-1975, a review of those species changes in the fish community thought to have most affected yellow perch within the past 50 yr, a comparison of year-class strength with the spring varning, and the results of a recent creel census are discussed. A comparison of the rate and regularity of the spring varning with the strengths of the strongest and weakest year-classes for the years 1957-1975 suggested that spring temperature had an important role in reproductive success. (ST)

<145>

Esterly, C.W., The Effect of a Thermal Effluent on the Benthos of Thomas Hill Reservoir,

Missouri.

1975. M.S. Thesis, University of Missouri
(University of Missouri, Columbia, MO)

A two-year study was undertaken to determine the effect of heated effluent on the benthos of Thomas Hill Reservoir, Mo. Maximum surface discharge temperature was 37°C; bottom mud temperatures within the hotwater area ranged between 8 and 29°C. Temperature could not be clearly separated from the associated factors of current and siltation. There were no significant differences in species composition and monthly average species diversity indices between the hotwater and control areas of the reservoir. Numerical abundance and biomass were significantly greater in the control area throughout the study. The seasonal cycle of numerical abundance in the hotwater area demonstrated a decrease during the winter months. These differences in abundance and seasonal fluctuation of benthos were attributed to predation by fish that were attracted by the thermal effluent during October-November. It was concluded that the effect of the thermal effluent in Thomas Hill Reservoir is minimal. (Auth) (ST)

<146>

Eure, H., Seasonal Abundance of *PROTODRACONUS AMBLOPLITIS* (Cestodea: Proteocephalidae) from Largemouth Bass Living in a Heated Reservoir.

1977. Parasitology, 73, 205-212 (Savannah River Ecology Laboratory, Aiken, SC; Wake Forest University, Winston-Salem, NC)

The effects of thermal effluent on the population biology of the bass tapeworm (*PROTODRACONUS AMBLOPLITIS*) parasitic in largemouth bass (*MICROPTERUS SALMOIDES*) were studied. Bass were collected monthly from thermally elevated and normal regimes of Par Pond, a large cooling reservoir on the Savannah River Plant, South Carolina. The migration of vomer plerocercoids from parenteral sites into the gut where maturation takes place coincided with a decrease in water temperature. It is postulated that a decrease in water temperature in southern latitudes and an increase in water temperature in northern latitudes initiates the migration response. (ST)

<147>

Eure, H., Seasonal Abundance of *NEORCHINOSTRICHUS CYLINDRATUS* taken from Largemouth Bass (*MICROPTERUS SALMOIDES*) in a Heated Reservoir.

1976. Parasitology, 73, 355-370 (Savannah River Ecology Laboratory, Aiken, SC)

Samples of largemouth bass were collected from Par Pond located on the Savannah River Plant in Aiken, South Carolina, from June 1972 to May 1973 inclusive. The sampling stations reflected water temperatures which were both normal and greater than 10°C above normal for the area. The acanthocephalan *NEORCHINOSTRICHUS CYLINDRATUS* was the dominant species found in the bass sampled. Incidences of infection for this parasite were generally greater than 95% regardless of location. A pronounced seasonal cycling pattern in the intensity of infection was noted in both thermal regions. Significant differences, however, in the mean density of *N. CYLINDRATUS* per host in fish taken from the heated area as compared with unheated areas were noted. Turnover in the

(187) COWY.

acanthocephalus population was measured by following the percentage of individuals less than 2 mm long. Fall proved to be the most intense parasite recruitment season, followed by maturation of the parasite and subsequent loss from the fish host. The principal factors responsible for the seasonal incidence and intensity patterns are considered to be changes in the fish feeding behavior and annual temperature regimes. (Auth)

(188)

Preerich, D., and J.C. Gonzalez, Critical Thermal Maxima of Two Species of Estuarine Fish.

1977. Marine Biol. (U.S. Ser.), 41, 141-145 (U.S. Environmental Protection Agency, Environmental Research Laboratory, Narragansett, RI)

Critical thermal maxima (CTM) were determined for winter flounder (*PSEUDOPLENICHTES VERNICATUS*, Walbaum) and scup (*STENOTOMUS CHOPUS*, L.), acclimated to ambient water temperature or constant increments above ambient. The acclimation regimes simulated a natural environment by tracking the temperature fluctuations in Point Judith Pond, a small Rhode Island estuary. An elevation in CTM from 30.2 to 35.6 °C was observed for scup as the mean acclimation temperature increased from 16.8 to 22.2 °C. CTM for flounder increased from 26.8 to 32.8 °C over an acclimation range of 8.2 to 23.0 °C. The use of CTM studies for predicting the effects of heated effluents is discussed. (Auth)

(189)

Fahay, P.K., Some Aspects of Temperature Acclimation in the Brook Trout (*SALVELINUS FONTINALIS*, Mitchell).

1976. Ph.D. Thesis, University of Toronto (University of Toronto, Canada)

The study attempted to investigate whether acclimation to temperature is controlled by one particular body system, or whether acclimation is locally induced in the various tissues of the organism. The response of whole fish to lethal temperature depended on the mean thermal history of the total tissue regardless of the anatomical site. When a section of a heterogeneously acclimated fish was exposed to a lethal temperature the response of the fish varied according to the level of acclimation of that section. Cells isolated from fish acclimated at different temperatures reflected the effects of acclimation. Those which were obtained from warm-acclimated fish were more thermostable than those obtained from cold-acclimated fish. (97)

(190)

Fairbanks, P.B., and R.P. Lawton, Occurrence of Large Striped Mullet, *MUGIL CEPHALUS*, in Cape Cod Bay, Massachusetts.

1977. Chesapeake Sci., 18, 309-310 (Massachusetts Division of Marine Fisheries, Sandwich, RI)

Several hundred unusually large striped mullet (*MUGIL CEPHALUS*) established residence in the discharge canal of Pilgrim Nuclear Generating Station, Plymouth, Massachusetts, in late November 1975. The school size, visually estimated at 100 fish on November 23, increased to approximately 500 fish by

December 3. Ambient seawater and discharge canal temperatures when the fish arrived were 10.0 and 19.8 °C, respectively, and declined to 2.0 and 11.0 °C by January 5, when mullet left the canal following an unscheduled plant outage. Seven of 11 specimens captured on December 11 exhibited gross external symptoms of gas-bubble disease. (57)

(191)

Pales, B.E., The Influence of Temperature and Salinity on the Accumulation and Elimination of Chromium by the Grass Shrimp *PALAEOMONES PUGIL* in the Laboratory.

1977. Ph.D. Thesis, Rutgers University (Rutgers University, The State University of New Jersey, New Brunswick, NJ)

Grass shrimp held in eight temperature-salinity combinations (10, 15, 20, 25 °C x 10, 20 ppt) were exposed to soluble sodium chromate and chromate contaminated food. Temperature and salinity acted synergistically to affect the rate of accumulation of soluble hexavalent chromium. The overall response was one of increased chromium uptake with increased temperature and (or) decreased salinity, but the pattern of response to one variable was not the same at all levels of the second variable. Salinity had no effect upon chromium elimination. Elimination rates were lowest at 10 °C and highest at 20 and 25 °C. No conclusions could be made about the influence of temperature and salinity on the accumulation of chromium from contaminated food because of the nature of the data. Increased temperature shortened the biological half-life of the metal. Temperature and salinity both affected the toxicity of soluble chromate to the shrimp as shown by 48-hr TL₅₀ values. Generally, toxicity increased with increased temperature and (or) decreased salinity. (57)

(192)

Falkowski, P.G., The Adenylate Energy Charge in Marine Phytoplankton: The Effect of Temperature on the Physiological State of *SKELTONIA COSTATUS* (Grev.) Cleve.

1977. Jour. Exp. Mar. Biol. Ecol. (Beth.), 27, 37-45 (University of Rhode Island, Graduate School of Oceanography, Narragansett, RI)

The adenylate energy charge $[ATP]/1/2[ADP+ATP+AMP]$ was measured in axenic batch cultures of *SKELTONIA COSTATUS* (Grev.) Cleve at 2, 10, 15, 20, 25, and 30 °C. The results suggest that this eurythermal diatom is physiologically capable of adapting to the 28 °C range of temperature with little apparent difference in the potential energy available to the cell. In N-limited continuous cultures at 15 °C, the energy charge values were lower than those observed in batch culture by 0.2, implying nutrient stress may result in decreased intracellular chemical energy. The utilization of the adenylate energy charge as an indicator of physiological state is suggested. (Auth)

(193)

Parasfarinas, A., Integration of Thermal and Food Processing Residues into a System for Commercial Culture of Freshwater Shrimp (Power Plant Waste Heat Utilization in Aquaculture). Final Report, Volume II.

1977. Final Report of the Public Service

<151>

<152> C777.

Electric and Gas Company to the National Science Foundation, 129 N. Duncanson University, Center for Coastal and Environmental Studies and Department of Physiology, New Brunswick, NJ

Discharge water from the Mercer Generating Plant, Trenton, NJ, was used in a preliminary assessment of the survival, growth, and food conversion ratio of the giant freshwater shrimp, *MACROBRACHIUM ROSENBERGII*, and the rainbow trout, *Salmo gairdneri*. Acute or chronic exposure to cover plant intake and discharge water: discharge with or without coal particles; and discharge with or without slurry overflow air did not significantly affect metabolism, short-term survival, growth, or conversion efficiency of these species. Histological examination of various tissues of shrimp which were directly exposed to a monolayer of coal microparticles for three months revealed no accumulation of coal particles in any tissues except stomach and intestine. Chlorine in the discharge water had a severe deleterious effect on the behavior, metabolism and survival of both shrimp and trout. The behavior and survival of trout and shrimp exposed to mercury, an environmental contaminant from coal, were evaluated in the laboratory. Both species were affected by raised mercury levels. Results of laboratory studies on the critical temperature maxima and minima, lethal temperature maxima and minima, and the optimal temperature for growth and food conversion ratio are given in tabular form. Interactions between acclimation temperature, temperature tolerance, and dissolved oxygen are noted. (ST)

<153>

Fisher, S.J., and F.W.R. Beasish. Influence of Water Temperature on the Growth Rate of the Landlocked Sea Lamprey (*PETROMYXON MARINUS*) and the Associated Rate of Host Mortality.

1977. Jour. Fish. Res. Bd. Can., 34, 1373-1378 (University of Guelph, Department of Zoology, Guelph, Ontario, Canada)

Groups of sea lampreys (*PETROMYXON MARINUS*) of 15 to 90 g initial were held at temperatures of 1 to 20 C for 30 days and allowed to feed ad lib. on white suckers (*CATOSTOMUS COMENSALIS*). Increases in water temperature and in lamprey size caused the rate of host mortality to increase in agreement with observations that mortality in the Great Lakes is seasonal. Instantaneous growth rates were maximal at 20 C for lampreys of 10 to 30 g, the optimal temperature for growth shifting to 15 C for larger lampreys of 30 to 90 g. Growth rates were intermediate at 10 C and lowest at 5 C for lampreys of all size. Accordingly, host mortality increased with temperature over the 5 to 20 C range. At all experimental temperatures, increases in lamprey weight were accompanied by an exponential decline in instantaneous growth rates, a phenomenon also observed for teleosts. Laboratory growth rates at temperatures of 5 to 15 C were comparable to rates observed for lampreys in Lake Huron between April and November and agree with the observation that lampreys feed in deeper waters between April and June before moving to warmer, shallower waters during the summer when growth rate increases. (Ruth)

<155>

Wilmett, C.R., and T. Alpert, The Effect of Temperature on the Distribution and Biomass of

HYALUS EDULIS in the Alameda Bay Area.

1977. Veliger, 20, 39-42 (Claremont Colleges, Joint Science Department, Claremont, CA)

The distribution of the cosmopolitan bivalve, *HYALUS EDULIS* with respect to water temperature in the Alameda Bay area and lower San Gabriel River is described. Although *HYALUS EDULIS* is abundant in both areas, its abundance appears to decrease in the warmer waters near four large electrical power generating plants which discharge cooling water into the San Gabriel River. The mean number of mussels collected in the colder Alameda Bay waters was 121 per sample, while the mean for the San Gabriel River was 22 per sample. Shell length was not significantly different for the two habitats, but overall biomass was considerably greater in the colder habitat. The mean wet weight of Alameda Bay samples was approximately four times greater than of those from the San Gabriel River, while the mean ash free weight was almost 10 times greater in Alameda Bay samples. There appeared to be no significant trend toward increased biomass of mussels in the cooler, down-stream stations. Standard water quality analyses for dissolved oxygen, salinity, and water clarity showed no differences for the two habitats. Since almost all the water in the San Gabriel River passes through the generation plants, thermal shock may cause sufficient mortality to explain the small numbers of mussels in the San Gabriel River. (ST)

<154>

Fennel, S., Life Cycle of Appendicularia *CHIROPLEURA BICICA* Pol, 1972. Description and Chronology.

1976. Ann. Inst. Oceanoogr. (Pr.), 52, 89-101 (Station Zoologique, Villefranche-sur-Mer, France)

The full life cycle of *CHIROPLEURA BICICA* is described with the aid of photographic illustrations at different stages in laboratory culture. The chronology of growth is studied as a function of temperature, all other conditions remaining fixed. There was no growth synchronizing in any given culture so that the full cycle can vary from 3 to 5 days at a temperature of 22 C and from 10 to 12 days at 10 C. (Ruth)

<157>

Finlay, B.J., The Dependence of Reproductive Rate on Cell Size and Temperature in Freshwater Ciliated Protozoa.

1977. Oecologia (Ger.), 30, 75-81 (University of Stirling, Department of Biology, Stirling, United Kingdom)

Reproductive rates were calculated for ten species of ciliated protozoa in defined conditions. Interspecific double log regressions of generation time vs cell volume were computed at each of three temperatures (8.5, 15, and 20 C) indicating a significant dependence of reproductive rate on cell size. Recorded generation times varied from 6.30 hr in *VORTICELLA MICROSTOMA* at 20 C to 1000 hr in *SPINOSOMUS TERES* at 8.5 C. These values correspond to a range in r_{max} of 2.607 (intrinsic rate of natural increase) of 2.607 to 0.017 and λ_{max}/day (finite rate of increase) of 13.554 to 1.017. The relationship between these data and similar published data for marine ciliates is examined and the value of such regressions is

(157) CONT.

ecological studies of the protozoa is discussed. (Auth)

(159)

Fish, J. D., and S. Fish, The Effects of Temperature and Salinity on the Embryonic Development of *HYDROBIA ULVAE* (Poussart).

1977. Jour. Mar. Biol. Ass. U.K. 57, 213-219 (University College of Wales, Department of Zoology, Aberystwyth)

The effects of temperature and salinity on the rate of embryonic development and the survival of embryos to hatching were analysed by fitting surface responses. Percentage survival was high over a wide range of temperature/salinity combinations and the estimated optimum combination of temperature and salinity was 19.9 C and 37.6 ppt. Hatching was recorded in salinities ranging from 8 to 60 ppt and at temperatures up to 35 C. The minimum time taken to hatching (5 days) was recorded over a range of 13 to 41 ppt and 22.5 to 33 C; at higher salinities embryonic development was prolonged. The intensity of pigmentation of veliger larvae was related to the salinity of the seawater in which development took place; embryos incubated in low salinities hatched as larvae with little pigmentation, while those incubated in high salinities showed intense pigmentation. (Auth)

(159)

Fisher, T. D., Oxygen Uptake of the Solitary Tunicate *STYELA PLICATA*.

1976. Biol. Bull., 151, 297-305 (Duke University Marine Laboratory, Beaufort, NC; Duke University, Dept. of Zoology, Durham, NC)

Between 20 and 30 C, the low Q10 and well-developed oxygen regulatory capabilities observed in *STYELA PLICATA* suggested a degree of homeostasis in subtropical environments where the organism commonly occurs. In contrast, *S. PLICATA* became an oxygen conformer with a very high (more than 5) Q10 below 10 C. Data indicated that aerobic metabolism ceased near 5 C and, although the organism has been maintained for several weeks at 2 to 3 C, no growth or attachment occurred below 8 C. Therefore, physiological adaptation of *STYELA* at temperatures below 10 C is apparently reduced. (RPC)

(160)

Fisher, T. D., Metabolic Maintenance Costs of the Suspension Feeder *STYELA PLICATA*.

1977. Marine Biol. (U.S.), 41, 361-369 (Duke University, Department of Zoology, Durham, NC; Duke University Marine Laboratory, Beaufort, NC)

At a given temperature, the rate of ingestion of the solitary tunicate *STYELA PLICATA* was proportional to the 0.7 power of wet mass. The ingestion rate increased rapidly with increasing temperature between 12 and 18 C (Q10 = 3), but was independent of temperature between 18 and 28 C. Absorption efficiency was independent of temperature and body size and averaged approximately one-third for both carbon and nitrogen. (Auth) (RPC)

(161)

Flemer, D., and J. A. Sherk, Jr., The Effects of Steep Electric Station Operation on Entrained Phytoplankton.

1977. Hydrobiologia (Dordr.), 55, 33-44 (University of Maryland, Chesapeake Biological Laboratory, Solomons, MD; U.S. Fish and Wildlife Service, Office of Biological Services, Washington, DC)

The effect of entrainment on estuarine phytoplankton was studied at three steam electric stations located on tributaries of Chesapeake Bay. In most cases, chlorine rather than heat was implicated as the most important factor in the reduction of the rate of carbon assimilation. The reduction of carbon assimilation in the mixture of a plant effluent and augmentation water was greater than explained as mechanical and heat effects. Thus, chlorine was judged as the primary factor under these conditions. One study that involved three consecutive days emphasized the problem of interpreting significant statistical interactions and main effects in a multivariate design when tests are conducted under natural conditions. (Auth)

(162)

Fletcher, G. L., Circannual Cycles of Blood Plasma Freezing Point and Na⁺ and Cl⁻ Concentrations in Newfoundland Winter Flounder (*PLEUROCHTHYS AMERICANUS*): Correlation with Water Temperature and Photoperiod.

1977. Can. Jour. Zool., 55, 769-795 (Memorial University of Newfoundland, Marine Sciences Research Laboratory, St. John's, Newfoundland, Canada)

A four-year field program was conducted on the winter flounder to correlate changes in plasma Na⁺, Cl⁻, and freezing-point depression with sea-floor water and sediment temperatures, day length, salinity, depth of capture, and observations on burrowing in sediments. Plasma Na⁺, Cl⁻, and freezing-point depression showed annual cycles with maxima in winter (January-April) (temperature -1.1 to -1.4 C) and minima in summer (July-October) (10 to 14 C). The change in freezing-point depression from summer to winter was about 0.65 C, 26% of this was attributable to Na⁺ and Cl⁻ and the remaining 80% to the presence of an 'antifreeze'. The data suggest that plasma 'antifreeze' appeared in November (8 to 6 C) and disappeared during May (-1.0 to 3 C). During the winter the flounder were found only in the deeper areas of the sampling site and were usually buried up to 12 to 15 cm in the sediments which were warmer (0.1 to 0.4 C) than the seawater. The plasma Na⁺, Cl⁻, and freezing-point depression of winter flounder held in the laboratory for seven days were always significantly lower than the field-sampled fish. The differences between these two groups was greatest during the summer, suggesting that the effects of 'stress' during capture differ seasonally. (Auth)

(163)

Fletcher, G. L., The Effects of Culture Concentration and Age, Time, and Temperature on Bacterial Attachment to Polystyrene.

1977. Can. Jour. Microbiol., 23, 1-6 (University College of North Wales, Marine Science Laboratories, Menai Bridge, Gwynedd, Wales)

The attachment of a marine pseudomonad to polystyrene was found to be dependent upon (a) culture concentration, (b) the time allowed for attachment, (c) the growth phase

<163> COST.

of the culture, and (2) temperature. The number of attached cells increased with both culture concentration and the time allowed for attachment, until the attachment surface approached saturation. The number of cells which attached and the rate of attachment was greatest with log-phase cultures, and progressively decreased with stationary and fourth-phase cultures. A temperature of 3 C noticeably decreased the proportion of stationary phase cells which attached, compared with cells at 20 C. These results can be described by a model based on physicochemical adsorption, which suggests that non-biological processes may play a major role in the initial events of bacterial adhesion. (Auth)

<164>

Frank, T., Experimental Investigations of the Respiration of *CAVIRIUS FOSSABUM* Koch 1835 (Crustacea-Amphipoda) in Relation to Temperature, Oxygen Concentration and Water Movement.

1977. Arch. Hydrobiol. (Suppl.) (Ger.), 80, 394-391 (Tegginerstr. 1, Badolzell, Germany)

The oxygen uptake of *C. FOSSABUM* was measured at different combinations of temperature, O₂-concentration, and water movement. *C. FOSSABUM* is a partial regulator in decreasing O₂. Because of the slow diffusion of gases in water, a high O₂-content and continuous renewal are essential. The PO₂ minimum was about 53 µm Hg. The maximal temperature was 27 C. In the micro-habitat *C. FOSSABUM* preferred slowly running water with an optimal value of about 5 cm/sec. Also discovered was the relation between respiration and body-size, and the relation (standard): (routine): (active-metabolism). (Auth)

<165>

Frederick, L.B., The Effects of Light Intensity, Temperature, Cell Density and Heavy Metals (Mercury and Chromium) on Two Marine Phytoplankters in Continuous Culture.

1976. Ph.D. Thesis, 125 pp. (Texas A&M University, College Station, TX)

The specific growth rates of both *ISOCHRYSIS GALPANA* and *GLENNODINUS HALLII* were inversely related to the cell density of the cultures, except for an apparent plateau at low cell concentrations. No significant change of chlorophyll-a/cell was noted for *C. HALLII* in any concentration while *I. GALPANA* at densities more than 1.35×10^5 (cells) showed a significant change. The specific growth rate of each species followed a continuously changing pattern in relation to the temperature, even within the optimum temperature range, irrespective of the light intensities. Responses of the two species to sublethal concentrations of mercury and chromium are detailed. (BFC)

<166>

Freiburg, H.W., and D.H. Hazelwood, Oxygen Consumption of Two Amphibious Snails: *PCNACEA PULVOSA* and *HABISA COQUARDIETIS* (Prosobranchia: Ampullariidae).

1977. Malacologia (G.B.) (Tag.), 16, 541-548 (University of Missouri, Department of Zoology, Columbia, MO)

A general increase in respiratory rate of both *PCNACEA PULVOSA* and *HABISA COQUARDIETIS*

occurred with an increase in temperature from 10 to 35 C. The Q₁₀ values were higher at low temperatures for *PCNACEA*, but not for *HABISA*. Large *PCNACEA* animals showed lower standard deviations and standard errors at each temperature, indicating that large snails are less affected by rising temperature. During aquatic respiration of both species, the Q₁₀ at 10 to 20 C and 20 to 30 C increased with large snails. (BFC)

<167>

French, P., H. Bilton, Y. Ozaki, and A. Bortt, Distribution and Origin of Sockeye Salmon (*OSMOXYCHTHUS NERKA*) in Offshore Waters of the North Pacific Ocean.

1976. Bull. IUPFC, 34, 113 pp. (Northwest Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, WA)

Results of 16 years of high-seas research on sockeye salmon (*OSMOXYCHTHUS NERKA*) by scientists in Canada, Japan and the USA is summarized. Sockeye salmon are unique, typically spawning in streams tributary to lakes and, after hatching, post young fry spend either 1 or 2 years in lakes before migrating to the ocean. They return as adults primarily after 2 or 3 years in the ocean, in their 4th, 5th, or 6th year of life. Sockeye salmon are distributed from the southern Kurile Islands to northern coast of USSR in Asia, and from Columbia River to Northern Alaska in North America. The most important production areas are enumerated. Details of movements and feeding migrations throughout the North Pacific and adjacent seas are presented. Movement in reaction to seasonal sea surface temperature was noted with fish moving to waters ranging in temperature from 0 to 13 C, varying with season and state of maturity. (Auth) (BFC)

<168>

Fried, S.N., Seaward Migration of Hatchery-Reared Atlantic Salmon (*SALMO SALAR*) Smolts in the Penobscot River Estuary, Maine: Riverine Movements.

1977. Ph.D. Thesis; University of Maine (University of Maine, Orono, ME)

During 1975 and 1976 onset of increased activity of hatchery-reared *SALMO SALAR* smolts occurred when hatchery and Penobscot River water temperatures increased above 5 C. Full expression of migratory behavior occurred at temperatures above 8 C. Earlier increased activity in 1976 coincided with earlier warming trends. The first long seaward migration was made May 10 both years, indicating that factors such as photoperiod, in addition to water temperature, were important for onset of migratory behavior. (ST)

<169>

Fudge, H., The "Red Tides" of Malta.

1977. Marine Biol. (W. Ger.), 39, 381-386 (Harriet Costello School, Basingstoke, England)

A 5 year survey of Marsaxetxe Harbour, Malta, was carried out to investigate mass factors contributing to "red tides" and to identify the causative organisms. "Red tides" occurred usually in May but, less predictably, also during June - August. Causative organisms included the diatom *CHAETOCEROS* sp., and the dinoflagellate genera *PROROCENTRUM*, *PERIDINIA*,

<169> CONT.

PHYTODIETARY, CONTAYAT, CEPATION and COCHLODIETARY. Early summer red tides occurred at a time of increasing insolation, and water temperature, prevailing onshore winds and salinities in the range 30.4 to 35.6 ppt. A consistent feature was a quick rise in sea temperature of more than 2 C during the week preceding red water. Red tides later in the year coincided with higher temperatures and salinities and calm weather. (Auth)

<172>

Cable, W.P., and B.A. Croker, The Salt Marsh Amphipod, *GAMMARUS PALUSTRIS* Bensfield, 1969 at the Northern Limit of its Distribution 1. Ecology and Life Cycle.

1977. Estuarine & Coastal Mar. Sci., 5, 123-130 (University of New Hampshire, Department of Zoology and Jackson Estuarine Laboratory, Durham, NH)

Location of the amphipod, *GAMMARUS PALUSTRIS* was observed to include a seasonal distributional cycle which is associated with both microhabitat preferences and seasonal temperature variation, with most frequent habitation of those microhabitats with smallest temperature range. Embryonic development is relatively fast at temperatures above 10 C compared with other *GAMMARUS* species. (MPC)

<171>

Galloway, G.W., Responses of Caddisfly Larvae (*BRACHYCEPHALUS* spp.) to Temperature, Food Availability and Current Velocity.

1977. Amer. Midland Naturalist, 98, 59-66 (University of Wisconsin, Laboratory of Limnology, Department of Zoology, Madison, WI)

Larvae of the stream caddisflies, *BRACHYCEPHALUS AMERICANUS*, and *B. OCCIDENTALIS*, were studied in eight simulated stream channels to determine their behavioral responses to temperature, food availability (brine shrimp) and current velocity. As temperatures increased above 8 C, *B. OCCIDENTALIS* larvae filtered more frequently but above 20 C, the percentage of larvae filtering steadily decreased and the percentage withdrawn increased dramatically with increasing temperature. Percentages of larvae case-building and unattached generally decreased over the range of 8 to 27 C. Despite this decrease in case-building, *B. OCCIDENTALIS* larvae generally grew faster as temperature increased from 8 to 16 C. Behavior of *B. AMERICANUS* as a function of temperature was similar to behavior of *B. OCCIDENTALIS*. (MPC)

<172>

Gannon, J.R., Measurement of Entrainment and Predictions of Impact on the Sabash and Ohio Rivers.

1977. In Third National Workshop on Entrainment & Impingement: Section 316(b)--Research and Compliance, L.B. Jensen, Ed. Ecological Analysts, Inc., Melville, NY (Duquesne University, Department of Zoology, Greenacres, IN)

The results of several studies assessing damage to drifting river biota which pass through electric generation stations on the Sabash and Ohio rivers are presented. Phytoplankton productivity measurements conducted over a 4-year period indicated that

any increase in temperature beyond 30 C caused inhibition of production, while at lower temperatures additional heat was often stimulatory. Mechanical damage was judged to be easier for this group. Among the macrobenthic taxa, *BARTIS* spp. were found to be very susceptible to loss of physical condition and mortality because of both mechanical effects and high temperatures, whereas *POTAMIA FLAVA* and chironomids passed through a station with little or no mortality. Mortality for other taxa were estimated to be 15 to 25%. A nonrandom spatial and temporal distributions of benthic drift complicated entrainment assessment. The number of drifting fish larvae frequently exceed that of drifting benthos during early summer, but few were found after late July. Gizzard shed larvae predominated, but during 1973 a successful spawning of carp was marked by the appearance of significant numbers of carp larvae and fry over a 17-day period in June. (Auth)

<173>

Gastayot, S.C., and B.K. Pattnaik, Studies on Collagen in Some Species of Indian Fishes: 1. Influence of Sex and Temperature on the Collagen Content of the Skin and Muscle of *OPHIOCEPHALUS PUNCTATUS*.

1975. Science and Culture, 31, 404-406 (Berhampur University, Zoology Department, Orissa, India)

The influence of sex and temperature on the collagen content of the skin and muscle of *OPHIOCEPHALUS PUNCTATUS* was studied. Control fish were kept at 26 C and experimental fish at 16 C. The collagen content of skin and muscle were significantly higher in females than in males. The total collagen content of skin in fish at 16 C was higher than that of control fish. There was no temperature effect on muscle collagen. (ST)

<174>

Gerlo, E.V., Opisthobranchs Found off Little Egg Inlet, New Jersey, with Notes on Three Species New to the State.

1977. Nautilus, 91, 23-28 (Ichthyological Association, Inc., Abasco, NJ)

An intensive ecological survey in the vicinity of Little Egg Inlet, New Jersey found three species of opisthobranchs which are new to New Jersey (*PLEUROBRANCHIA YANNA*, *OMPHODONIS MELANELLATA*, and *PACELINA BOSTONIENSIS*) and southern range extensions for *DEMBOROTUS PROBOSUS* and *TERGIPES TERGIPES*. The occurrence of cold water opisthobranchs in New Jersey is explained in part by ocean water temperatures which rarely exceed 25 C, by the numerous submerged artificial structures, and by the predominant southwest flow of coastal water which may transport eggs and young from breeding populations located to the north. Temperature ranges for occurrence of 13 species are tabulated. (Auth) (ST)

<175>

Garside, E.T., D.C. Seizze, and S.E. Barbour, Thermal Preference in Relation to Salinity in the Threespine Stickleback, *GASTEROSTEUS ACULEATUS* L., with an Interpretation of its Significance.

1977. Can. Jour. Zool., 55, 590-594 (Dalhousie University, Dept. of Biology, Halifax, Nova Scotia, Canada)

<175>

<175> CONT.

In thermal gradients of fresh water and sea water (32 ppt salinity), preferred temperatures of the threespine stickleback, *Gasterosteus aculeatus*, increased with acclimation temperatures of 5, 15 and 25 C, with those for the freshwater tests being about 2 C lower at each acclimation. Final preferences (the highest obtainable preferences equaling acclimation temperature for such haloplastic species) were 16 and 18 C for freshwater and seawater, respectively. A later series of disjunct preference determinations in approximately 10.5 ppt for subjects acclimated to 7, 15, and 20 C yielded mean values of 17.7, 18.2, and 19.7 C, respectively. Final preferences were not determined since the samples were of separate origins. The immediate cause of upper lethal temperature response for this and other haloplastic species is apparently differentials in metabolic loading occasioned by osmoregulative stresses. (PFC)

<175>

Parsile, E.T., and G.C. Morrison, Thermal Preferences of *Fundulus heteroclitus* L., and Banded Killifish, *P. diaphanus* (Lesueur), (Cyprinodontidae) in Relation to Thermal Acclimation and Salinity.

1977. Can. Jour. Zool., 55, 1790-1794 (Dalhousie University, Dept. of Biology, Halifax, Nova Scotia, Canada)

Frequency distributions corresponding to various levels of thermal acclimation from 5 to 25 C were recorded for samples of marine *Fundulus heteroclitus* L., and samples of freshwater banded killifish, *P. diaphanus* (Lesueur), in thermal gradients formed in columns of fresh water (less than 0.5 ppt salinity) or sea water (32 ppt salinity). Mean preferred temperatures comprised roughly parallel but irregularly inflected trends for the two series of tests, within each species. In *Fundulus*, preferred temperatures for corresponding thermal acclimations ranged from 3 to 6 C higher in tests conducted in sea water. In banded killifish, preferred temperatures for corresponding thermal acclimations ranged from 5 to 8 C higher in fresh water. Thus, each species regularly preferred higher temperatures in salinity which approximated that of the typical habitat. The inference to be taken is that the unusual salinity for each species places an extraordinary osmoregulative load which influences the reactions of the fish to the series of thermal or other correlated stimuli in the gradient. (Auth)

<177>

Gould, D.T., and E.C.S. Raju, Some Measurements of the Respiration of Planktonic Crustacea.

1975. Bull. Dep. Mar. Sci. Univ. Cochin, 7, 201-223 (Marischal College, University of Aberdeen, United Kingdom)

Measurements were made of the respiration rates of copepods, penaeid post larvae and mysids, obtained from the plankton at Porto Novo, South India, and related to the dry weight of the animals. At a temperature of 27.5 C, the mean sea temperature of the area, the mean respiratory rates were about 10 ul O₂/mg dry wt/h. This is substantially higher than figures reported for northern species at 10 C and about twice the rate one might expect at 27.5 C on the basis of a doubling of the rate for each 10 C rise in

temperature. (Auth)

<178>

See, J.H., Effects of Size of Fish, Water Temperature and Water Velocity on Buoyancy Alteration by Pathed Minoes, *Pimephales pimephales*.

1977. Comp. Biochem. Physiol., 56A, 563-568 (University of Manitoba, Department of Zoology, Winnipeg, Manitoba, Canada)

Pathed minnows (*PIMEPHALES PIMEPHALES*) alter buoyancy by changing swimbladder volume to compensate for changes in water velocity with the lowest buoyancy attained in faster water velocities. Extent of buoyancy adjustment is greater and rate of increase faster at 21 than at 4.5 C. Buoyancy is inversely related to water velocity. Compared to large fish, small fish make a lesser adjustment, have a higher internal pressure, and secrete gas faster during an increase in buoyancy. Gas secretion is used to increase swimbladder volume. Changes in internal pressure occur during adjustment but do not influence the rate of adjustment. (Auth)

<179>

Gerking, S.D., T. Battliff, and R.C. Otto, Laboratory and Field Tests of Temperature Tolerance on *Gambusia affinis*, the Western Mosquitofish.

1975. Verh. Intl. Ver. Limnol. (Ger.), 19, 2498-2503 (Not given)

Fish acclimated to constant temperatures in the laboratory and those acclimated to fluctuating temperatures in the field yield similar median survival times, similar upper incipient lethal temperatures, and similar Critical Thermal Maxima (CTM). The slight differences between the two groups is attributed to fluctuating temperatures at stream-side and other environmental variables. Also, the process of acclimation is the same under the two sets of conditions. Exposure to increasingly higher acclimation temperatures increases median survival times and CTM at test temperatures above or bordering on the upper lethal limit. Furthermore, male fry, and immatures are more heat resistant than are adult females in the few CTM and upper lethal limit tests accomplished in the field. (Auth)

<180>

Gift, J.J., Application of Temperature Preference Studies to Environmental Impact Assessment.

1976; 1977. CONF-760899; Jour. Fish. Res. Bd. Can., 34, 746-749 (Ecological Analysts, Inc., Melville, NY)

Examples are given which illustrate ways in which fish behavioral data, biological survey information, and hydrothermal maps can be used to help predict the environmental impact of a thermal discharge. The ability of fish to perceive and respond to temperature gradients and the quantification of these temperature responses provide important information that should be included in power plant siting studies, preoperational evaluations, and general impact analyses. (ST)

<181>

Gilman, R.W., and E.C. Burns, On the Reduced Sensitivity of the Adult Male Lobster (*Homarus*

<101> COPE.
APPEL (1975) to Testosterone at Reduced
Temperatures.

1977. Comp. Biochem. Physiol., 50, 33-36
(Fisheries and Marine Service, Halifax, Nova
Scotia, Canada)

Adult, male lobsters held at ambient
temperature (2 to 6 C) did not respond to
injections of up to 3.0 mg oestradiol/kg live
weight, while animals from the same group
held at 15 C were all forced into oocyte
growth by 2.5 mg oestradiol/kg. These
results were confirmed by a second experiment
in which lobsters held at ambient, or 7 to 12
C, did not respond to doses up to 3.0 mg
oestradiol/kg within 62 days while those at
15 C did. Environmental temperature could
control molting in the lobster by markedly
altering the sensitivity to the molt hormone.
(Auth)

<102>
Gillet, C., B. Billard, and P. Proton, Effects of
Temperature on the Level of Plasma Gonadotropin
and Spermatogenesis of the Goldfish (*CARASSIUS
AURATUS*).

1977. Can. Jour. Zool., 55, 242-245 (Institut
National de la Pêche, The Agromuseum, Laboratoire
de Physiologie des Poissons, Jouy-en-Josas,
France)

Concentrations of immunoreactive plasma
gonadotropin (c-GTH) were measured for
goldfish kept at conditions of temperature
held constant or increasing between 10 and 30
C, between February and July. At
temperatures of 17 C or above the levels of
plasma c-GTH were significantly higher during
April and May than at 10 C. In April the
pituitary concentration of c-GTH was maximum
for fish held at 17 C or above and the
minimum for fish held below 17 C, but in June
the situation was reversed. A study of the
gonads showed that spermatogenesis is faster
at 17 to 24 C than at 10 C, but at 30 C
spermatogenic activity was inhibited. (Auth)

<103>
Gillet, C., B. Billard, and P. Proton, The
Effects of Temperature on the Reproduction of
Goldfish (*CARASSIUS AURATUS*).

1977. Cah. Lab. Hydrobiol. Montreaux (Pt. 1), 5,
75-82 (Laboratoire de Physiologie des Poissons,
1924, Jouy-en-Josas, France)

As increase in water temperature, between 10
and 30 C starting in January caused an
increase in circulating gonadotropin (c-GTH)
which lasted for three months. At the
highest experimental temperature, the
increased c-GTH concentrations did not lead to
a stimulation of spermatogenesis and
oogenesis. Exposure to 24 C led to a
completion of spermatogenesis in April and
only 15% of the females were ready to spawn
in June. At 17 C, gametogenesis proceeded
normally though spermatogenic processes
were slow with a decrease of the G.S.I. In
controls the level of c-GTH increased with
temperature with a complete gametogenesis
which yielded spermatiation and ovulation in
response to hypophysectomy. Daily
oscillations of temperature (4 C to 17 and 24
C) did not influence the c-GTH levels
compared with controls raised at fixed
temperature (17 and 24 C), but G.S.I. were
lower. At 10 C under increasing photoperiod
c-GTH levels of pituitary and plasma
increased between February and June

suggesting an effect of the photoperiodism in
the stimulation of the synthesis and
secretion of gonadotropin. At this
temperature gametogenesis was completed but
neither spermatiation and ovulation were
induced in response to hypophysectomy. (Auth)

<104>
Giles, G.J., and J.C. Rason, Comparative Effects
of Temperature and Photoperiod on Laboratory
Growth of Underyearling Coho Salmon and Coastal
Cutthroat Trout.

1976. Manuscr. Rep. Ser., Fish. Res. Bd. Can.,
No. 1010, 50 pp. (Pacific Biological Station,
Fisheries and Marine Services, Nanaimo, British
Columbia, Canada)

In tests to determine growth patterns of
underyearling coho salmon (*Oncorhynchus
kistutchi*) and coastal cutthroat trout (*Salmo
clarki*) over a range of static test
combinations of temperature and photoperiod,
it was found that coho grew much faster than
trout under most conditions, especially at
temperatures > 5 C. Photoperiod response was
temperature-related, being more rapid at high
temperatures. There seems to be definite
shifts in the optimum conditions for coho,
and possibility for trout, growth between
summer and winter periods: high temperatures
and longer photoperiods in summer,
intermediate temperatures and shorter
photoperiods in winter. Coho seem to have a
better physiological capacity for growth than
do trout in partially controlled conditions.
However, in streams, trout have certain
behavioral strategies that appear to help
offset their size disadvantages against
salmon in possible competition for food and
space. (Auth)

<105>
Giles, G.J., and J.E. McInerney, Critical
Swimming Speeds of Coho Salmon (*Oncorhynchus
kistutchi*) Fry to Smolt Stages in Relation to
Salinity and Temperature.

1977. Jour. Fish. Res. Bd. Can., 34, 151-154
(University of British Columbia, Institute of
Animal Resource Ecology, Vancouver, British
Columbia, Canada; University of Victoria,
Department of Biology, Victoria, British
Columbia, Canada)

Critical swimming speeds (fork lengths per
second, L/s) of early fry, advanced fry, and
pre-smolt coho salmon, *Oncorhynchus kistutchi*,
surpassed those of smolts. Performances were
inversely related to size, varying from a
peak of 7.3 L/s in fry to 5.5 L/s in smolts.
In early fry to pre-smolt stages, salinity
had little effect whereas in smolts a
distinct maximum performance occurred near 13
ppt. Swimming performances of all stages
varied directly with temperature: maximum
occurred between 20 and 23 C. As temperature
decreased, critical speeds of early fry
declined at a faster rate than that of later
stages, the values at 23 and 3 C being 7.2
and 3.5 L/s in early fry and 5.5 to 3.5 in
smolts. This study shows that on a
size-related basis underyearling coho are
capable swimmers in estuarine conditions.
Thus, their apparent failure to survive
premature seaward migrations cannot be
explained by their inability to perform
important locomotor-dependent behaviors.
(Auth)

<106>
Goldman, J.C., Biomass Production in Mass

<186> CONT.

Cultures of Marine Phytoplankton at Varying Temperatures.

1977. Jour. Exp. Mar. Biol. Ecol. (Beth.), 27, 161-169 (Woods Hole Oceanographic Institution, Woods Hole, MA)

Assimilation of virtually all of the influent inorganic nitrogen occurred at every temperature tested between 5 and 33 C by natural populations of marine phytoplankton grown on waste water-sea water mixtures in laboratory continuous cultures. The change in species dominance with temperature was distinct, however, with *PHAEODACTYLUM TRICORNUM* dominant at 19.0 C, *WITKINIA* sp. at 27 C, and *OSILLATORIA* sp. increasingly dominant above 27 C. The excellent growth of *P. TRICORNUM* below 10 C may have been related to a dramatic increase in the nutrient content per cell with temperature decrease, thus compensating for reduced division rates. It follows that there is a transfer of phytoplankton protein from numerous small cells at intermediate temperatures to large cells that are reduced in numbers at lower temperatures but which represent the same total organic matter. The effect of this phenomenon on annual food chain efficiencies in both controlled and natural marine ecosystems is unknown. (RFC)

<187>

Gollan, J.C., Temperature Effects on Phytoplankton Growth in Continuous Culture.

1977. Limnol. & Oceanogr. 22, 932-936 (Woods Hole Oceanographic Institution, Woods Hole, MA)

Temperature has a strong influence on the chemical composition of marine phytoplankton. A common characteristic of several species is a minimum nutrient content (as nitrogen or carbon) per cell at the temperature optimum for cell division, with increasing cellular biomass at lower and higher temperatures. Hence, cell division and nutrient uptake rates are uncoupled with respect to temperature. This raises doubts concerning the role of temperature in phytoplankton ecology and the predictive value of existing models of kinetic growth and uptake. (Auth)

<188>

Gollan, J.C., and J.A. Davidson, Physical Model of Marine Phytoplankton Chlorination at Coastal Power Plants.

1977. Environ. Sci. & Technol., 11, 908-913 (Woods Hole Oceanographic Institution, Woods Hole, MA)

A physical model of the impact of coastal power plant chlorination on marine phytoplankton was developed. Several steady state biomass levels of the test algae *PHAEODACTYLUM TRICORNUM* were established in continuous cultures by varying the concentration of phosphorus in the growth medium. The algae were then exposed to combinations of chlorine and temperature stress for one hour (30 C from initial values of 15, 20, and 25 C), and deviations from the prestress steady state were observed over long periods of time. Temperature shock alone had no effect on steady state populations. Three types of response occurred that were a function of the applied chlorine/biomass ratio: no effect, effect followed by recovery, and complete washout. It is suggested from the results that, given the typical organic loads present in coastal

waters, excessive levels of chlorine may be in current use, and that the effects on entrained phytoplankton probably have little bearing on the ultimate effect on the standing crop in the receiving water. The most important considerations were the hydrologic, biological, and chemical qualities of the receiving waters themselves. (Auth)

<189>

Gollan, J.C., and J.A. Ryther, Temperature-Influenced Species Competition in Mass Cultures of Marine Phytoplankton.

1976. Biotech. & Bioengr., 18, 1125-1140 (Woods Hole Oceanographic Institution, Woods Hole, MA)

Five marine phytoplankton species (*PHAEODACTYLUM TRICORNUM*, *THALASSIOSIRA PSEUDONANA*, *SKELETONA COSTATUS*, *NOCTHYSIS LUTHERI*, and *DONALDIA TERTIOLETA*) were grown in enriched laboratory continuous cultures and natural populations were mass cultured outdoors for 16 months. Steady-state biomass levels were determined for the five species in the temperature range 10 to 30 C. Growth of *D. TERTIOLETA* increased progressively from zero at 10 C to over 30 mg/liter PC (particulate carbon) at 30 C. An opposite effect was demonstrated for *S. COSTATUS*: over 35 mg/liter PC was produced at 10 C followed by a continuous decrease to cell washout at 30 C. *PHAEODACTYLUM TRICORNUM* and *N. LUTHERI* grew best at 20 C and decreased in growth at higher and lower temperatures. Steady-state biomass levels could not be maintained for either species at 30 C. *NOCTHYSIS LUTHERI* displayed minimal growth at 10 C (3 mg/liter PC), whereas *P. TRICORNUM* at 20 C exhibited the highest growth of the five species, 46 mg/liter PC. Growth of *T. PSEUDONANA* was generally unaffected by temperature changes: between 10 and 30 C levels were in the range 20 to 28 mg/liter. Competition among the species was shown to be highly dependent on temperature, although the actual production of plant organic matter at the low growth rates used was relatively independent of this variable. Control of marine species in mass cultures does not appear economically feasible, but this drawback may be overcome by selecting herbivorous shellfish that are capable of assimilating these temperature-dependent phytoplankton species dominating in a particular locale. (Auth) (ST)

<190>

Gopalakrishnan, K., Larval Rearing of Red Shrimp *PENAEUS MARGINATUS* (Crustacea).

1976. Aquaculture, 9, 165-154 (University of Hawaii, Honolulu Community College, Honolulu, HI)

Developmental and survival rates were determined for the red shrimp, *PENAEUS MARGINATUS*, at four temperatures. Survival rates of postlarval larvae were higher at 20 and 25 C than at 15 and 30 C. The lower level of salinity tolerance for the larvae was about 24‰. (RFC)

<191>

Gordon, H.R., and D.J. McLeay, Sealed-Jar Bioassays for Pulpmill Effluent Toxicity: Effects of Fish Species and Temperature.

1977. Jour. Fish. Res. Bd. Can., 34, 1389-1396 (British Columbia Research, Division of Applied Biology, Vancouver, British Columbia, Canada)

<191> CONT.

To standardize the sealed-jar bioassay for optimum sensitivity to whole bleached kraft pulpmill effluent, experiments were designed to assess the effects of test temperature, acclimation temperature, and fish species. Coho salmon (*Oncorhynchus kisutch*) conformed to a previously recognized test paradigm showing progressively decreased oxygen utilization with increasing toxicant concentrations; however, rainbow trout (*Salmo gairdneri*) did not. In concentrations of effluent less than 1.5 LC50, rainbow trout used significantly more oxygen than control groups, while coho salmon used significantly less oxygen. The sensitivity of these responses was influenced by test temperature and acclimation temperature. Results for coho confirmed that this species was most sensitive to effluent when tested at ambient room temperature. Both species showed significantly decreased oxygen utilization in effluent concentrations greater than 1.5 LC50 irrespective of test temperature or acclimation temperature. The significance of these responses is discussed, and the applicability of sealed-jar bioassays for assessing the acute toxicity of pulpmill effluents is reviewed. (Auth)

<192>

Grabowski, S.J., Effects of Fluctuating and Constant Temperatures on Some Histological Characteristics, Tissue Glycogen Levels, and Growth of Steelhead Trout (*Salmo gairdneri*).

1977. Ph.D. Thesis, University of Idaho (University of Idaho, Moscow, ID)

Hematocrit, hemoglobin levels, erythrocyte counts, liver and muscle glycogen levels, and growth were measured in steelhead trout (*Salmo gairdneri*) subjected to fluctuating (8 to 18 C) and constant (8, 15, and 18 C) temperatures. A least squares analysis of variance indicated no effect of temperature on hematocrit, hemoglobin levels, and erythrocyte counts in fish maintained in closed water system for two or eight weeks. Temperature had a highly significant effect on liver glycogen levels in both two- and eight-week runs, but temperature had no apparent effect on muscle glycogen levels. Trout maintained at 15 C had the highest instantaneous growth rate (88.7% weight/two months) and actual weight gain (108.9%), while trout at 8 C had low values for these parameters. Fish in the fluctuating temperature had mean values close to those found in fish at 15 C. Temperature had a highly significant effect on instantaneous growth rate for fish maintained in the four different temperatures for eight weeks. (ST)

<193>

Gray, R.W., Avoidance of Thermal Effluent by Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) and its Implications in Waste Heat Management.

1977. In Conference on Waste Heat Management and Utilization held in Miami Beach, Florida, on May 9, 1977; BWWT-84-6222; CONF-770516-8; PC A02/W, WT13, Springfield, VA (Battelle Pacific Northwest Laboratory, Richland, WA)

Responses of juvenile chinook salmon, *Oncorhynchus tshawytscha*, to a simulated river-thermal plume interface encountered in a model raceway were recorded on videotape. Juveniles tested under three discharge conditions (no plume, ambient plume and heated plume) avoided plume temperatures

greater than 9 to 11 C above ambient. They occasionally oriented to the discharge current, but were not attracted to the thermal component of the plume when plume delta T's were below the avoidance level of 11 C. Fish did not pass to the lower end of the raceway when plume delta T's exceeded 9 to 11 C. Observations suggested that organismic behavior may prevent juvenile salmon in nature from experiencing lethal conditions from thermal discharges. (NPC)

<194>

Gray, R.W., R.C. Genoway, and S.A. Barraclough, Behavior of Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) in Relation to Simulated Thermal Effluent.

1977. Trans. Amer. Fish. Soc., 106 366-370 (Battelle Pacific Northwest Laboratories, Ecosystems Department, Richland, WA)

Instantaneous responses of juvenile salmonids that encounter a simulated river-thermal plume interface were assessed in a model raceway with a thermal discharge. Fish movement and response to the discharge were recorded on videotape. Juvenile chinook salmon (*Oncorhynchus tshawytscha*) tested under three discharge conditions (no plume, ambient plume, and heated plume) avoided heated plumes when plume delta T's were greater than 9 to 11 C above ambient. Fish occasionally oriented to the discharge current, but were not attracted to the thermal component of the plume when plume delta T's were below the avoidance level of 11 C. Fish did not pass to the lower end of the raceway when plume delta T exceeded 9 to 11 C. (Auth)

<195>

Griffiths, E.J., Temperature Acclimation in *ACTINIA EQUINA* L. (Anthozoa).

1977. Jour. Exp. Mar. Biol. Ecol. (Neth.), 28, 285-292 (University of Natal, Zoology Department, Pietermaritzburg, South Africa)

Respiratory adaptation to different sea temperatures on the Natal (east) and Table Bay (west) coasts of southern Africa is demonstrated in *ACTINIA EQUINA* L. Animals are able to acclimate to lower sea temperatures but are unable to adapt to an increase of 3 C or more above summer sea temperatures. Acclimation to elevated water temperatures may be limited by thermal sensitivity of the tissues and by lack of feeding when under thermal stress. The successful colonization of the Natal littoral zone by *A. EQUINA* may be attributed partially to metabolic adaptability but also to its brooding ability, tolerance of desiccation, and capacity to retain water within the coelenteron. Slow exudation of this water enables evaporative cooling of the tissues during low tide. Other actinian species from Natal lack this range of features and are hence limited to damp habitats at lower tidal levels. (Auth)

<196>

Griffiths, E.J., Thermal Stress and the Biology of *ACTINIA EQUINA* L. (Anthozoa).

1977. Jour. Exp. Mar. Biol. Ecol. (Neth.), 27, 149-156 (University of Natal, Zoology Department, Pietermaritzburg, South Africa)

Oxygen consumption for juvenile anemones (*ACTINIA EQUINA*) of different weight classes,

<196> CONT.

measured over the temperature range 19 to 39 C, increased with increasing temperature, and smaller individuals had a relatively higher respiratory rate. Adult *A. EQUESTRIS* at constant temperatures showed marked fluctuations in oxygen consumption. At 19 C the respiratory rate varied between 9.2 and 9.5 ml O₂/kg dry weight. This doubled at higher temperatures and no short-term acclimation to the increased temperatures was apparent. Comparison with similar curves for British animals showed evidence of acclimation to the different geographical zones in which *A. EQUESTRIS* is found. (ST)

<197>

Grinas, T., Ecological Aspects of Cooling Water Discharges.

1975. Fauna Flora (Sued.), 70, 50-55 (Entomologiska avdelningen, Box 541, Uppsala, Sweden)

Thermal discharges from power plants may lead to serious effects on the environment. In the immediate discharge area there is a direct effect on biota activity and on species abundance and diversity. Increased temperature stimulates the incorporation of toxic substances such as heavy metals and biocides, into organic matter. This accumulation affects a larger area than that affected by the heated discharge. Increased temperature also has a favorable effect on fish parasites and diseases. The heat increases the rate of decomposition of organic matter in the receiving water and the fisherman current permits transport of oxygen. In the future the heat and kinetic energy might be used for positive effects if the ecology of the affected water body is understood and synergistic effects are better understood. (Auth)(ST)

<199>

Guerrin-Acey, O., Experimental Study of the Nitrogen Excretion of Bass (*DICENTRARCHUS LABRAIX*) During Growth. III. Effects of Water Volume and Initial Ammonia Concentration on the Excretion of Ammonia and Urea.

1976. Aquaculture, 9, 253-258 (Station Marine d'Enfouie, Marseille, France)

The effects of water volume and ambient ammonia were examined for young fish acclimated to 16, 18 and 20 C. *DICENTRARCHUS LABRAIX* excreted less ammonia nitrogen when ambient ammonia was increased and when the volume of water was decreased. Fishes subjected to increasing ambient ammonia levels showed an increase in the rate of urea excretion. Ammonia poisoning occurred at an ammonia level of 10 mg/l. The minimum non-autotoxic volume for bass is 12 l/kg at 16 C, 15 l/kg at 18 C and between 15 and 20 l/kg at 20 C. (Auth)

<199>

Guerra, C.R., B.L. Godfrin, A.F. Eble, A. Farnsworth, P. Pittman, and P. Campbell, Integration of Thermal and Food Processing Residuals into a System for Commercial Culture of Freshwater Shrimp (Power Plant Waste Heat Utilization in Aquaculture), Final Report, Volume I.

1977. Final Report of the Public Service Electric and Gas Company to the National Science Foundation, 52 p. (Public Service Electric and Gas Company, Newark, NJ; Trenton State College,

Trenton, NJ; Rutgers University, New Brunswick, NJ; Long Island Oyster Farm, Long Island, NY)

The biological feasibility of rearing freshwater shrimp (*MACROBRACHIUM ROSENBERGII*) and rainbow trout (*Salmo gairdneri*) in the thermal effluent of PSEG's Boreas Generating Station on the Delaware River, NJ, was evaluated. Secondary objectives of the study were to make preliminary evaluations of the engineering and economic feasibility of rearing these species in thermal effluents and to make some preliminary assessments of product quality. Growth, feed conversion and mortality rates for both species were equal to or better than the results obtained from more traditional methods of rearing. There were no serious disease outbreaks for either species. Temperature limits in the thermal effluent acceptable for *MACROBRACHIUM ROSENBERGII* and rainbow trout culture were 15 to 37.5 C and 0.4 to 26.5 C, respectively. There was a temperature-dissolved oxygen interaction at the upper thermal limit for both species which tended to depress the limits. Shrimp were especially sensitive to a combination of momentary high temperature (35 C) and low dissolved oxygen in the recovery. Rainbow trout were sensitive to the chlorine residual in the recovery during periods of chlorination. Heavy metal, arsenic and polychlorinated biphenyl levels of the products were within acceptable limits. The process of alternating crops seasonally was found suited to the seasonal temperature fluctuations in New Jersey. (ST)

<200>

Hadderingh, R.H., Effects of the Cooling Water Discharge on the Macroinvertebrates and Fish Populations around Flevo Power Station.

1975. Verh. Intl. Ver. Limnol., 19, 2218-2218 (Not given)

Changes in the macroinvertebrates around the Flevo power station were limited to a small area around the outlet, where temperatures were relatively high. With a few exceptions all of the more commonly occurring species are found both near the intake and the outlet. For a number of species the abundance differed significantly between these locations. Fish abundances near the outlet were markedly higher than elsewhere in the lake. Negative effects on fish condition were found in pike-perch and bream. The spawning time of roach was advanced by 2 weeks near the outlet. Additional investigations are necessary to gain more insight in the condition and migration of fish. (Auth)

<201>

Hadley, D., Intra- and Interspecific Variability in Tolerance of Southern California *LITTORINA FLAVAXIS* and *LITTORINA SCUTULATA* to Petroleum.

1977. Environ. Res., 3, 184-208 (Allan Hancock Foundation, University of Southern California, Los Angeles CA)

The present study was designed to investigate the inter- and intraspecific responses of Southern California *LITTORINA FLAVAXIS* and *LITTORINA SCUTULATA* from coastal and inland sites when exposed to gasoline, kerosene, Santa Barbara crude oil, Kuwait crude oil, and a Louisiana crude oil, under laboratory conditions. Variations in tolerance of *LITTORINA* to different petroleum at 6, 17, and 29 C, as indicated by mortality rate and rate of animal attachment to the substrate,

<201> COTT.

were observed. Differences in animal size, composition of the petroleum, and the natural habitat of the animals were considered. The attachment rate of LITTORINID varied with temperature, but not in a consistent way for different petroleum, localities, or species. The most consistently high rate of attachment for both species occurred at 17 C. While L. STYGLIA exhibited a greater tolerance to various conditions at 6 C, L. FLABRIS had a greater tolerance at 29 C. The only mortalities occurred at 29 C. The mortality rate varied with the type of petroleum used and appeared to be size and species related. Gasoline had the greatest influence on attachment rates at all temperatures, and kerosene had the least effect on attachment rates. There was no consistent attachment rate trend among crude oils; however, their influence was intermediate between that of gasoline and kerosene. (Auth)

<202>

Raefer, P.A., Jr., Aspects of the Biology of the Jonah Crab, *CANCER PORCELLANUS* Stimpson, 1859 in the Mid-Atlantic Bight.

1977. Amer. Nat. Hist. 11, 303-320 (Virginia Institute of Marine Science, Gloucester Point, VA)

Jonah crabs were contagiously distributed within a depth of 20 to 400 m on the continental shelf of the mid-Atlantic Bight. Maximum abundances occurred within 150 to 400 m depths and 8 to 13 C. (ST)

<203>

Hall, D.J., and E.E. Werner, Seasonal Distribution and Abundance of Fish in the Littoral Zone of a Michigan Lake.

1977. Trans. Amer. Fish. Soc., 106, 545-555 (Michigan State University, Department of Zoology, Michigamoo Corners, MI; W.K. Kellogg Biological Station)

The seasonal distributions and abundances of 15 littoral zone fish species were determined from May to October 1976 in a small Michigan lake. The bluegill (*LEPOMIS MACROCHIRUS*), the dominant species, exhibited seasonal onshore-offshore movements. Greater than 90% of the population occurred on the slope (steeply sloping region 1.5 to 6 m deep) in early May; there followed an onshore movement as water temperature increased. From late May to September about 26% of the bluegill population occupied the bench (gently sloping region 0 to 1.5 m deep) zone. In September when water temperatures fell below 20 C the bluegill moved off the bench and 90% of the population was again found on the slope. As the upper boundary of the thermocline was forced deeper, the small bluegills moved down the slope but only after water temperatures rose above 20 C. These abundance and distribution patterns appeared to be stable from year to year. Temperature appeared to set the overall bounds to the movements and habitats utilized, but ecological interactions were probably responsible for the finer resolution of microhabitat utilization among size classes and species in the littoral zone. (Auth) (ST)

<204>

Hallam, J.C., The Modification of Vertebral Rubber in Salmonidae.

1977. Ph.D. Thesis, University of Toronto; Dissertation Abstracts, 37, 6011-B-6012-B

(University of Toronto, Toronto, Canada)

Response of vertebral rubber to temperature of incubation in the Salmonidae varied among six species and many of their reciprocal hybrids. Two main responses were found. Brook and rainbow trout, brook trout by arctic/alpine char and brook by lake trout hybrids have more vertebrae the lower the temperature of development. Brown trout and probably Atlantic salmon too, exhibited a V-shaped response where fewer vertebrae were formed at intermediate temperatures. Morphological criteria were described for 21 embryonic stages of salmonids. The period during which the vertebrae were formed occurred approximately from Stage 5 to Stage 13. The number of vertebrae was positively correlated with the relative length of the period of vertebral formation in either of the two main responses to temperature mentioned above. Relationship between log time to selected embryonic stages and temperatures was generally linear or slightly curvilinear. (Auth) (ST)

<205>

Bauer, T., and E.T. Genside, Size Relations and Yolk Utilization in Embryonated Ova and Blewies of Atlantic Salmon *Salmo salar* L. in Various Combinations of Temperature and Dissolved Oxygen.

1977. Can. Jour. Zool., 55, 1892-1898 (Dalhousie University, Department of Biology, Halifax, Nova Scotia, Canada)

After continuous incubation at 5 and 10 C and three levels of dissolved oxygen, the hatching weight of embryos of Atlantic salmon varied from 22.1 mg (5 C, 100% air saturation) to 11.9 mg (5 C, 30%) and from 18.5 mg (10 C, 100%) to 10.0 mg (10 C, 30%). Cumulative and mean daily yolk depletion declined with lowered oxygen supply, but were considerably greater at 10 C than at 5 C. Yolk was used more efficiently at 5 C and 100% saturation. (ST)

<206>

Hargreaves, R.V., The Ecology of an Artificial Cooling Lake.

1975. Verh. Internat. Verein. Limnol. (Ger.), 19, 2189-2200 (Not given)

The ecology of Lake Sannechris, an artificial cooling lake in Illinois is briefly summarized. Information is provided on the physical and chemical characteristics of the water, plankton, benthos, and fishery resources. (ST)

<207>

Harris, R.P., Some Aspects of the Biology of the Harpacticoid Copepod, *SCOTTALANA CAMBESINIS* (Willey), Maintained in Laboratory Culture.

1977. Chesapeake Sci., 18, 245-252 (University of Maryland, Chesapeake Biological Laboratory, Center for Environmental and Estuarine Studies, Solomons, MD)

Generation time of the epibenthic harpacticoid copepod *SCOTTALANA CAMBESINIS* was 23 to 25 days at 20 C, and 12 to 17 days at 25 C. (ST)

<208>

Harrison, P.L., E.H. Boag, and E.E. Heft, Interactions of Radiocesium in Water, Particulates, and Oysters in the Discharge Canal

<200> COTY.
of a Nuclear Power Plant.

1978. TCEL-51978, Lawrence Livermore Laboratory (Lawrence Livermore Laboratory, University of California, Livermore, CA)

The study was designed to provide data for toxicologic modeling of radioactive pollutants in marine ecosystems adjacent to nuclear power plants. Gamma-emitting radionuclides (⁵⁹Fe, ⁶⁰Co, ⁶⁵Zn, and ¹³⁷Cs), introduced as liquid wastes into the discharge canal of the San Jose Bay Power Plant, Calif., were determined in water, particulates, and oysters. Concentrations in the water varied widely with time. Partitioning between the soluble and particulate phases of the water and accumulation in the sediments were radionuclide-dependent and varied with the biological and hydrological conditions. Concentrations of radionuclides in oysters in the discharge canal generally reflected levels measured in the water and particulates. Suspended particulates played an important role in the accumulation of some radionuclides. For ⁵⁹Fe, ⁶⁰Co, and ⁶⁵Zn the concentration factors calculated from the expected water concentrations were higher than those predicted from the concentration factors for the corresponding stable elements. (ST)

<209>
Harrison, P.T., Seasonal Changes in the Heart Rate of the Freshwater Prawn *LYNCEA STAGNALIS* (L.).

1977. Comp. Biochem. Physiol., 50A, 37-41 (Queen Mary College, Department of Zoology and Comparative Physiology, London, England)

LYNCEA STAGNALIS (L.) exhibits seasonal changes in the heart rate-temperature relation. Seasonal acclimatization induces capacity adaptations, whereby winter animals show a higher heart rate than summer animals at any temperature between 15 and 25 °C, and also resistance adaptations, which give summer animals increased tolerance to heat and winter animals greater resistance to cold. The appearance of a bimodality in the rate-temperature curves at certain seasons of the year illustrates that control of heart rate is complex. Some possible modes of action of heart rate control mechanisms are discussed. (Auth)

<211>
Harrison, P.T., Laboratory Induced Changes in the Heart Rate of *LYNCEA STAGNALIS* (L.).

1977. Comp. Biochem. Physiol., 50A, 43-46 (Queen Mary College, Department of Zoology and Comparative Physiology, London, England)

Thermal acclimation induces significant changes in the heart rate-temperature relation of *LYNCEA STAGNALIS* (L.). Resistance adaptations occur at both temperature extremes but there is no evidence for capacity adaptation. An acclimation temperature of 20 °C induces a bimodality in the rate-temperature curve similar to that sometimes found in seasonally adapted snails. Various similarities exist in the changes in heart rate function induced by seasonal and experimental acclimations. Capacity adaptation, however, is present only in seasonally adapted snails, suggesting that acclimation to temperature alone is not sufficient to produce this response. (Auth)

<211>
Maidment, R.C., and J. H. Crawford, Effect of Temperature and Feeding Rate on the Liver-Somatic Index of the Largemouth Bass, *MICROTHERES SALmoides*.

1977. Jour. Fish. Res. Bd. Can., 34, 633-638 (Southern Illinois University, Fisheries Research Laboratory and Department of Zoology, Carbondale, IL)

After 30 days at a given feeding regime, at a controlled food intake level, the liver-somatic index (liver weight as a percentage of body weight) of largemouth bass, *MICROTHERES SALmoides*, was positively correlated with daily food intake. At temperatures of 20.0 and 26.0 °C there was no overlap in the ranges of the liver-somatic index of bass fed 0, 2, and 8% of their body weight in live green sunfish (*LEPOMIS CYANELLUS*) per day. Within a given feeding regime, increased temperature lowered the liver-somatic index. (Auth)

<212>
Walt, R., and R. Fingerman, The Influence of Size, Sex and Temperature on the Toxicity of Mercury to Two Species of Crayfishes.

1977. Bull. Environ. Contam. Toxicol., 10, 572-580 (Tulane University, Department of Biology, New Orleans, LA)

The effects of various concentrations of inorganic mercury on the edible crayfish, *PROCAMBARUS CLARKII*, and the smaller ecologically important crayfish, *PACIFELLA CLYPEATA*, were determined under conditions likely to be encountered in their environment. Females and larger animals seemed better able to withstand the effects of mercury than did males or smaller animals. As temperature decreased from 30 °C to 20 °C to 5 °C the ability of both species to withstand a 5 X 10⁻⁶ M HgCl₂ solution increased. As HgCl₂ was increased above the lethal concentration, crayfish maintained at 20 °C had a greater number of survivors than those at 30 °C. The ability of crayfish to cope with inorganic mercury depends greatly on the species, its size and sex, and the external temperature. (SW)

<213>
Weithamp, U., Zur Fortpflanzungsbiologie von *Mesostoma Ehrenbergii* (Focke, 1836) (Turbellaria).

1977. Hydrobiologia (Ber.), 55, 21-31 (Universität Göttingen, Zoologisches Institut und Museum, Göttingen, Germany)

Turbellarians (*MESOSTOMA EHRENBEGII*) that had hatched from summer (non-resting or subitaneous) eggs produced non-resting eggs at a high rate only above 20 °C. Below 10 °C no development occurred in juveniles. At temperatures between 22 and 30 °C (20-7 °C) the first summer eggs were formed after 6 to 9 days; at temperatures between 9 and 14 °C (10-7 °C) they were formed after 30 days. Gonogeneration extended over 16.5 days at the higher fluctuating temperature regime and over 75 days at the lower. Young worms in resting eggs had a dormant period of at least 15 to 30 days. At 20 °C no juveniles hatched from resting eggs. By combining room and refrigerator temperatures (3-5 °C) the hatching rate increased to a maximum of 85%. (ST)

<210>

Teale, R.G., and P.F. Millican, Experiments in the Hatchery Rearing of Pacific Oyster Larvae (*CRASSOSTREA GIGAS* Thunberg).

1977. Aquaculture, 11, 1-12 (Minist. Agric., Fish. & Food Exp. Sta., Conwy, Gwynedd, England)

In experiments conducted to determine the influence of salinity, temperature, larval density, water change frequency and antibiotics on the growth and survival of larvae of the Pacific oyster, *CRASSOSTREA GIGAS*, maximum growth was at 20 C and 25 ppt salinity. Optimum salinity for larval rearing was not significantly altered when adults were conditioned for spawning at different salinities. No tests were made on larvae of adults conditioned to different temperatures. (DPC)

<215>

Seallier, G., Development of *APPHIOPUS ADDITUS* (Perrill) (Echinodermata: Ophiuroidea): I. Larval Biology.

1977. Biol. Bull., 152, 51-63 (Woods Hole Oceanographic Institution, Woods Hole, MA)

Development of *APPHIOPUS ADDITUS* embryos was faster in cultures held at 21 C than at 16 C. At 16 C, development proceeded only to a point where the embryonic body was nearly resorbed. (DPC)

<216>

Nerantzen, A., Effects of Temperature on the Nutritional Requirements of *APHTHIA SHIINA* (L.).

1976. Biol. Bull., 151, 310-321 (Laboratoire de Zoologie Nationale d'Histoire Naturelle au Centre d'Etudes et de Recherches Scientifiques de Pierrefitte, France)

In studies on the effects of temperature on the nutritional requirements of *APHTHIA SHIINA* (L.), the following conclusions were reached: (1) The growth rate of *APHTHIA* in a uniform basic medium is faster at 30 C than at 25 C. (2) Temperature and salinity have opposite effects on the quantitative requirement for ATP. (3) At 30 C maximal growth is achieved with more ATP, more albumin, and less starch than at 25 C. (4) The effects of temperature are mediated by the ratio between energetic nutrients and ATP. (Auth) (M)

<217>

Hillman, B.E., H.W. Davis, and J. Venneman, Abundance, Diversity, and Stability in Shore-Zone Fish Communities in an Area of Long Island Sound Affected by the Thermal Discharges of a Nuclear Power Station.

1977. Estuarine & Coastal Mar. Sci., 5, 355-381 (Battelle Columbus Laboratories, Columbus, OH; William F. Clapp Laboratories, Duxbury, MA)

Shore-zone fish communities in the area of a nuclear power station at Hillstone Point, Connecticut, on Long Island Sound, were studied from May 1969 through December 1975. Over 81,500 fish representing 35 species were collected. Species diversity, richness, and evenness fluctuated at the thermally affected and control sites seasonally and from year to year such that no trends could be determined. It is suggested that the concept of community or ecosystem stability be re-examined and possibly redefined in light of these distinct fluctuations over six

years. (ST)

<218>

Himmelman, J.H., Factors Regulating the Reproductive Cycles of Some West Coast Invertebrates.

1976. Ph.D. Thesis, University of British Columbia (University of British Columbia, Vancouver, British Columbia)

Eight species of chitons and one sea urchin were studied for several years in the coastal area of southeastern British Columbia to determine the factors regulating annual reproductive cycles. Although there was usually a major spawning in one area when temperatures reached 7 to 8 C in spring, observations over the several years of study suggested that spawning did not occur in response to a physiological threshold temperature, or to a sudden change in temperature. *STROMBOCYCLOSTOMUS*, *STROMBOCYCLOSTOMUS*, and *TORRELLA LINEATA* collected prior to spawning and maintained in the laboratory at 5 and 10 C did not spawn. In several cases abrupt spawning in the field corresponded to the spring phytoplankton bloom. In the laboratory a later proportion of *S. STROMBOCYCLOSTOMUS*, *T. LINEATA* and *T. LINEATA* spawned when they were exposed to natural phytoplankton collected during the spring bloom. (ST)

<219>

Hirshfield, R.P., The Reproductive Ecology and Energetics of the Japanese Medaka, *OSTEATIS LATIPES*.

1977. Ph.D. Thesis, University of Michigan (University of Michigan, Ann Arbor, MI)

A theoretical model relating optimal reproductive effort to demographic and environmental variables was developed; observations from laboratory experiments and field studies were used to test the predictions. The food intake of female medaka at three temperatures (25, 27, and 29 C) was controlled while several variables associated with reproduction and growth were measured. Increased temperature led to greater reproduction and less growth. Increased food intake caused greater total production at all temperatures, but its effect on the allocation of production to growth and reproduction differed at the three temperatures. Reproductive effort was highest at 29 C, declining with increased food intake at 29 and 27, but increasing at 25 C. Reproduction was significantly negatively correlated with growth at all temperatures. Mortality increased as temperature or reproductive effort increased. (ST)

<220>

Hoffman, R.L., Catalytic Efficiency and Structural Properties of Invertebrate Muscle Pyruvate Kinases: Correlation with Body Temperature and Oxygen Consumption Rates.

1976. Jour. Comp. Physiol., 140, 185-195 (Lehrstuhl II University, Zoology Institute, Erlangen, German Federal Republic)

Structural, kinetic and thermodynamic activation properties of muscle pyruvate kinases from *BOCCIPUS UROSAURUS*, *ASTERIAS RUBENS*, *LITTORINA LITTORINA*, and *STILION* *EDULIS* adapted to different thermal environments were examined. Structural

<221>

<222> (cont.)

rigidity, as estimated by ammonium sulfate precipitation, and heat inactivation temperature was positively correlated with acclimation temperature. (ST)

<223>

Notkanson, E.E.P., Temperature Requirements of Some Percids and Adaptations to the Seasonal Temperature Cycle.

1977. Jour. Fish. Res. Bd. Can., 34, 1526-1550 (Environmental Research Laboratory-Duluth, Monticello Ecological Research Station, Monticello, MN)

Temperature requirements are reviewed for three North American percids (walleye, *STIZOSTEDION VITREUM VITREUM*; sauger, *S. FLAVESCENS*; and yellow perch, *PERCA FLAVESCENS*), three Eurasian percids (perch, *P. PERCA*; bream, *P. LUCIOPERCA*; and ruffe, *ACIPERES CYPSELUS*), and nine cottontail fish species for comparison. Whole-organism responses are described for each species--primarily concerning reproduction, growth, survival, and activity. The percids are classified as temperature mesotherms and they are arranged in order of their thermal requirements as follows: bream, perch, ruffe, sauger, walleye, perch, and *STIZOSTEDION* spp. are annual consumers with synchronous oocyte growth during fall through winter, culminating in spring spawning. Fertilization occurs below 12°C. Spawning occurs from late February through early July at 2 to 6°C over their geographic ranges. Oocyte growth of ruffe is asynchronous, accelerated by warm temperatures; batch spawning occurs over a prolonged period, from mid-April through July at 11 to 18°C. Physiological optimum range from 22°C for sauger and walleye to 25°C for perch and 27°C for bream. The ultimate upper incipient lethal temperatures of percids range from 29 to 35°C, depending on species and experimental conditions. Adaptations to the seasonal temperature cycle of a temperate climate are also reviewed. (Auth) (ST)

<224>

Notkanson, E.E.P., C.F. Fleiner, and T.W. Hocutt, Effects of Constant Temperatures and Diel Temperature Fluctuations on Specific Growth and Mortality Rates and Yield of Juvenile Rainbow Trout, *Salmo gairdneri*.

1977. Jour. Fish. Res. Bd. Can., 34, 639-648 (U.S. Environmental Protection Agency, Environmental Research Laboratory-Duluth, Monticello, MN)

Specific growth and mortality rates of juvenile rainbow trout (*Salmo gairdneri*) were determined for 50 days at seven constant temperatures between 8 and 22°C and six diel temperature fluctuations (nine curve of amplitude plus and minus 3.0°C about mean temperatures from 12 to 22°C). For constant temperature treatments the maximum specific growth rate of trout fed excess rations was 0.12%/day at 17.2°C. An average specific mortality rate of 0.35%/day was observed at the optimum temperature and lower. At temperatures in excess of the growth optimum, mortality rates were significantly higher during the first 20 days of this experiment than the last 30 days. The highest constant temperature at which specific growth and mortality rates became equal (initial biomass remained constant over 40 days) was 23°C. The upper incipient lethal temperature was

25.6°C for trout acclimated to 16°C. A yield model was developed to describe the effects of temperature on the living biomass over time and to facilitate comparisons of treatment responses. When yield was plotted against mean temperature, the curve of response to fluctuating temperatures was shifted horizontally an average 1.5°C towards colder temperatures than the curve of response to constant temperature treatments. This response pattern to fluctuating treatments indicates that rainbow trout do not respond to mean temperature, but they acclimate to some value between the mean and maximum daily temperatures. These data are discussed in relation to establishment of criteria for summer maximum temperatures for fish. (Auth)

<225>

Holopainen, I.J., and E. Sants, Carbon Dioxide Output in the Respiration of Three Pisidium Species (Pisidium, Pisidiidae).

1977. Oecologia (Ger.), 30, 1-8 (University of Jyväskylä, Department of Biology, Finland; University of Helsinki, Lanni Biological Station, Lanni, Finland)

Using a closed-bottle method and an infrared gas analyzer to measure dissolved inorganic carbon, the carbon dioxide output in respiration of *PISIDIUM CASERTANUM*, *P. HENSLOWIANUM* and *P. CONVERTUS* was studied. The mean value of the constant *b* in equation $V = aV^b$ (where *V* is the respiration rate and *b* the ash-free dry weight of the animal, was about 0.75 in both the eurytherm *P. CASERTANUM* and the cold-stenotherm *P. CONVERTUS* at 3, 6, 10, 15 and 20°C, but the temperature dependence of *b* was opposite in these species. The temperature dependence of metabolism increased with increasing size in *P. CASERTANUM* and *P. HENSLOWIANUM* but decreased in *P. CONVERTUS*. A 'reversed acclimatization pattern' was found, where the metabolism rate and its temperature dependence was lower in the cold-adapted stenotherm species. (Auth)

<226>

Molt, R.S., and R. Strawn, The Culture of Black Drum (*POGONIAS CHRONIS*) in Cages Receiving Effluent from a Power Plant.

1976. In Avault, A.B. (Ed.), Proc. 7th Ann. Meet. World Mariculture Soc., 109-127, Louisiana State University, Baton Rouge, LA (Texas A&M University, Department of Wildlife and Fisheries Sciences, College Station, TX)

Black drum were cultured from June 1974 until May 1975 in 0.36 m³ cylindrical cages in the plant intake and at several stations in the cooling lake of an upper Galveston Bay electric generating station. All caged drum died at the intake station by November 12; survival during summer and fall in the cooling lake was 97%. Survival during winter and spring was poor with complete mortality occurring by May at all stations in the cooling lake. Deaths were associated with periods of poor water quality due to heavy rainfall and resultant low salinities. (ST)

<227>

Horne, R.T., R.M. Richards, R.J. Roberts, and P.C. Smith, Paraceto Vibriosis in Juvenile Turbot *SCOPHTHALMUS MAXIMUS*.

1977. Jour. Fish. Biol., 11, 355-361 (University of Stirling, Department of Biology and Unit of

<225> CONT.

Neuromuscular Pathology, Scotland: White Fish Authority, Marine Cultivation Unit, Ardeer, Argyll, Scotland)

An outbreak of an acute edematous disease characterized by orbital and abdominal swelling, and high mortality, in young turbot, was studied. The clinical and pathological picture was consistent with a circulatory toxemia principally affecting the heart, orbit and kidney. *VIBRIO ANGUILLOMORBUS*, virtually identical with type strain BCY86, was isolated in pure culture from all organs of all fish. Therapy was only marginally successful using antibiotics but in a small group subjected to temperature reduction below 10 C, losses were reduced from 70% to 5% compared with the controls. (Auth)

<226>

Boraszewicz, L., Survival of Carp Fry Starving in Water of Various Temperature.

1978. *Pol. Wodn. Ser. B Rybnictwo (Pol.)*, 96, 45-46 (Not given)

Survival of starving three- and ten-day old carp larvae held at ambient temperatures of 19 to 23 C and at constant temperatures of 25, 27, 30, and 32 C were compared. Survival rate decreased with an increase of temperature from 19 to 30 C. Survival rates were similar at 30 and 32 C. (ST)

<227>

Houde, E.D., Abundance and Potential Yield of the Pond Herring, *ETHEUS TYPES*, and Aspects of Its Early Life History in the Eastern Gulf of Mexico.

1977. *Fish. Bull.*, 75, 61-89 (University of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami, FL)

Spawning of round herring in the eastern Gulf of Mexico occurred from mid-October through May where depths ranged from 30 to 200 m, surface temperatures from 19.6 to 26.9 C, and surface salinities from 34.5 to 36.5 ppt. A major spawning area was present 150 km from Tampa Bay, Fla. (ST)

<228>

Houde, E.D., Abundance and Potential Yield of the Scaled Sardine, *HAEMULUS JAGUANA*, and Aspects of Its Early Life History in the Eastern Gulf of Mexico.

1977. *Fish. Bull.*, 75, 613-628 (University of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami, FL)

Eggs and larvae of the scaled sardine, *HAEMULUS JAGUANA*, were collected in 1971-1978 from the eastern Gulf of Mexico to determine spawning seasons, spawning areas, adult biomass, and fisheries potential. Aspects of the early life history of the species also were studied. Spawning occurred from January to September, but was most intense from May to August, when surface temperatures ranged from 20.8 to 30.7 C and surface salinities were 29.9 to 36.9 ppt. All spawning occurred between the coast and the 30-m depth contour, mostly within 50 km of the coast. (Auth) (ST)

<229>

Houde, E.D., Abundance and Potential Yield of the Atlantic Thread Herring, *OPISTHOGNATHUS OGLINUS*, and Aspects of Its Early Life History in the Eastern

Gulf of Mexico.

1977. *Fish. Bull.*, 75, 493-512 (University of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami, FL)

Spawning of the Atlantic thread herring (*OPISTHOGNATHUS OGLINUS*) in the eastern Gulf of Mexico occurred from February to September. Spawning was most intense from April through August, when surface temperatures were 22.5 to 30.3 C and surface salinities ranged from 32.0 to 36.8 ppt. (ST)

<230>

Redden, P.L., Thermal Effluent and the Distribution and Abundance of Benthos in Keweenaw Reservoir.

1976. *Proc. 28th Ann. Meeting N. Amer. Benthol. Soc. held in La Crosse, Wisconsin, March 20-26, 1976* (U.S. Fish and Wildlife Service, Southeast Reservoir Investigations, Clemson, SC)

The distribution and relative abundance of benthos in relation to the heated effluent discharged into Keweenaw Reservoir is described. The benthos was numerically dominated by oligochaetes (52%), Chironomids (30%), and *CHAUDRONUS PUNCTIPENNIS* (6%). Of the 10 species of oligochaete species, *naids* predominated and were most abundant from 0 to 10 m. Twenty-four of 64 identified species of chironomids were common. Emergence of chironomid species occurring within the plume was hastened by two to three weeks. (ST)

<231>

Ignatiev, A.V., E.V. Krasnov, and V.E. Sheikus, Study of Growth Temperature Conditions of Scallops by Oxygen Isotope Ratios of their Shells.

1976. *Viol. Morya (USSR)*, 5, 62-68 (Academy of Sciences of the USSR, Laboratory of Paleontology, Institute of Marine Biology, Far East Science Center, Vladivostok, USSR)

Catogenetic dynamics of oxygen isotopes was investigated in agreement with the shell growth of *PATINOPECTEN YESSOENSIS*, *CHLAMYPS SWIFTI*, and *CHLAMYPS FABREI*. Age, annual increases and seasonal growth rates have been estimated for these mollusks. The temperatures of their growth were determined by oxygen-18. The upper and lower growth temperatures were 17.6 to 0.0 C for *PATINOPECTEN YESSOENSIS*, 24.2 to 4.6 C for *CHLAMYPS SWIFTI*, and 33.3 to 17.4 C for *CHLAMYPS FABREI*. The maximal growth rates were fixed at 8 to 12 C for *CH. SWIFTI*, and 12 to 16 C for *P. YESSOENSIS*. (Auth) (NO)

<232>

Ingram, B.B., and C.E. Jenner, Influence of Photoperiod and Temperature on Developmental Time and Number of Molts in Nymphs of Two Species of Odonata.

1976. *Can. Jour. Zool.*, 54, 2033-2045 (Clemson University, Department of Zoology, Clemson, SC; University of North Carolina, Department of Zoology, Chapel Hill, NC)

Nymphs of the damselflies *STALLAGNA PACIFICI* and *STALLAGNA ASPERSUM* were collected in North Carolina from August to , and subjected to 11- and 14-h photoperiods at 16 and 21 C. Development was generally completed more rapidly under long-day conditions. Under all day-length and temperature regimes, developmental time from

<232>

<232> CONT.

the middle instars to emergence decreased from a maximum for those nymphs collected in August to a minimum for those collected in March. The two species had similar developmental times under long photoperiods at 21 C; short photoperiods, however, were more inhibitory to the growth of *E. HUGERI* than to *E. ASPERSUM*. The photoperiodic responses of *E. HUGERI* were similar at both temperatures, the developmental times being only slightly slower at 16 C. In contrast, nymphs of *E. ASPERSUM* reared at 16 C showed no photoperiodic response. In both species, diapause or prolonged development occurred primarily in the two instars before the final, but not in the final itself. Extra molts usually accompanied slow developmental times in both species, regardless of photoperiod. The incidence of extra molting was greatest under conditions combining high temperature and short daylength. Extra molts were apparently common in field populations of *E. ASPERSUM*, but were rare in those of *E. HUGERI*. (Auth)

<233>

Isaacs, P.A., Theoretical Consideration of the Cause of Gas-Bubble Disease in Fish in a Heated Effluent.

1977. N.Y. Fish & Game Jour., 24, 95 (New York State Public Service Commission)

The probable causes of gas bubble disease in fish are discussed. It is suggested that gas supersaturation is a necessary condition for occurrence of the disease, but that the disease is triggered by cold stress. The author notes that all reported incidents of gas-bubble disease at thermal power stations have occurred in the winter when the possibility of cold stress existed. Desaturatory failure in cold-stressed fish is documented. (ST)

<234>

Jackin, E., G. Morrison, and P. Steele, Effects of Environmental Factors on Radiocesium Uptake by Four Species of Marine Bivalves.

1977. Marine Biol. (W. Ger.), 40, 303-308 (Environmental Protection Agency, Environmental Research Laboratory, Narragansett, RI)

Temperature, salinity, bottom-sediment type, and zinc concentration all influenced Cd uptake by 4 marine bivalves (*MYA AENEARIA*, *MYTILUS EDULIS*, *MULINIA LATERALIS* and *MACULA PROLATA*) in short-term static assay systems using ^{109}Cd as a tracer. The experimental system consisted of aquaria containing 10 l of seawater maintained under controlled light and temperature conditions. The water contained either 5 or 20 $\mu\text{g/l}$ Cd and tracer. Distribution and kinetics of the metal were monitored in the water column and organisms. The results demonstrate that Cd uptake rates differed widely among the organisms tested. An increase in temperature increased Cd uptake rate by all test organisms. A decrease in salinity increased Cd uptake by all organisms tested. The presence of bottom sediment depressed Cd accumulation in some benthic animals. Zinc in concentrations of 0.5 $\mu\text{g/l}$ substantially decreased Cd uptake by *MYTILUS EDULIS* and *MULINIA LATERALIS*. It is suggested that all important species and environmental variables be considered when studying heavy-metal uptake by marine organisms or when establishing water-quality criteria. (Auth)

<235>

Jacobs, R., and O. Lind, The Combined Relationship of Temperature and Molybdenum Concentration to Nitrogen Fixation by *ANABENA CYLINDRICA*.

1977. Microbiol. Soc. L., 3, 205-217 (Baylor University, Institute of Environmental Studies and Department of Biology, Waco, TX)

The joint effects of growth temperature, incubation temperature, and molybdenum concentration on the nitrogen fixation rate of *ANABENA CYLINDRICA* were determined using the acetylene-reduction technique. The nitrogen-fixation response to increased molybdenum concentration varied among three growth temperatures (15, 23, and 30 C). The pattern of rate change was similar within a growth temperature but increased overall in magnitude with the three incubation temperatures (also 15, 23, and 30 C). The maximum rate of nitrogen fixation occurred at 30 C regardless of previous growth temperature. The minimum molybdenum concentration necessary to yield substantial acetylene reduction varied with growth temperature: at 15 C, 15 $\mu\text{g/l}$ was effective; at 23 C, less than 5 $\mu\text{g/l}$ was effective; and at 30 C, 50 $\mu\text{g/l}$ was effective. At all three growth temperatures, increases in molybdenum concentration above the minimum effective concentration produced increases in acetylene reduction. However, at higher molybdenum concentrations inhibition of nitrogen fixation occurred. (Auth)

<236>

Jacobson, S.S., Aquatic Behavior, Dominance and Territoriality in the American Lobster, *NEBORA AMERICANA*.

1977. Ph.D. Thesis, Boston University Graduate School (Boston University Graduate School, Boston, MA)

In January lobsters and other species characteristic of Cape Cod subtidal habitats were established in two aquaria receiving seawater. After six months of observation, the incoming seawater was slowly heated to 20 C over a four week period, and returned to ambient temperature over an equal period. Nocturnal activity levels were similar in both tanks through June 27, but diverged thereafter. In both tanks, activity during the period of artificial heating remained at a level similar to previous weeks. (ST)

<237>

Janicki, A.J., and J. DeCosta, The Effect of Temperature and Age Structure on P/B for *BOSSINA LONGIROSTRIS* in a Small Independent.

1977. Hydrobiologia (Den.), 56, 11-16 (West Virginia University, Biology Department, Morgantown, WV)

The relationships between temperature, the age structure, and daily production/biomass (P/B) ratios for *BOSSINA LONGIROSTRIS* are examined. Temperature is the single most important factor affecting the daily P/B, while also having an indirect influence on the age structure. The rate of change of the daily P/B with temperature is nearly identical to the rate predicted by the 'normal' Krogh curve. (Auth)

<238>

Jeffries, R.P., and R.C. Johnson, II, Petroleum,

<238> C997.

Temperature, and Toxicants: Examples of Suspected Responses by Plankton and Benthos on the Continental Shelf.

1976. University of Rhode Island Marine Postscript 49: In "Sanowitz, B. (Ed.), Effects of Energy Related Activities on the Atlantic Continental Shelf. Brookhaven National Laboratory, Upton, NY (University of Rhode Island, Graduate School of Oceanography, Kingston, RI)

Cross population changes carefully enumerated over time in natural communities of the New York Bight and nearby areas are examined in order to gain an understanding of sensitivity within natural systems. The effect of energy-related activities, such as temperature increases and petroleum discharges, on copepods is reviewed. The collapse and rapid recovery of a planktonic community is documented. It is generalized that for open-coastal areas, the direct effect of energy-related activities on copepod populations is at present not a concern except for short-term effects seen only at discharge points. Lasting damage to the benthos, however, is a concern. The catch of winter flounder (*PSEUDOPLUTERUS VERNICATUS*) in Narragansett Bay in relation to subtle climatic change (temperature), an interaction possibly mediated through the plankton, is given as an example of small-scale environmental changes having cumulative effects that are enhanced by ecosystem processes. (ST)

<239>

Jensen, L.O. (Ed.), Third National Workshop on Entrapment and Impingement. Section 316(h) -- Research and Compliance.

1977. Ecological Analysts, Inc., Melville, NY (Ecological Analysts, Inc., Melville, NY)

Power plant impact was assessed at the individual level, focusing on entrapment and impingement phenomena. The volume is an information resource for identification of completed and ongoing entrapment and impingement-related research and the data and results produced. Four papers dealing with temperature effects were selected and abstracted individually for the data base. (ST)

<240>

Jebbing, R., D. Guyther, and D.J. Grove, Some Effects of Temperature, Meal Size and Body Weight on Gastric Evacuation Time in the Dab, *LIMANDA LIMANDA* (L).

1977. Jour. Fish Biol., 10, 291-298 (Marine Science Laboratories, Rosal Bridge, Anglesey, Wales, United Kingdom)

Gastric emptying time in the dab, *LIMANDA LIMANDA*, was studied using an X-ray technique. The addition of 25% barium sulphate to a test meal did not significantly affect the transit time. Lowering the experimental temperature from 16.0 to 8.5 C markedly decreased gastric evacuation time. An increase in ration size led to an increase in the time required to empty the stomach and also to increase the amount of food digested per unit of time. For any given ration size, expressed as percent body weight, the larger the animal the longer is the time required for evacuation of that meal. It is suggested that the food intake per day, as a percentage of live body weight, will be smaller for larger *L. LIMANDA* in the wild. (Auth) (ST)

<241>

Johnson, C.B., Observations on Growth, Breeding, and Fry Survival of *GAMBUSIA AFFINIS AFFINIS* (Pisces: Poeciliidae) under Artificial Rearing Conditions.

1976. Proc. Pap. Ann. Conf. Calif. Mosquito Control Assoc., 34, 48-51 (University of California, Division of Biological Control, Albany, CA)

Growth of mosquitofish (*GAMBUSIA AFFINIS*) was slightly greater in a pool maintained at a daylight temperature range of 18.1 to 29.1 C than in one maintained at 18.1 to 23.9 C, but the difference was not significant. Growth was rapid in both pools with some of the fish born in May reaching sexual maturity by mid-June. (ST)

<242>

Johnson, D.L., A Comparison of Florida and Northern Largemouth Bass in Missouri.

1976. Ph.D. Thesis, University of Missouri (University of Missouri, Columbia, MO)

Survival and growth of Florida and northern bass subspecies in Missouri was compared. Northern bass had a significantly greater weight gain than Florida bass during both years of the study. Length increments were similar during one year of study and greater for northern bass during the other. Confinement in cages greatly reduced growth in both species. Survival in small ponds was 65% for northern bass fingerlings; Florida bass survival was 4%. In laboratory temperature tolerance tests, survival of Florida bass was 0% at 4 C while survival of northern bass was about 86%. In further laboratory tests, gradual cooling of 1 C/day from 15 C to 4 C resulted in 0% survival of Florida bass and 95% survival of northern bass. (ST)

<243>

Johnson, L.L., and J.L. Shick, Effects of Fluctuating Temperature and Immersion on Asexual Reproduction in the Intertidal Sea Anemone *HALIPLASSELLA LUCIAE* (Verrill) in Laboratory Culture.

1977. Jour. Exp. Mar. Biol. Ecol. (Neth.), 20, 181-189 (University of Maine, Department of Zoology, Orono, ME)

HALIPLASSELLA LUCIAE was maintained in laboratory cultures according to a 2 x 2 factorial design. The factors were 1) constant immersion or continuously alternating periods of 6 hr immersion followed by 6 hr emersion, and 2) 18 C constant temperature or 24 C during one 6-hr period each day and 18 C for the remaining 18 hr. Significantly different numbers of fissures were observed between both the two immersion and two temperature conditions, with more individuals at the fluctuating temperature. (Auth) (ST)

<244>

Johnson, R.S., Association of Allozymes and Temperatures in the Crested Blenny *ADOPLANCHUS PSEUDOPHSCHEUS*.

1977. Marine Biol. (N. Ger.), 41, 187-192 (University of Western Australia, Department of Zoology, Nedlands, Western Australia)

<284> (1977)

The crested bleamy *ABUPLANCHUS PUGNATIPES* occurs intertidally in the Puget Sound area, where it is subjected to substantial variation in temperature. A study of a polymorphic esterase in *A. PUGNATIPES* revealed a latitudinal cline and a correlation of allelic frequencies with summer water temperature. This finding agrees with previous results for a lactate dehydrogenase polymorphism in *A. PUGNATIPES*, suggesting a pervasive genetic adaptation to temperature in this species. For each of these enzymes, comparisons within and between two species of *ABUPLANCHUS* indicate an association between heterozygosity and temporal variability of the thermal environment. (Auth)

<285>

Johri, P.L., and S.L. Coles. Effects of Temperature on the Mortality and Growth of Hawaiian Reef Corals.

1977. Marine Biol. (U. Ger.), 43, 261-268 (Hawaii Institute of Marine Biology, Kaneohe, HI)

Three common species of Hawaiian reef corals, *POCYLLOPOSA DANICOWICIS* (L.), *POCYLLOPOSA YOUNGII* (Lamarck), and *POMIA SCUTARIA* (Lamarck), were grown in a temperature-regulated, continuous-flow sea water system. The skeletal growth optimum occurred near 24°C, coinciding with the natural summer ambient temperature in Hawaii, and was lowest at 21 to 22°C, representative Hawaiian winter ambient. Levels of approximately 32°C produced mortality within days. Prolonged exposure to temperatures of approximately 30°C eventually caused loss of photosynthetic pigment, increased mortality, and reduced calcification. Corals lived only 1 to 2 weeks at 30°C. The corals showed greater initial resistance at the lower lethal limit, but ultimately low temperature was more deleterious than high temperature. Results suggest that a decrease in the natural water temperature of Hawaiian reefs would be more harmful to corals than a temperature increase of the same magnitude. (Auth)

<286>

Jones, P.L., Factors Controlling Phytoplankton Production and Succession in a Highly Eutrophic Lake (Kinneko Bay, Lough Neagh) III. Interspecific Competition in Relation to Irradiance and Temperature.

1977. J. Ecol. (G.B.), 65, 579-586 (New University of Ulster, Limnology Laboratory, School of Biological and Environmental Studies, Coleraine, N. Ireland)

Different rates of respiration and different responses of respiration to temperature were observed for the diatom and blue-green alga dominating the phytoplankton populations in Kinneko Bay, Northern Ireland at different times. A growth-prediction model derived from data on the photosynthetic and respiratory rates under varying conditions of irradiance and temperature indicated that species dominance was apparently largely determined by differences in the light attenuation properties of their cells and by the relative advantages conferred at different temperatures by their dissimilar respiration responses. (PFC)

<287>

Jorgensen, S.E., A Model of Fish Growth.

1976. Ecological Modelling, 2, 303-313 (Danmarks Farmaceutiske Højskole, Universitetsparken, Copenhagen, Denmark)

A fish model based upon mass balances is set up. Several of the parameters have been determined by experiment. The remaining parameters are based upon literature values and it was not necessary to find any parameter by calibration. The model was validated with a completely acceptable result. The model includes equations giving the fish growth, the production of ammonia and organic matter, the oxygen consumption, and the influence of the temperature. The model can be used for management of fish farms and as a submodel for a total aquatic system. (Auth)

<288>

Kaschowski, B., and S.J. Zeigler. The Diurnal Vertical Migration of Noctile Phytoplankton through Temperature Gradients.

1977. Limnol. & Oceanogr., 22, 148-151 (University of Texas Marine Science Institute, Port Aransas Marine Science Laboratory, Port Aransas, TX)

In experiments in a 10 m, thermally stratified seawater column, *CACODONIA REX* crossed a 5°C gradient during a 6-h diurnal vertical migration, while *IMPEDISUM CASTRUM* remained in the upper, isothermal, part of the water column during a 1-h diurnal vertical migration. The experiments confirm that some marine dinoflagellates have access to subthermocline nutrient pools. These same species may also exhibit spatial and temporal patchiness in response to countercurrent flow across the thermocline. (Auth)

<289>

Kaschowski, B., Daily, Seasonal and Migratory Locomotor Activity Patterns, Migratory Zeitgebers and Ecology of the Spiny Lobster, *PALINURUS ARGUS* (Decapoda, Scyllaridae).

1976. Ph.D. Thesis, The Florida State University; Dissertation Abstracts, 17, 4820-2 (Florida State University, Tallahassee, FL)

Field and laboratory studies on the autumnal mass migration of the spiny lobster, *PALINURUS ARGUS*, were conducted over a period of four years. The hypothesis that a sharp drop in temperature serves as the environmental trigger for the mass migration was tested. Actograph and time-lapse photographic records of lobster behavior showed that all three major characteristics of mass migration (i.e., hyperactivity extending into daylight, massive continuous queuing, and directional orientation) occurred in association with temperature declines. This laboratory and field identification of a temperature stimulus as a sufficient (if not exclusive) trigger for mass migratory behavior in a benthic crustacean is unique to the literature. (HW)

<290>

Kardatzke, J., Hatching of Northern AEPES (Diptera - Culicidae) at Low Temperatures.

1977. Ann. Entomol. Soc. Amer., 70, 663-668 (University of Illinois at Urbana-Champaign, Department of Entomology, Urbana, IL)

Hatching of conditioned eggs of 13 species of nonmolt AEPES was related to the

<250> COPT.

temperatures at which they were hatched. Prime chemical reduction of the dissolved oxygen as the hatching stimulus, most species hatched better at or below 15 degree C. (Auth)

<251>

Kasorzak, K., The Effect of Heated Waters on *Chironomus tentans*.

1974. *Pol. Ecol. (TSSB)*, 22, 63-68 (Zahrad
Ziol. Bolacj, Institute Ecol. PAN, Poznan, Poland)

From observations on communities of oligochaete species, the progressive changes in their structure and composition, and the occurrence of certain species in Polish cooling reservoirs, it is concluded that these animals are important indicators of the degree of thermal pollution. (57)

<252>

Kays, C.R., Reproductive Biology of Rainbow and Brown Trout in a Geothermally Heated Stream: The Firehole River of Yellowstone National Park.

1977. *Trans. Amer. Fish. Soc.*, 106, 354-361 (Montana State University, Department of Biology, Bozeman, MT)

Geothermally heated waters discharged into the Firehole River increase downstream temperatures by about 10.5 C, and affect the reproduction of the resident brown and rainbow trout. Gross and histological comparisons of gonadal development and annual maturation cycles between trout from an upstream, unheated station and a station downstream in the warmest part of the river indicate that the two species respond differently to the heating of the stream. Brown trout from the unheated station reproduced well, with all adults examined having normally maturing gonads and young of the year abundant in the area by early summer. However, those from the warm station had poor reproductive success, with a low percentage of adults having normally maturing gonads, preponderant degeneration of ova in some females, and very few young of the year evident in the area. Rainbow trout at the warm station reproduced successfully and had changed their annual spawning time from spring to fall. In the warm, fertile waters of the Firehole River, this early spawning not only avoided the high temperatures that would prevail during the spring and early summer, but also enabled the young to grow through the winter. (Auth)

<253>

Kays, C.R., L.R. Keeding, and D.E. Burkhalter, Use of a Cold-Water Refuge by Rainbow and Brown Trout in a Geothermally Heated Stream.

1977. *Progressive Fish-Culturist*, 39, 37-39 (Montana State University, Department of Biology, Bozeman, MT)

During the warmest part of the summer, rainbow trout (*Salmo gairdneri*) and brown trout (*Salmo trutta*) from Firehole River, Wyoming, concentrated in Sentinel Creek, the only cold-water tributary in the lower, warmest part of the river. These movements into the creek appeared to be related to mean daily temperatures exceeding 20 C or maximum daily temperatures exceeding 25 C. Summer temperatures in Sentinel Creek consistently averaged 6 to 10 C lower than those of the geothermally heated Firehole River. (57)

<254>

Keller, V.A., The Drift and Its Ecological Significance. Experimental Investigation on *ECYTOMUS VENTOSUS* (Fabr.) in a Stream Model.

1975. *Schweiz. Zeits. Hydrol. (Switz.)*, 37, 294-331 (Eidg. Technische Hochschule Zurich, Institut für Gewässerschutz und Wassertechnologie, Dübendorf, Switzerland)

With one-factor experiments, the drift of larvae of *ECYTOMUS VENTOSUS* was analysed in a stream model. The distances travelled by drifting animals as a function of water velocity were determined, as well as some drift rhythms. Drift-inducing factors are principally scarcity of food (lack of periphyton) and movement of substrate. Induction of drift by small water velocities can be caused by insufficient oxygen supply. The typical drift minimum during the final larval instar is said to be caused by a pseudo-pupal stage. After temperature shocks of plus or minus 5 C respectively the animals acclimate within two days. An increase in temperature induced a decrease in drift rates and vice versa. Sex, predation and competition do not influence drift. The mean flight range of the imagoes (flight-mill) is 2.794 m, the maximum upstream movement of the larvae 100 m/24 h. (Auth)

<255>

Kemp, W.R., Energy Analysis and Ecological Evaluation of a Coastal Power Plant.

1977. Ph.D. Thesis, University of Florida (University of Florida, Gainesville, FL)

The energy basis and ecological interactions of a coastal power plant near Crystal River, Florida were evaluated at three levels: the power plant region, affected coastal ecosystems, and the ecosystems of the cooling water canals at the interface between estuary and power plant. Extraneous mortalities and productivity inhibition in the discharge area were documented and evaluated in coal equivalent energy units. A simulation model of the estuarine ecosystem receiving thermal wastes was used to predict the effects of adding a third generating unit. A parabolic relationship between temperature and productivity, derived as a simplification of theoretically based functions, produced model behavior which closely matched field data. A model was also developed to describe the power plant's effects on stocks of estuarine organisms in terms of equivalent amounts of primary productivity needed to support these organisms. The cooling water canals were observed to be viable interface ecosystems characterized by high productivities and large standing stocks of animals. (57)

<256>

Kennish, R.J., Effects of Thermal Discharges on Mortality of *HEMICHANIA HEMICHANIA* in Barnegat Bay, New Jersey.

1977. Ph.D. Thesis, Rutgers University (Rutgers University, The State University of New Jersey, New Brunswick, NJ)

Thermal discharges from the Oyster Creek Nuclear Generating Station did not affect mortality in natural populations of *HEMICHANIA HEMICHANIA* in Barnegat Bay, New Jersey. The analyses of daily growth increments and disturbance bands in shell cross-sections of death assemblages of the

<254> CONT.

clams collected at the mouth of Oyster Creek (strongly affected by thermal discharges) and at three control sites (unaffected by thermal discharges) in the bay indicated that similar mortality patterns exist in all assemblages. This was revealed by mortality rate curves, survivorship curves, and life tables which are nearly identical for each assemblage. (ST)

<257>

Vennish, V.J., Monitoring Thermal Discharges: A Natural Method.

1976. *Waterwater Naturalist*, 9, 9-17 (Queens University, Department of Zoology, New Brunswick, NJ)

Breaks in daily growth of the clam *PERCENYRIA PERCENYRIA* due to thermal shocks were most numerous in clams closest to the mouth of the Oyster Creek Generating Station and decreased sharply in all directions away from the plant. The use of thermal-shock breaks as an ecological monitoring tool is suggested. (ST)

<258>

Vennish, V.J., Effects of Thermal Discharges on Mortality of *PERCENYRIA PERCENYRIA* in Barnegat Bay, New Jersey (Abstract only).

1977. *Jour. Paleontol.*, 52 (Suppl. 2), 17 (Rutgers University, Department of Geology and the Marine Sciences Center, New Brunswick, NJ)

Thermal discharges from the Oyster Creek Nuclear Generating Station do not affect mortality in natural populations of *PERCENYRIA PERCENYRIA* in Barnegat Bay, New Jersey. The analysis of daily growth increments and disturbance bands in shell cross-sections of more than 300 specimens from death assemblages collected from the mouth of Oyster Creek (strongly affected by thermal discharges) and from three control sites (unaffected by thermal discharges) in the bay indicate that similar mortality patterns exist in all assemblages. Statistically, there is no significant difference in the season of death and the absolute age and size at the time of death for individuals sampled from these four sites. This is revealed graphically by size-frequency and age-frequency histograms which are nearly identical for each assemblage. Each death assemblage is the result of natural rather than census mortality, as is evidenced by its corresponding death-frequency histogram which shows that individuals died at different times of the year. The peak frequency of stress and death in populations of the polychaete occurs in the summer and winter when environmental conditions are at extremes. (Auth)

<259>

Versting, K., and B. van der Leede, The Use of the Coulter Counter for Measuring the Feeding Rates of *DAPHNIA MAGNA*.

1976. *Hydrobiologia*, 89, 233-237 (University of Amsterdam, Laboratory of Animal Physiology, Netherlands)

Maximum filtering and rates of *DAPHNIA MAGNA*, fed *CHLORELLA VULGARIS*, were above 22°C. The feeding rate was maximal between 22 and 26°C and the filtering rate had its maximum at a slightly higher temperature. (ST)

<263>

Phalanski, W., and J.P. Besson, Evolution of the Planktonic Pigment Content of the River Loire between Sempierre-en-Burly and Montmorsan.

1977. Cah. Lab. Hydrobiol. Montmorsan (Fr.), 5, 71-84 (Electricite de France, Direction des Etudes et Recherches, Department L.A.A., Chateau, France; Institut d'Ecologie Appliquee, Orleans, France)

The chlorophyll and carotenoid content of Loire water has been measured once a month between 1973 April to November in ten sampling stations on the river Loire between Sempierre-en-Burly and Montmorsan (236 km). Very high amounts of planktonic pigments (above 100 µg/l of chlorophyll a) were observed during summer. The evolution of chlorophyll and ratio $B_{0.30}/B_{0.675}$ in this stretch of the river is described. The ratio of the optical density of acetone extracts at 0.30 µm to that at 0.675 µm ($B_{0.30}/B_{0.675}$) is used as an index of the proportion of phaeophytin. This ratio was found to decrease in summer from Sempierre-en-Burly to Montmorsan. The effect of heated effluent of Saint-Laurent-des-Bois nuclear power station on the phytoplankton biomass is discussed. It appears that the heated discharges do not induce a large variation in the planktonic biomass downstream from the power plant. (Auth)

<261>

King, I.N., Respiration in Three Species of the Genus *GLADIOFERUS* (Copepoda: Calanoida).

1976. *Aust. Jour. Mar. Freshwater Res.*, 27, 529-532 (Monash University, Zoology Department, Clayton, Victoria, Australia)

Respiration was the same for both *GLADIOFERUS PECTINATUS* and *GLADIOFERUS SPIRIGOSUS* at 10 and 15°C and at the same salinity. (ST)

<262>

King, R.G., The Effects of Heated Water Discharge on Zooplankton in a 4,500 Acre Missouri Reservoir.

1976. M.S. Thesis, University of Missouri (University of Missouri, Columbia, MO)

Zooplankton samples were collected with a Clarke-Bumpus plankton sampler from a 4500-acre cooling reservoir to determine if there were any effects on zooplankton of waste heat produced by two steam-electric generators. Standing crop, species composition and diversity indices were used as indicators of effect. Water quality and chlorophyll a data were collected to aid in the interpretation of differences among stations. The thermal discharge elevated the water temperature in the receiving arm of the reservoir a mean of 1.86 to 2.09°C above ambient. Greater abundance of larval copepods and cladocerans was evident in the heated water arm when compared with the two control stations. The rotifers were more abundant in the control arm, but the heated water station had similar rotifer densities when compared to the other control station. The species composition was similar at all stations, and there were no major differences in the calculated diversity values. The population pulses were generally synchronous among stations. The differences observed among stations cannot be attributed to temperature differences alone. It is suggested that turbidity and wind action are

<262> CONT.

important contributing factors. The heated water did not drastically reduce the abundance of the zooplankton. The rapid heat rejection which occurs due to the placement and length of the discharge canal minimizes the effect of the heated water effluent. (Auth)

<263>

Kirby-Smith, W.U., and R.T. Parker, Suspension-Feeding Aquaculture Systems: Effects of Phytoplankton Concentration and Temperature on Growth of the Bay Scallop.

1976. Aquaculture (Beth.), 3, 135-145 (Bahr University Marine Laboratory, Beaufort, NC)

The growth rate of the bay scallop *ARGOPECTEN LINCOLNII* was studied in relation to temperature and phytoplankton concentration. At 10 C growth was slow but constant throughout the series. At 16 C maximum growth was approximately 3 times the rate at 10 C. At 22 C growth rates of the first 5 animals in the series were equal; however, there was a rapid drop to near zero growth shown by the last animal in the series. At 24 C a similar drop in growth rate occurred beginning with the first animal in the series. The decreased growth rate at 22 and 24 C was directly related to chlorophyll-a concentration. Results suggest that seasonal variations in phytoplankton concentration do not influence the growth rate of scallops in their natural habitat. Increasing the concentration of phytoplankton above natural levels did not result in increased growth rates while decreasing the phytoplankton concentration resulted in a decrease in growth rate of the scallops. A mathematical model of scallop growth rate as a function of phytoplankton concentration is proposed as a tool for comparing the functioning of different suspension feeders in aquaculture systems. (Auth) (RM)

<264>

Kitchell, J.F., and D.J. Stewart, Applications of a Bioenergetics Model to Yellow Perch (*PERCA FLAVESCENS*) and Walleye (*STIZOSTEDION VITREUM*).

1977. Jour. Fish. Res. Bd. Can., 34, 1922-1935 (University of Wisconsin, Laboratory of Limnology, Madison, WI)

A simple energy budget equation is developed to yield a bioenergetics model designed to simulate fish growth. Parameters for the model are estimated from the literature for application to yellow perch (*PERCA FLAVESCENS*) and walleye (*STIZOSTEDION VITREUM*). Simulations are presented that demonstrate model output as functions of body size, activity level, ration level, food quality, and environmental temperature. Sensitivity analyses identify the importance of food consumption, activity, and excretion as biological processes represented in the parameters. On the basis of temperature conditions in selected lakes and specified feeding levels, simulations are presented to quantify the importance of year-to-year variation of temperature in determining growth. In heterothermal systems, temperature selection by percids can have a significant effect on growth. For walleye on fixed rations, annual growth can vary from zero to twofold increments due entirely to differences in summer temperatures. Variations in food quality have lesser effects. (Auth)

<265>

Ho, S.C., Effects of Temperature Acclimation on Infection of *ECHEMOCYPRIDUS SINENSIS* (Monogene: Tenthosomatidae) from Oysters to Rittens.

1977. Can. Jour. Zool., 55, 1129-1132 (University of Hong Kong, Department of Zoology, Hong Kong, China)

About 700 oysters (*CRASSOSTREA GIGAS*) were acclimated in the laboratory to 33, 28, 20-24, 15, and 5 C. Third-stage larvae of *ECHEMOCYPRIDUS SINENSIS* Ho, 1975 recovered from the tissues of these molluscs were fed to 31 rittens which were examined 16 hr postinfection. The number of successful infections produced and the number of worms located in tissues of rittens were found to be directly related to the ambient temperature of the molluscan host. Substantial infections were obtained only with worms from 33 and 28 C. Worms could be effectively killed if the infected oysters were deep fried with batter for 7 sec or dipped in boiling water for 30 sec. The possibility of finding other monogeneids of polychaetes similar to *E. SINENSIS* in the tropics is briefly discussed. (Auth)

<266>

Koch, D.L., Life History Information on the Cut-ni Lakeshopper (*CHASSISTES CUJUS*, Cope 1883) in Pyramid Lake, Nevada.

1976. Biol. Soc., Nev. Occas. Papers, 80, 1-12 (Desert Research Institute, Center for Water Resources Research, Reno, NV)

Hatching time for eggs of the Cut-ni Lakeshopper, *CHASSISTES CUJUS*, varied according to the water temperature. Water from Haris Crabbie Creek within the Pyramid Lake Basin provided increasing mean temperatures as the season progressed, increasing from 10 C when the first eggs were fertilized and took 13 days to hatch. At 13 and 15.5 C, 11 and 6 days were required for hatching, respectively. (NFC)

<267>

Koelbl, G., New Data on Ascites in Carp.

1975. Oesterr. Fisch., 28, 69-72 (Bundesanst. Virusserchenbehoepf. Gesundheit, Vienna, Austria)

At water temperatures above 15 C controlled virus cross-infection and auto-inoculation takes place if young carp are exposed to mature fish which are potential carriers of the ascites virus. Immunization can also be effected by inoculation of the fish in summer or early fall while water temperatures are above 15 C. (ST)

<268>

Kohler, A.C., D.J. Faber, and W.J. McFarlane, Eggs, Larvae and Juveniles of Fishes from Plankton Collections in the Gulf of St. Lawrence during 1970-1971.

1976. Technical Report No. 605 (Department of the Environment, Fisheries and Marine Service Biological Station, St. Andrews, New Brunswick, Canada)

This report contains tabular data on abundance and distribution of 45 species or categories of fish eggs and larvae caught on stations spread throughout the Gulf of St. Lawrence, mainly south of the Laurentian

<768> CONT.

Channel, in May and August of 1976 and 1977. The various types of catching gear are indicated. Temperature and salinity data are given for each station as well as volumes of water strained by the nets. Length measurements of samples of some species of fish larvae and development of fish eggs are also included. Track charts for each cruise are shown. (Auth)

<769>

Tomoda, H., The Number of Segments and Body Length of *PLECOGLOSSUS ALTIVELIS* Fry in the Nagara River, Japan.

1977. Copeia, No. 3, 573-574 (Gifu College of Dentistry, Department of General Anatomy, Notani-cho, Notosu-gun, Gifu-ken, Japan)

The number of myotomes and standard length of newly hatched fry of the ayu, *PLECOGLOSSUS ALTIVELIS*, in the Nagara River were measured to determine the effects of water temperature during incubation. Fry hatched between September and December showed increasing number of myotomes as water temperature decreased. Eggs reared at different constant temperatures ranging from 10 to 25 C also produced young with vertebral numbers inversely associated with temperature. The intermediate season (November) and experimental temperature (20 C) produced longer fry than did earlier and later seasons or higher and lower temperatures. (RM)

<770>

Tomoda, H., Influence of Temperature on the Vertebral Number of the Ayu, *PLECOGLOSSUS ALTIVELIS*.

1977. Copeia, No. 3, 572-573 (Gifu College of Dentistry, Department of General Anatomy, Notani-cho, Notosu-gun, Gifu-ken, Japan)

Hatchability, duration of development, and vertebral number of *PLECOGLOSSUS ALTIVELIS* were studied in relation to reservoir water temperature (10 to 25 C) and experimental low temperature (6 C). Eggs incubated at 15 C took twice as long to hatch as did those maintained at 20 C. Few eggs hatched at 25 C and more than half of the larvae were humpbacked. About one-fifth of the larvae reared at 13 C had this deformity. (Optimal rearing temperatures are 15 to 20 C.) Eggs treated to low temperature in the first 24 hr after fertilization and subsequently held at 20 C took two days longer to hatch than did those treated at the same temperature four days after fertilization. More eggs (11.0%) hatched when cold stressed later than did those cold stressed early. Incubating newly fertilized eggs at 6 C for three days resulted in 85% mortality and after six days all were dead. Young ayu incubated at 20 C showed approximately two fewer vertebrae than eggs kept at 13 C, and approximately 1.6 more than those held at 25 C. Thus vertebral number varied inversely with temperature. Eggs treated to 6 C for 24 hr and reared at 20 C produced young with more vertebrae when they were cold stressed on the second and fourth days of incubation than when they were treated immediately after fertilization. (57)

<771>

Wootton, J.F., T.B. Baggett, P.V. Carline, R.E.P. Robinson, and H. "aglec, Factors Influencing Year-Class Strength of Percids: A Summary and a Model of Temperature Effects.

1977. Jour. Fish. Res. Bd. Can., 34, 1908-1909 (Case Western Reserve University, Cleveland, OH; Freshwater Biological Association, Ableside, England; Ohio Cooperative Fisheries Unit, Ohio State University, Columbus, OH; U.S.E.P.A., Monticello Ecological Research Station, Monticello, NY; Institute for Ichthyobiology and Fisheries, Kortova, Poland)

Factors regulating year-class strength in the period genera *STIZOSTEDION* and *PERCA* are summarized. Some index of water temperature regime correlates significantly with year-class strength of percids in many water bodies. Moderate synchrony of year-class strength is noted for walleye (*STIZOSTEDION VITREUM VITREUM*) in several lakes in North America. A probabilistic model is proposed to explain the basis of temperature dependence of year-class strength in percids, but tests of the model using Lake Erie data indicated that observed correlations between temperature and year-class strength of yellow perch (*PERCA FLAVESCENS*) and walleye may not be the result of direct effects of the temperature regime on survivorship of early life-history phases. (Auth)

<772>

Zeep, P.B.J., Plankton Investigations near Fleva Power Station.

1975. Verh. Intl. Ver. Limnol., 19, 2207-2213 (Not given)

Analyses of plankton samples collected over a 10 year period showed no correlation between water temperature and the number of species found or between water temperature and the relative abundance of the various species. Mechanical damage to colonies of the diatoms *ASTHINELLA FOWERSII* and *DIATOMA ELONGATUM* was minor. The increase in water temperature in the condenser at full load is 8 C. (57)

<773>

Kordylewska, A., The Developmental Disturbances of the Fresh-Water Snail *LIMNAEA STAGNALIS* (L.) after Treatment with Some Chemical and Physical Factors.

1975. Przegl. Zool., 19, 304-308 (Zaklad Zool. Systemat., Inst. Zool. JJ Krakow, Poland)

Many investigations showed that the embryos are more sensitive than the adults. In this article the effect of pulse treatment with azide, lithium chloride, heat shock, the interaction between lithium and heat shock treatment, centrifuging, and ultraviolet light on the development of the fresh-water snail *LIMNAEA STAGNALIS* is described. (Auth)

<774>

Krantz, G.E., and J.P. Morris, Culture of Pink Shrimp, *PENAEUS DUROSSINI* at the Turkey Point Experimental Mariculture Laboratory.

1976. Technical Bull. No. 36, 36 pp. (University of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami, FL)

Data from production hatchery culture attempts and pond 'grow-out' studies conducted at Turkey Point, Florida, were analyzed to determine biological and economic feasibility of growing pink shrimp, *PENAEUS DUROSSINI*, in Florida. Biological failure, human error, and mechanical equipment failure were important factors in survival of larval shrimp (ranging from 0.5 to 55% for nauplius to postlarval stages) while low oxygen

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levels, pond design problems, and low winter temperatures were related to survival of juvenile pink shrimp in ponds. Estimates of production costs indicated that greatest costs were labor for diatom production, capital investment, acquisition of gravid shrimp, and labor for harvest. Research areas for reduction of total market price were determined. (NPC)

<275>

Freder, P. G., The Ecology of the Ctenophore *PLEUROSIA LEIDYI* in Narragansett Bay.

1976. Ph.D. Thesis, 325 pp. (University of Rhode Island, Kingston, RI)

A dramatic biomass increase in mid-summer of the dominant ctenophore in Narragansett Bay, *PLEUROSIA LEIDYI*, took place. Biomass rose to a peak in late summer and declined sharply in autumn. Measurements made over three seasons showed that feeding rate (liters cleared/day) was independent of food concentration but was a function of both temperature and organism size. The weight specific daily feeding rate (liters/mg dry wt) ranged from about 0.01 for larger animals at 10 to 15 C to about 0.1 for smaller animals at 20 to 25 C. Respiration and excretion rates were measured for a variety of sizes of *P. LEIDYI* at temperatures from 10.1 to 20.5 C. Both were a direct linear function of animal weight and very temperature sensitive. Oxygen uptake ranged from 155 to 409 micrograms at 0/(g dry wt/day) and carbon dioxide release from 43 to 166 micro R. Elemental composition was detailed. A population dynamics model was developed from laboratory studies. (NPC)

<276>

Krkac, V., Dynamics of Populations and the Cycle of Reproductive and Neurosecretory Activity of the Species *PADII PEREGRINA* O. F. Muller (Gastropoda, Pulmonata) under Diverse Thermic Conditions. 3. Correlation of Reproductive and Neurosecretory Activity and Thermic Conditions of Life.

1976. Bull. Sci., Cons. Acad. Sci. Arts BVS Yougosl., Sect. A, 21, 77-78 (Zool. Zavod Prirodno-Matematichog Fakulteta, Zagreb, Yugoslavia)

Gametogenesis was studied histologically in the snail, *PADII PEREGRINA*, and under different temperature conditions. The succession of gametogenesis stages was retarded at 9 to 13 C compared with that at 17 and 20 C. (ST)

<277>

Krkac, V., Dynamic of Populations and the Cycle of Reproductive and Neurosecretory Activity of the Species *PADII PEREGRINA* O. F. Muller (Gastropoda, Pulmonata) under Diverse Thermic Conditions 2. Laboratory Investigations of Parameters Significant for the Dynamic of the Population.

1976. Bull. Sci., Cons. Acad. Sci. Arts BVS Yougosl., Sect. A, 21, 76-77 (Zool. Zavod Prirodno-Mat. Vd., Beograd, Zagreb, Yugoslavia)

In laboratory studies of the effects of temperature on egg development, number of eggs in the egg mass, growth of the shell, amount of egg-laying and lifetime of *PADII PEREGRINA*, temperatures of 27.1 to 28.2 C favored egg development compared to 10.0,

21.0, and 18.2 to 16.2 C although number of eggs was less. A rapid growth rate was favored by 29.5 and 29.8 C only in the first two months, shortening the life span compared to controls cultivated at 20.5 and 20.3 C. Growth of the young was slowed by low average temperatures of 11.9, 10.1 and 15.8 C, but lifespan was increased considerably. (NPC)

<278>

Kroner, G., J. Benrucker, D. Hilla, B. Borgan, L. Behrja, and J. Young, Invertebrate Distribution along a Thermal Gradient in a Power Plant Cooling Lake.

1976. Proc. 20th Ann. Meeting N. Amer. Benthol. Soc. held at La Crosse, Wisconsin, March 28-29, 1976 (University of Wisconsin, Laboratory of Limnology, Madison, WI)

The abundance and distribution of aquatic macroinvertebrates along a thermal gradient in a power plant cooling lake near Portage, Wisconsin were studied. Population changes following plant shutdown were also studied. Catches of chironomids were greatest in the warmer portion of the gradient. *HYALELLA AZTECA* was confined to the coldest stations. *CHEUS* populations exhibited two modes of abundance which was attributed to the presence of more than one species in the lake. Following plant shutdown a lake-wide decline in catch of chironomids occurred, and *HYALELLA* catches increased. Dispersal rates were calculated for these two species. Some observations were made on the interaction of temperature and predation by fish in determining the distribution and abundance of the taxa studied. (ST)

<279>

Krywler, E. L., *CRABON NIGRICAUDA* and *CRABON FRANCISCORUM* in Yaquina Bay, Oregon (Abstract only).

1975. Proc. Natl. Shellfish. Assn., 65, 9 (Oregon State University, School of Oceanography, Corvallis, OR)

The distribution, reproduction, and growth of *CRABON NIGRICAUDA* and *CRABON FRANCISCORUM* in Yaquina Bay, Oregon are described from the examination of 8,244 *C. NIGRICAUDA* and 4,564 *C. FRANCISCORUM* collected by beam trawl at bi-monthly intervals during December 1970 through February 1972. The distribution of *C. NIGRICAUDA* and *C. FRANCISCORUM* was generally related to water temperature and salinity. Both species exhibited a wide tolerance for temperature (5.2 to 16.5 C for *C. NIGRICAUDA*; 5.3 to 21.5 C for *C. FRANCISCORUM*) and salinity (less than 79 ppt for *C. FRANCISCORUM*). Between species, *C. NIGRICAUDA* displayed a preference for cooler temperature and higher salinity than did *C. FRANCISCORUM*. Within species, variations in response to temperature and salinity changes were observed between size and sex groupings. The spawning season for both species was from December to mid-August. *C. FRANCISCORUM* and *C. NIGRICAUDA* ovigerous females disappeared from the Bay in August and September, respectively. Berried females were collected in waters ranging from 6.8 to 12.9 C for *C. NIGRICAUDA* and 6.8 to 19.2 C for *C. FRANCISCORUM*, and with salinity of less than 25.4 ppt for *C. NIGRICAUDA* and less than 10.6 ppt for *C. FRANCISCORUM*. (both) (ST)

<280>

Kuznetsov, V. L., The Reproduction, Distribution and Growth of Juveniles of Non-Commercial Fish

<291> CONT.

Species in Sviyazh Bay, Kuybyshev Reservoir.

1974. Jour. Ichthyol., 16, 746-756 (Kuzen State University, Department of Vertebrate Zoology, TSSA)

The places, times and conditions of spawning, the distribution and growth of juvenile dace, *LEUCISCUS LEUCISCUS*, the perch, *PERCA PERCA*, the quagga, *COBIO COBIO*, the spiny loach, *COBITIS TAENIA*, and the Baltic lake smelt, *OSMUNDUS EPERLANUS* were studied. The reproductive efficiency of the dace, "perch" and quagga was evaluated in relation to surface level and temperature regimes. Spawning of dace and quagga was initiated with the lowering of the water level, i.e., with the appearance of a current. Spawning took place as a rule at higher temperatures than noted by a number of authors under river conditions. Also, dace and quagga have begun to use a more varied substrate for spawning. In the quagga, spawning began at a water temperature of above 15 C and in the presence of even a weak current. The coincidence of these two factors is by no means always observed and this to some extent is compensated for by the intermittent nature of the spawning of the quagga. The perch and the spiny loach are summer-spawning species with intermittent spawning; they reproduce in sections with rich aquatic vegetation. The reproduction of the perch is particularly efficient in the Arya River and in the shallows of the Bus River which are in the upper part of the bay. The Baltic lake smelt, penetrating into Kuybyshev reservoir from higher bodies of water, spawns in littoral sections with submerged meadow vegetation at a temperature of more than 10 C. (Auth) (BAP)

<291>

Laniv, A.G., Jr., Life History and Susceptibility of Fishes in Galveston Bay, Texas to Power-Plant Cooling-Water Operations. (Volumes I and II).

1977. Ph.D. Thesis, Texas A&M University (Texas A&M University, College Station, TX)

Seasonal occurrence, abundance, and susceptibility to cooling-water operations were determined for 89 species of fish occurring in intake and discharge canals of the F.M. Robinson Generating Station on Galveston Bay, Texas, from February 1969 through March 1976. Susceptibility of most species to cooling-water operations was dependent upon their life history, swimming ability, water temperature, and current. Most young fish entered the study area via a series of well-defined recruitment waves coinciding with noticeable drops in ambient water temperature during fall and winter. Emigration rates generally were highest during months of cool-water temperatures and peak recruitment of young into the area. Intake-canal catch/effort statistics were generally higher than discharge-canal samples. Spot and Atlantic croaker were the only species to establish resident populations in the discharge canal. Spot grew faster in effluent waters than in ambient waters. As effluent temperatures reached 32 C in late April, resident species left the discharge canal. Temperatures above 35 C were stressful to species in transit down the discharge canal. (ST)

<282>

Lane, W.R., Jr., The Matriarch Larvae of North Inlet, South Carolina (Cicripedia: Thoracica).

1977. Ph.D. Thesis, University of South Carolina (University of South Carolina, Columbia, SC)

Larvae of four cicripid species were reared at 10, 15, 20, 25 and 30 C. *BAIUS BAIUS* and *B. ANPHITRITE* completed development to cyprid over a temperature range of 1 to 30 C. *CHLORISIA PATULA* completed development only from 20 to 30 C and *OSTOLASIA NUTTALLI* only at 25 C. The rate of larval development tended to increase with increasing temperature in all species tested. The rate of development for *B. ANPHITRITE* was highly temperature dependent from 15 to 25 C (10 = 1.0). Larval size increased at lower rearing temperatures. (ST)

<283>

Larson, E.J., J.V. Wilkinson, and R.B. Rumer, The Effect of Food Concentration and Temperature on Respiration and Excretion in Herbivorous Zooplankton.

1975. In Sladcock, V. (Ed.), Congress in Canada, 1976, Verh. Int. Ver. Theor. Angew. Limnol., 15 (part 2) ISB 3-516-54039-3. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, G.F.R. (Not given)

As food level and temperature increased, the rate of nitrogen and phosphorus excretion increased for all of the mixed copepodites and the species *DAPHNIA GALATEA HEDGECOCKI* and *DIAPYCNUS SICILIENSIS* tested. Respiration also increased with both increased temperature and food level. Generally, the rates of physiological response increased proportionately to increased food concentration. (BPC)

<284>

Laybourn, J., Respiratory Energy Losses in the Protozoan Predator *DIFINION NASUTUM* Heller (Ciliophora).

1977. Oecologia (Ger.), 27, 305-309 (University of Stirling, Department of Biology, Stirling, Scotland)

Respiration in *DIFINION NASUTUM*, an active protozoan predator, was investigated in relation to cell weight at 10, 15, and 20 C by means of cartesian diver microrespirometry. Oxygen uptake increased progressively over the 10 to 20 C temperature range; a table of Q10 related to weight is presented. Regression coefficients of log weight versus log oxygen uptake (b) were 0.96 at 10 C, 0.90 at 15 C and 1.00 at 20 C. *DIFINION NASUTUM* was shown to expend very much higher levels of respiratory energy than a mainly sedentary carnivorous ciliate of comparable weight. (Auth)

<285>

Leatherland, J.F., C.Y. Cho, and S.J. Slinger, Effects of Diet, Ambient Temperature, and Holding Conditions on Plasma Thyroxine Levels in Rainbow Trout (*SALMO GALEORINUS*).

1977. Jour. Fish. Res. Bd. Can., 30, 677-702 (University of Guelph, Departments of Zoology and Nutrition, Guelph, Ontario, Canada)

The study examined the effects of food deprivation, different diets, ambient temperature, and holding methods on plasma thyroxine levels (thyroid function) in rainbow trout. Trout acclimated to 19 C and

<205> CONT.

fed a pelleted diet of either 6% soybean oil or 6% tallow fat and trout acclimated to 7°C and fed the tallow diet had plasma thyroxine levels that were not significantly different (although 7°C-acclimated fish generally had higher values), but fish acclimated to 7°C and fed the soybean diet had significantly higher plasma thyroxine levels. Fish deprived of food for 40 days had a significantly lower plasma thyroxine concentration than fish fed daily. There was no significant diurnal variation in plasma thyroxine over the light phase of a 12 hr light:12 hr dark photoperiod, nor did the limitation of light entering the aquaria significantly affect plasma thyroxine values. (ST)

<206>

Leibron, P., Biological Consequences of Atomic Power Stations on the Sea Shore.

1976. Bull. Ecol., 7, 33-59 (Not given)

The ecological effects of large nuclear power plants (5,000 MW) on the coastal environment are reviewed. Problems of concern - siting, mechanical effects, thermal effects, and chemical and radiochemical pollution - and the multidisciplinary nature of minimizing these effects are pointed out. (ST)

<207>

Lee, J.J., J.H. Tietjen, and J.B. Garrison. Seasonal Switching in the Nutritional Requirements of *HYTICHA TYPICA*, a Harpacticoid Copepod from Salt Marsh Aufwuchs Communities.

1976. Trans. Amer. Microsc. Soc., 95, 628-637 (City College of New York, Department of Biology, New York, NY)

The nutritional requirements of *HYTICHA TYPICA* were studied in quabiotic cultures incubated at either 15 or 25°C. Both temperature and food quality affected the growth rate and fecundity of the copepods. On adequate diets generation time at 15°C was 37 to 41 days, while at 25°C it was 13 to 24 days. (ST)

<208>

Loygett, W.C., The American Shad (ALCSA SHADISSIMA), with Special Reference to its Migration and Population Dynamics in the Connecticut River.

1976. In the Connecticut River Biological Study: The Impact of a Nuclear Power Plant, B. Harrison and L.W. Thorpe (Eds.), Amer. Fish. Soc. Monograph No. 1, American Fisheries Society, Bethesda, MD (Connecticut River Biological Study, Connecticut Yankee Atomic Power Company, Hartford, CT)

Results of tagging studies and ultrasonic tracking revealed that no thermal block to the upriver passage of adult American shad exists as a result of the operation of the Connecticut Yankee Atomic Plant. This conclusion was based on the similarity of rates and patterns of upriver migration from year to year, the similarity in the annual percentage of tag recoveries above the Connecticut Yankee discharge from fish that had been released in the lower 3 km of the river over a nine-year period before and after plant operation, and the absence of significant changes in behavior or migration times of shad in the immediate area of the thermal discharge before and after the onset

of plant operation. During both upstream and downstream migration shad stayed in the channel of the river. Detailed analysis of the annual variations from 1935 to 1973 in the size of the Connecticut River shad run revealed large scale, year-to-year fluctuations. It was concluded that the pattern of variation of the run was not influenced by thermal discharge from the Connecticut Yankee. (ST)

<209>

Lohmann, R.J. (Ed.). Thermal Pollution. Part 2. Biological Effects. Volume 2. 1970-February 1977: A Bibliography with Abstracts.

1977. NTIS/PS-77/0005, National Technical Information Service (National Technical Information Service, Springfield, VA)

Abstracts covering the effects of heated effluents on fish, shellfish, microorganisms, and plants in both fresh and salt water are presented. Included are effects on growth, ecology, metabolism, host tolerance and productivity. The effluent sources are both power and industrial plants. This updated bibliography contains 169 abstracts, 37 of which are new entries to the previous edition. (Auth)

<210>

Lenke, A.L., Optimum Temperature for Growth of Juvenile Bluegills.

1977. Progressive Fish-Culturist, 39, 55-57 (Environmental Research Laboratory-Bullet, Duluth, MN)

Juvenile bluegills, *LEPOMIS MACHOCHIS* (initial weight, 1.0 to 2.0 g), were individually marked and fed to excess during a 30-day constant temperature test; day length was 16 hr. Fish were tested at temperature intervals of 2°C from 20 to 36°C. The highest specific growth rate occurred at 30°C (2.35%/day); however, growth rates of only the groups held at 20 and 36°C were statistically different from the rate for the group held at 30°C. (Auth)

<211>

Lenat, D.R., Effects of Power Plant Operation on the Benthos of Lake Hyco, North Carolina.

1976. Proc. 20th Ann. Meeting E. Amer. Benthol. Soc. held in La Crosse, Wisconsin, March 24-26, 1976 (University of North Carolina, Chapel Hill, NC)

Littoral and profundal benthic macroinvertebrates were sampled quarterly at 5 stations on Lake Hyco, N.C., to assess the effects of a coal-fired steam station. For most profundal organisms the impact of thermal effluents was limited to the discharge pool area. Comparisons with control areas indicated that chironomidae standing crop was significantly lower in the discharge pool (especially *CHIRONOMUS TENTATIVUS*) and oligochaete standing crop (*LIMNODRILUS NOCTURNUS*, *PERIODURA*, and *ALLODRILUS VIGINTI*) tended to be higher. A temporary depression of Chironomidae standing crop also was noted at one other station shortly after the introduction of thermal effluents into this area. *CHIRONOMUS TENTATIVUS*, the dominant profundal organism, was affected over a much wider area of the lake. Power plant currents caused a reduction in *CHIRONOMUS* density at both intake and discharge areas. The distribution of

<291> COST.

littoral organisms was strongly related to temperature. Standing crop of Chironomidae (all species) and Ephemeroptera (EPTACUSIA) was strongly depressed by thermal discharges. Qualitative data indicated that ASPOGNA was similarly affected. Oligochaeta became the littoral dominant in thermally affected areas, although standing crop levels were not greater than those in control areas. (Auth)

<292>

Loeng, S., Maturation and Induced Spawning of Captive Pacific Hake, SCOMBER JAPONICUS.

1977. Fish. Bull., 75, 205-211 (National Marine Fisheries Service, Southwest Fisheries Center, La Jolla, CA)

Pacific hake, SCOMBER JAPONICUS, became sexually mature under laboratory conditions and were induced to spawn with hormone injections. Fish caught before the major spawning season became mature under the natural photoperiod and under artificial photoperiods of 4 h light 20 h dark, 8 h light 16 h dark, and 16 h light 8 h dark. Hake caught near the end of the spawning season redeveloped their gonads more rapidly at 10 C than at 15 C or ambient temperature. At 16 C the 16 h light to 16 h dark environment was effective in maintaining hake in spawning condition beyond the normal spawning season. Hormone-induced spawning is described. (Auth) (ST)

<293>

Lesel, R., and J.L. Schaefer, Toxicity of Substances at Sub-lethal Concentrations in Fish. 1. Temperature Effect on Ion Toxicity in Rainbow Trout (SALMO GAIARDUS) Richardson).

1977. Bull. Cent. Stud. Tech. Sci., Biarritz (Pr.), 11, 231-239 (Lab. Microorganismes, INRA, BP no. 79, Biarritz, France)

The toxicity of anionic detergent at sub-lethal concentrations at 20 C and 28 C was evaluated in rainbow trout (SALMO GAIARDUS) by using a circular water flow apparatus. Results showed a linear statistical regression between log sub 10 of the concentration. Slopes of the two straight lines were significantly different: detergent toxicity increased according to temperature, and concentration; however the two effects were not simply additive. The relative effect of one of the two factors being the less low while the other was active at a higher degree. (Auth)

<294>

Lesley, D.E., A Field and Laboratory Investigation of the Salinity and Temperature Tolerance of an Estuarine Calanoid Copepod, ACARTIA TOWSA Dana.

1977. Ph.D. Thesis, Tulane University (Tulane University, New Orleans, LA)

Average lengths of ACARTIA TOWSA in Lake Pontchartrain, La., were lower than those from northern locations. The longest individuals were found in winter at a temperature of 11.0 C. ACARTIA TOWSA was the dominant copepod above 1.0 ppt salinity and occurred to 0.1 ppt. In a factorial design experiment using salinities from 5 to 30 ppt, temperatures of 5, 15, 22, and 32 C, and varied culture conditions, optimum survival varied with the culture conditions, but were

usually at salinities and temperatures near and lower than the culture conditions. (ST)

<295>

Lillehammer, A., Norwegian Stoneflies. V. Variations in Morphological Characters Compared to Differences in Ecological Factors.

1976. Norv. Jour. Entomology, 23, 161-172 (University of Oslo, Zoological Museum, Oslo, Norway)

In some Norwegian stonefly species, environmental factors have produced differences in the time of emergence of local populations, thus partly isolating them from other populations of the same species. Ecological differences existing between populations were often associated with morphological differences such as genital appendages, body length, wing length, and wing venation. Wing length and body length seemed greatly influenced by temperature and nutrition. At high altitudes where there was little food and low temperatures, wing length was often reduced more than body length, giving a small wing area and a large body. (Auth) (ST)

<296>

Loesch, J.C., and R.A. Land, Jr., A Contribution to the Life History of the Blueback Herring, ALOSA AESTIVALE.

1977. Trans. Amer. Fish. Soc., 106, 583-589 (University of Connecticut, Marine Sciences Institute, Newuk, CT)

Blueback herring (ALOSA AESTIVALE) were first detected near the mouth of the Connecticut River on April 13, 1966, April 18, 1967, and April 19, 1968, when water temperatures were 7.0, 8.7, and 9.4 C, respectively. Spawning was first observed when stream temperature was 14 C. Abundance in the river was greatest from mid-May to mid-July, but smaller spawning groups were observed in late April and mid-September. Blueback herring preferred a swift stream flow and hard substrates for spawning sites, and to a great degree were spatially isolated from spawning alewives. (Auth) (ST)

<297>

Lorda, E., and J.W. Zahradnik, Operating Characteristics of a Heated, Raw Sewer, Oyster Finishing Pilot Plant (Abstract only).

1976. Proc. Natl. Shellfish. Assn., 66, 162-163 (UMASS Aquaculture Engineering Laboratory, Weymouth, MA)

Growth of oysters, CRASSOSTREA VIRGINICA, in raw sewer at four temperatures, at different initial size of the experimental oysters, and at flow rates of 10 to 120 liters/oyster day was evaluated. Tentative mathematical models to describe the growth response are being developed through multiple regression analysis and correlation of the most significant variables. A pilot plant was designed and built for the experiment. (ST)

<298>

Loring, R.W., and L.C. Hill, Temperature Selection and Shelter Utilization of the Crayfish, ORCONECTES CAUSSET.

1976. Southwestern Naturalist, 21, 219-226 (University of Oklahoma Biological Station)

<298> cont.
Vancouver, BC)

Temperature selection and shelter utilization of the crayfish, *DECAPODITES CHUSSEYI*, were assessed. The crayfish exhibited sensitivity to an array of temperatures. This sensitivity establishes a thermal selection index (14 to 29 C). Thermal acclimation influenced significantly the initial movements of the crayfish, although this effect subsided after 20 min in the thermal gradient. This species also responded positively to shelter configurations, but only within optimum thermal areas. (Auth)

<299>

Lubshin, V.V., and V.I. Gurina, Adaptive Reactions of Mussels from the White Sea to Changes of Environmental Temperature and Salinity.

1977. Biol. Morya (USSR), 2, 46-50 (Academy of Sciences of the USSR, White Sea Biological Station, Zoological Institute; Leningrad University, Department of Cytology and Histology, Leningrad, USSR)

The intensity of respiration of the White Sea mussels, *MYTILUS EDULIS* L., at different salinities and temperatures was investigated. The intensity of oxygen consumption varied slightly at the salinity fluctuations up to 10 ppt, and 10 ppt, the normal salinity being 25 ppt. Only at the salinities of 10 ppt and 35 ppt, the oxygen consumption decreased with the following increase. When temperature and salinity change simultaneously (to 17 C and 1 C and to 10 ppt, respectively) normalization of the respiration in the mussels is not observed. (Auth)

<300>

Liquori, P., C. Leger, and P. Derquet, Effects of Sucrose-Free Diet on the Rainbow Trout Reared at a Temperature of 16 C. 1. Growth According to Protein Intake Level.

1976. Ann. Hydrobiol. (Fr.), 7, 179-184 (I.N.R.A. Centre National de Recherches Technologiques, Laboratoire de Nutrition des Poissons, Jouy-en-Josas, France)

The influence of diets with or without sucrose on the growth of rainbow trout (*SALMO GAIRDNERI*) was studied in relation to dietary protein level and environmental temperature. The growth of groups fed a high protein diet with or without sucrose was identical and superior to that of the groups receiving a low protein diet. Raising the temperature from 10 C to 16 C resulted in a faster growth rate and an increase in the feed conversion ratio due to increasing requirements for maintenance. (WB)

<301>

MacGregor, R.D., and R.D. MacCrimmon, Evidence of Genetic and Environmental Influences on Heritable Variation in the Rainbow Trout, *SALMO GAIRDNERI* Richardson.

1977. Environ. Biol. Fish., 2, 25-33 (University of Guelph, Department of Zoology, Guelph, Ontario, Canada)

An investigation of the effect of parentage and temperature on the expression of selected heritable characters of rainbow trout, *SALMO GAIRDNERI*, revealed statistical differences in the number of vertebrae, dorsal fin rays and anal fin rays among test batches of

progeny of different parentage. Batches of fertilized ova of the same stock or parentage which were incubated at 9.5 C and 10.8 C, produced lower mean dorsal and anal fin ray counts and a higher mean pectoral fin ray count at the higher temperature. Incubation temperature had no significant effect on the number of vertebrae. (Auth)

<302>

Meeker, A.P., Growth and Development of Larval Chironomidae.

1977. Oikos, 28, 270-275 (University of Reading, Zoology Department, England)

Development rates, length-age growth rates and length-weight relationships were measured for twelve species of larval chironomid from the River Thames, UK, at 10, 15, and 20 C. From these data weight-age growth rates were calculated. The relationship between the weight (W) of a larva and its length (L) was described as a power function $W = aL^b$. The exponent b was found to depend on the size of the larva at saturation. The type of food fed to the larvae of *AMELETUS* *SCUTELLIS* L. greatly affected growth and development rates. Larvae of *CHIRONOMUS* *DEICHTERUS* (Meig.) responded to an increase of temperature from 15 to 20 C by an increase in development rate but not of growth rate, while the other species studied responded by an increase in both. (Auth)

<303>

Mahood, R.E., Spotted Seatrout in Coastal Waters of Georgia.

1975. Proc. 29th Ann. Conf. Southeast. Assn. Game & Fish Comm., 195-207 (Georgia Department of Natural Resources, Game and Fish Division, Brunswick, GA)

Spotted seatrout (*CYBOSION SEMULOSUS*) moved from the shallow waters of estuaries to deeper waters in creeks and rivers when water temperatures dropped below 16 C or rose above 25 C. (ST)

<304>

Wiese, C., and R. Borsen, The Agglutinin Response of Rainbow Trout to *AEROMONAS SALMOSITICA*; Effect of Temperature, Adjuvant and an Immunosuppressive Agent.

1976. Ann. Rech. Vet. (Fr.), 7, 307-313 (Laboratoire Ichtyopathologie, INRA, Grignon, France)

Following immunization with a chloroform killed suspension of *AEROMONAS SALMOSITICA*, antibody activity was detected at day 50 in rainbow trout kept at 5 C and before day 20 in trout at 10 and 16 C. (ST)

<305>

Major, P.F., Studies of Predator-Prey Interactions in Schooling Fish.

1976. Ph.D. Thesis, 205 pp. (University of California, Santa Cruz, CA)

Grey mullet of 50 mm or more were observed to reside seaward of the tideline in water with lower and more uniform temperatures and higher salinities. In the laboratory, mullet of less than 50 mm selected median temperatures of 24.0-27.8 C at the three salinities tested (0, 15, 30 ppt) while larger fish selected 29.6 C at 30 ppt and

<105> CONT.

23.4 at 0 ppt. (19°C)

<106>

Valone, T.C., Light-Saturated Photosynthesis by Phytoplankton Size Fractions in the New York Bight, 1974.

1977. Marine Biol. (N. Ger.), 42, 281-292 (Lamont-Doherty Geological Observatory, Marine Biology, Palisades, NY)

Phytoplankton and nanoplankton blooms in the lower Hudson River estuary typically occur during late winter (2 to 8°C) and summer (18 to 24°C) respectively with assimilation numbers being higher during the bloom periods than during transition periods of rapid temperature change (8 to 18°C). These variations were not statistically related to the development or collapse of specific blooms based on weekly sampling but could account for the avoidance of nanoplankton in summer and netplankton in winter. Assimilation numbers were exponential functions of temperature between 8 and 20°C and 8 and 22°C for the nano- and netplankton, respectively. Below 8°C, the assimilation numbers of both plankton fractions were higher than expected on the basis of temperature. Above 20°C, assimilation numbers of netplankton declined with temperature. Assimilation numbers of both were occasionally correlated with dissolved inorganic nitrogen concentrations from less than 1 to more than 15 µg/l at which time nanoplankton growth rates were higher and increased more rapidly with dissolved inorganic nitrogen than netplankton growth rates. (STC)

<107>

Valour, P.C., The Effects of Temperature and Food Availability on Energy Partitioning and Growth in the Pacific Oyster CRASSOSTREA GIGAS (Thomberg).

1977. Ph.D. Thesis, Oregon State University (Oregon State University, Corvallis, OR)

Growth experiments conducted with juvenile oysters in an apparatus that provided controlled flows of untreated seawater indicated that growth rate generally increased with increasing temperature up to 15°C. Indications were, however, that if food is plentiful or qualitatively superior, maximum growth might be achieved at temperatures up to 18 to 20°C. The experiments also showed that the relationship between temperature and growth rate depends on water flow rate. In closed system experiments with recirculated seawater and conducted at 11, 15, 19, and 23°C, growth optimum occurred at 15°C. Maximum food consumption also occurred at 15°C and the energetic difference between food consumed and respiration was greatest at 15°C. (ST)

<108>

Reen, P., and J.R. Syther, Growth of Six Species of Bivalve Molluscs in a Waste Recycling-Aquaculture System.

1977. Aquaculture (Neth), 11, 231-241 (Woods Hole Oceanographic Institution, Woods Hole, MA)

Growth of six species of bivalve molluscs (CRASSOSTREA GIGAS, TAPES JAPONICA, MYTILUS EDULIS, CRASSOSTREA VIRGINICA, MYTILUS EDULIS and OSTREA EDULIS) was compared in a waste recycling-aquaculture system. Tests were conducted at experimental

temperatures of 15 and 20°C, over the period November 1975 to May 1976. Experimental animals were fed algae, predominantly PHAEODACTYLUM THICOSTRUM, grown in large outdoor cultures enriched with secondary treated sewage effluent. C. GIGAS, T. JAPONICA and O. EDULIS grew well. M. EDULIS, C. VIRGINICA and M. EDULIS exhibited poor growth. C. GIGAS exhibited a greater increase in total live weight at 20°C (139.0% vs 128.4%) but a greater increase in mean dry meat weight at 15°C (106.3% vs 59%). Similarly, at 15°C T. JAPONICA exhibited consistently higher increments of both live weight (90% vs 52%) and dry meat weight (88% vs 26%). (Auth)

<109>

Shanoch, C.S., III, Reproductive Cycle, Fecundity, and Sex Ratio of the Red Porgy, PAGRUS PAGRUS (Pisces: Sparidae) in North Carolina.

1977. Fish. Bull., 74, 775-781 (National Marine Fisheries Service, Atlantic Estuarine Fisheries Center, Beaufort, NC)

Red porgy spawned in Raleigh and Onslow Bays, NC, during March and April at bottom water temperatures of 16.4 to 21.5°C and at 21 to 100 m depth. (ST)

<110>

Varcoe, R.H., Temperature Induced Isozyme Variants in Individuals of the Sea Urchin, ABBACIA PUNCTULATA.

1977. Comp. Biochem. Physiol., 50B, 109-113 (Yale University, Department of Biology, New Haven, CT)

The technique of microacrylamide slab gel electrophoresis was used to repeatedly monitor the qualitative isoenzyme composition in the tube feet of the sea urchin, ABBACIA PUNCTULATA exposed to different temperature regimes. Four isoenzyme systems were assayed. Three (MDH, EN, and ACPH) were monomorphic for each animal studied and no change in band migration pattern was observed. Banding patterns for the fourth system (EST) were observed to vary in the same individual. The reversible induction of esterase variants in the tube feet of the same individual is reported. The change was temperature dependent, and a period of 7-14 days acclimation was required to induce the pattern alteration. (Auth)

<111>

Varry, B.C., Jr., Planktonic Fish Eggs and Larvae of the Lower Connecticut River and the Effects of the Connecticut Yankee Plant Including Retainment.

1976. In The Connecticut River Ecological Study: The Impact of a Nuclear Power Plant, D. Harrison and L.E. Thorpe (Eds.), Amer. Fish. Soc. Monograph No. 1, American Fisheries Society, Bethesda, MD (Connecticut River Ecological Study, Connecticut Yankee Atomic Power Company, Hartford, CT)

From 1965 to 1969 eggs and larvae representing 16 species of fish were collected in the lower Connecticut River and in its tributaries. Alewife, blueback herring, white perch, and yellow perch made up 98% of the total egg production. More than three-quarters of the eggs occurred in water of 19 to 25°C; 15% occurred in a lower range of 7 to 11°C. Retainment studies

<311> 1977.

conducted between 1976 and 1977 showed that all fish larvae and early juveniles of nine fish species that passed through the plant were dead by the time they reached the end of the discharge canal. Sampling during June and July, when 95% of the nonscreenable fish were present near the intake, showed that approximately 80% of the total mortality in the canal had been caused by mechanical damage and 20% by heat shock and prolonged exposure to temperatures above 28 C. There was no measurable mortality from the injection of sodium hypochlorite as a biocide. (ST)

<312>

Barry, R.C., Jr., Fishes of the Lower Connecticut River and the Effects of the Connecticut Yankee Plant.

1976. In The Connecticut River Ecological Study: The Impact of a Nuclear Power Plant, D. Harrison and L.H. Thorpe (Eds.), Amer. Fish. Soc. Monograph No. 1, American Fisheries Society, Bethesda, MD (Connecticut River Ecological Study, Connecticut Yankee Atomic Power Company, Hartford, CT)

After plant operation began, fewer species of fish were found at both the heated and control stations. There was a significant reduction in the number of white perch, brown bullheads, white catfish, and spottail shiners at the heated stations. Much of the decrease was attributed to the movement of these fish from the peripheral heated areas to the preferred higher temperatures within the discharge canal. In the discharge canal, 30,093 fish of 75 species were collected in 641 trawl hauls between 1968 and 1972; brown bullheads dominated the catch (67.3%), and together with white catfish made up 86.5% of the total catch. About one-third of the fish caught were young of the year. Two distinct seasonal peaks occurred in the fish population in the canal, one in March and April and a smaller one in November and December. More species were collected in June than in any other month. Five species (pumpkinseed, white perch, golden shiner, white catfish, and brown bullheads) were collected in the discharge canal in water as warm as 40 C. The majority of fish left the canal when the water reached 35 C, but returned after a one-degree drop in temperature. Several species, primarily bullheads and white catfish, overwintered in the discharge canal. Power plant shutdowns resulted in immediate evacuation of the canal. From tagging returns, it was estimated that the combined bullhead and white catfish populations ranged between 17,000 and 39,700. Weight and condition of individuals of these two species living in the canal were less and poorer than of those overwintering outside the canal. The ovaries of females of both species developed earlier in those fish living in the canal, but there was no evidence that they spawned earlier. A successful winter-spring fishery developed in the discharge canal. (ST)

<313>

Barry, R.C., Jr., and F.H. Jacobson, Early Life History Studies of American Shad in the Lower Connecticut River and the Effects of the Connecticut Yankee Plant.

1976. In The Connecticut River Ecological Study: The Impact of a Nuclear Power Plant, D. Harrison and L.H. Thorpe (Eds.), Amer. Fish. Soc. Monograph No. 1, American Fisheries Society, Bethesda, MD (Connecticut River Ecological Study, Connecticut Yankee Atomic Power Company, Hartford, CT)

Bethesda, MD (Connecticut River Ecological Study, Connecticut Yankee Atomic Power Company, Hartford, CT)

Because the American shad is the most important commercial and sport fish in the Connecticut River, all stages of its life in freshwater were scrutinized to determine possible adverse effects of the Connecticut Yankee Power Plant. The major portion of the shad spawning occurred well above the plant. Peak spawning occurred at 22 C in June 1967 and at 18.0 C in May 1968. Colder temperatures in 1967 may have delayed spawn maturation. Temperatures below 16 C prolonged the period of development and reduced survival. Embryonic development required 103 hr in 1967 and 217 hr in 1968. Most shad larvae were collected in June at temperatures between 9.7 and 30 C, with most at 21 to 23 C. Largest numbers of juveniles were found in the Haddam area in early August when the water temperature was 26 C. The bulk of the population emigrated downstream from early September through early October at temperatures ranging from 23 to 17.0 C. No juveniles were caught in the river by the end of November at temperatures below 6.6 C. Field studies and studies using caged shad in the plant effluent showed that young shad avoided temperatures above 30 C. It was concluded that young shad avoid potentially lethal temperatures above 30 C and are capable of traversing or avoiding the Connecticut Yankee heated effluent during their downstream migration. Observations on the upper lethal temperature and direct mortality were made by placing young shad in a shallow floating live box and drifting it through the heated effluent during different seasons. Behavioral changes are described. All specimens died between four and six days at 32.2 C. (ST)

<314>

Markarian, R.E., The Effects of Varying Temperature Regimes on the Growth, Emergence, and Distribution of Five Species of Aquatic Insects in a Small Mountain Stream.

1976. Ph.D. Thesis, 101 pp. (Pennsylvania State University, University Park, PA)

Five aquatic insect species, *DIPTERYGUS ROBERTSII*, *EURETHELLA DOBOTHIA*, *LEUCOTA TENELLA*, *NEUROBA WUI*, and *PALAEPTOBIELLA ASSINILIS* were studied to determine the effects of varying temperature regimes on their growth, emergence, and distribution in a small mountain stream in central Pennsylvania. Significant growth during the coldest periods of the year was shown by *E. DOBOTHIA*, *N. WUI*, and *L. TENELLA*. Growth of *P. ASSINILIS* and *D. ROBERTSII* stopped when mean water temperatures were below 2.5 C and 6.1 C, respectively. (HFC)

<315>

Masonqill, R.E., Entrapment of Zooplankton at the Connecticut Yankee Plant.

1976. In The Connecticut River Ecological Study: The Impact of a Nuclear Power Plant, D. Harrison and L.H. Thorpe (Eds.), Amer. Fish. Soc. Monograph No. 1, American Fisheries Society, Bethesda, MD (Connecticut River Ecological Study, Connecticut Yankee Atomic Power Company, Hartford, CT)

The zooplankton population in the plant area was dominated by ostracodan crustaceans and included fish and insect larvae. Estimates of zooplankton mortality due to

<315> C397.

mechanical damage during passage through the condenser cooling-water system were less than 1%. When the temperature of the discharge water ranged between 31.0 and 39.4 C, no cladocerans or copepods survived passage down the discharge canal to the river in the years 1970-1972. Insect larvae survived temperatures up to 33 C but were not collected dead or alive from river or canal samples at higher temperatures. (37)

<316>

Vassengill, R.B., Benthic Fauna: 1965-1976 versus 1960-1972.

1976. In The Connecticut River Biological Study: The Impact of a Nuclear Power Plant, D. Harrison and L.W. Thorpe (Eds.), Amer. Fish. Soc. Monograph No. 1, American Fisheries Society, Bethesda, 40 Connecticut River Biological Study, Connecticut Yankee Atomic Power Company, Part 3(1, C7)

More than 550,000 organisms involving 72 species were collected in order to assess the changes in the populations of benthic invertebrates in the vicinity of the Connecticut Yankee Atomic power during the years 1965 to 1972. During early operation of the plant, as siltation and temperature increased in the area upstream of the discharge canal, the number of species increased markedly. As silt continued to accumulate there was a decrease in the density of organisms, and the flowering plant *Vallisneria spiralis* disappeared from the sandy flats. The class *Pisidium* was markedly reduced in numbers, but the dipteran larvae *Cyrtopogon* increased sharply. Diversity indices reflected an increase in the number of species, but a reduction in the number of individuals. The bottom area adjacent to and directly below the mouth of the discharge canal for 100 m had temperature increases up to 10 C. The sand substratum became overlain by silt and detritus and the kinds and numbers of species increased from 1960-1972. *Amelids* (*Limnodrilus hoffmeisteri*) comprised more than two-thirds of the animals collected, insects were abundant, and clams disappeared entirely. The estimated population decrease from the area in direct contact with the plume (10.0 hectares) was approximately 2.2 million organisms. In contrast, all stations downstream from the plant and beyond the influence of the plume reflected increases in populations of benthic invertebrates during this period. In the heated discharge canal, the density of invertebrates decreased as temperatures rose to 37 to 40 C. During plant shutdown populations increased markedly. During the cold months of the year resident bottom feeding fishes moved into the canal and during these periods the abundance of benthic invertebrates was reduced. Fly larvae and *Limnodrilus hoffmeisteri* were collected during all seasons in the canal. (37)

<317>

Katey, V.G., The Function of the Hypothalamic-Hypophyseal Neurosecretory System of the Guppy (*Poecilia reticulata*) to an Alteration of Ambient Temperature.

1975. Jour. Ichthyol., 15, 775-781 (Institute of the Biology of Inland Waters, Borok, USSR)

The functional activity of the hypothalamic-hypophyseal neurosecretory system (HNHS) of the guppy was studied at ambient (21.5 C) and raised (32.5 C) and

lowered (11 C) temperatures. A 10 C reduction of ambient temperature caused a reduction in neurosecretion and build-up of secretions in the secreting cells. A rise in temperature caused an increased synthesis and active secretion of neurosecretions. The reaction of the HNHS to the increased temperature was of a biphasic nature: a period of stress followed by an increase in the level of functioning of the system. (37)

<318>

Withers, G.J., and L.C. Hill, Tolerance of the Red Shiner, *Notropis lutrensis* (Cyprinidae) to Environmental Parameters.

1977. Southwestern Naturalist, 22, 89-98 (University of Oklahoma, Department of Zoology, Norman, OK)

The red shiner survived hydrogen ion concentrations between 5 and 10 pH units, salinity of 10 ppt, dissolved oxygen values of 1.50 ppm, and thermal shocks of 10 to 20° (T = acclimation temperature of 27 C). (37)

<319>

My, R., L. Truett, and F.J. Pristas, Relation of Fish Catches in Gill Nets to Frontal Periods.

1976. Fish. Bull., 74, 849-853 (National Marine Fisheries Service, Gulf Coastal Fisheries Center, Panama City, FL)

Experimental data were collected to determine if catches of fish in gill nets increase during frontal periods in fall. The study area was located in St. Andrew Bay, Florida. A frontal period was defined as any four consecutive days, the first of which the water temperature dropped 2 C or more. Six frontal periods occurred in the study area from September 17 to December 13, 1972. Each front was characterized by a marked increase in the numbers of individuals caught. Such a marked increase occurred only once during a nonfrontal period. The mean number of fish caught per day was 354.7 during frontal periods and 113.1 between frontal periods. Mean catches were significantly higher during frontal periods for all species combined and for eight of the ten (gulf menhaden, spot, pinfish, pigfish, sea catfish, bluefish, yellowfin menhaden, and cleftmouth catfish) most abundant species. Atlantic croaker and Spanish mackerel were the exceptions. (37)

<320>

McCarthy, D.R., Vibrio Disease in Bels.

1976. Jour. Fish Biol., 8, 317-326 (Ministry of Agriculture, Fisheries & Food, Fish Diseases Laboratory, Weymouth, England)

This is a first confirmed report of vibriosis or red-pox from wild eel (*Anguilla anguilla*) stocks in Great Britain. It is postulated that the epizootic was provoked by severe stress resulting from the abnormally high estuarine water temperatures and low freshwater flows present in affected rivers at the time. Bacteriological characteristics of the isolate, which was classified as a *Vibrio* sp., are described. (37)

<321>

McCarty, L.S., and A.M. Houston, H₂O₂ and H₂O₂-Stimulated ATPase Activities in the Gills and Kidneys of Thermally Acclimated Rainbow Trout, *Salmo gairdneri*.

<321> CONT.

1977. Can. Jour. Zool., 55, 704-712 (Brock University, Department of Biological Sciences, St. Catharines, Ontario, Canada)

Gill and kidney Na⁺/K⁺-dependent, Na⁺/K⁺- and K⁺/K⁺-stimulated ATPase (EC 3.6.1.3) activities were estimated at 25°C and at acclimation temperature in rainbow trout, *Salmo gairdneri*, acclimated to 2, 10, and 18°C, as were plasma levels of sodium, potassium, and chloride. Sodium and chloride exhibited no significant variation between 2 and 18°C; potassium levels were elevated at 18°C. When assayed at 25°C Na⁺/K⁺-dependent and K⁺/K⁺-stimulated ATPase activities did not vary consistently or significantly in relation to acclimation temperature. Under comparable assay conditions both gill and kidney Na⁺/K⁺-stimulated activities declined at higher acclimation temperatures. Significant increases in all activities were encountered when preparations were incubated at the appropriate acclimation temperature. The data suggest that the branchial Na⁺/K⁺-ATPase system serves primarily as a high-temperature amplifier of sodium uptake, and may contribute little to the maintenance of sodium balance in the cold-adapted animal. No evidence of a critical involvement of K⁺/K⁺-stimulated ATPase in ionic regulations was obtained. (Auth)

<322>

McCusley, R.W., Laboratory Methods for Determining Temperature Preference.

1977. Jour. Fish. Res. Bd. Can., 34, 749-752 (Wilfrid Laurier University, Biology Department, Waterloo, Ontario, Canada)

Different types of temperature-gradient devices used in the laboratory to determine temperature preferences of fish are classified and reviewed. The type of device used seems to have less effect on experimental results than do other variables such as age, size, season, physiological state, or social interactions. (Auth)

<323>

McCusley, R.W., J.B. Elliott, and L.A.B. Reid, Influence of Acclimation Temperature on Preferred Temperature in the Rainbow Trout *Salmo gairdneri*.

1977. Trans. Amer. Fish. Soc., 106, 362-365 (Wilfrid Laurier University, Departments of Biology, Mathematics, and Physics, Waterloo, Ontario, Canada)

The relation of preferred temperature to acclimation temperature of 29 rainbow trout 15 months old was examined during summer. Fish were acclimated to 5, 10, 15, 20, and 25°C, respectively, and tested individually in an electrically controlled shuttlebox device. Body temperatures monitored by a radiothermometer inserted by the fish closely approximated occupied temperatures to within 0.2°C. No significant differences were found in preferred temperature over the acclimation range studied. The calculated final preference was 11.3°C. Fish regulated environmental and body temperature with the same precision as they selected temperature in a spatial gradient. (Auth)

<324>

McGurnick, J.B., D.P. Jones, and R.E.P. Robinson, White Sucker (*Catostomus commersoni*) Embryo Development, and Early Growth and Survival at Different Temperatures.

1977. Jour. Fish. Res. Bd. Can., 34, 1019-1025 (U.S. Environmental Protection Agency, Environmental Research Laboratory-Buluth, Buluth, MN)

White suckers (*Catostomus commersoni*) were exposed from fertilization through hatching to seven constant temperatures from 6.1 through 26.1°C. High percentages of apparently normal larvae hatched at temperatures from 9.0 through 17.2°C. Maximum percent hatch occurred at 15.2°C, while only a few normal larvae were produced at 6.1°C, and none at 26.1°C. Growth rates increased from near zero at 10.0°C to a maximum at 26.9°C. At 29.7°C growth fell below the maximum, and the incidence of spinal deformities was high. Death rates were uniformly low from 15.7 to 26.9°C and were significantly higher at 10.0 and 29.7°C. The rate of net biomass gain for test groups was maximum at 26.9°C. Net rates of biomass gain declined progressively with temperatures below 26.9°C, until by 10.0°C the rate of population growth became less than the rate of weight loss through deaths within the population. The temperatures producing maximum hatching, 15°C, was nearly 12°C lower than that providing for maximum growth and net biomass gain. Upper thermal 1-, 2-, and 7-day TL50 values for both newly hatched and swim-up larvae, when acclimated to 9 and 16°C, were between 28 and 29°C. When acclimated to 15 and 21°C, they were between 30 and 32°C. Lower 1-day TL50 temperature values for both groups of larvae acclimated to 21°C were near 3°C, 2-day TL50 values were approximately 0.5°C higher, and 7-day values were 0.8°C for newly hatched larvae and 6.1°C for swim-up larvae. (Auth)

<325>

McKellar, R.W., Jr., Metabolism and Model of an Estuarine Bay Ecosystem Affected by a Coastal Power Plant.

1977. Ecol. Modelling, 3, 85-110 (University of South Carolina, Belle W. Baruch Institute of Marine Biology and Coastal Research, Columbia, SC)

The effects of a coastal power plant on an outer estuarine bay ecosystem on the west coast of Florida were evaluated with measurements and an ecological model. Field measurements of community metabolism and biomass were taken from the thermally affected bay and from similar control bays. The ecosystem developed structure and functions with lower biomass than in the control bays but with slightly faster rates of organic turnover. The productive turnover time of producer biomass during the summer was approximately five days in the discharge bay and approximately six days in the control bays. Power plant influence on total community metabolism was small with less than a 10% difference in annual averages between discharge and control bays. In the model, temperature served as a stimulant to both productivity and respiration. When the isolated effects of increased temperature were simulated, the model responded with lower producer biomass and faster rates of organic turnover, as was found in field measurements. These simulations also showed increased nutrient recycling and indicated patterns of temperature-induced migration. (Auth) (ST)

<326>

McKenzie, R., A.H. McVicar, and I. Vaddell, Some Parasites of Fluke *Platyhelminthes* *Platyhelminthes* L. in

<326> COST.

Three Different Farm Environments.

1976. P3-267 W6, BTIS, Springfield, VA;
Scottish Fisheries Research Report Number 9, 16
pp. (Marine Laboratory, Aberdeen, Scotland)

Over a period of fifteen months, young plaice (*Pleuronectes platessa* L.) were held in three different experimental farm environments and periodically examined for parasites. These environments were: onshore tanks with heated chlorinated water (Hunterston Power Station); "floating cages in a marine pond (Ardross); and "floating cages in a sea loch (Loch Heidart). The parasite fauna of the Hunterston farm fish showed a different pattern from the others, notably in the complete absence of *CRIPTOCOTYLE* *UNICOMULA*. This was in contrast to the heavy infestations in August in Loch Heidart which, by November, had decreased considerably without treatment despite a history of no previous infestation. Several fish-borne metacercariae which are common in wild plaice were absent from farm fish, although one, *CRYPTOCOTYLE* *LISCUA*, was more common in farm stock than in wild fish. The transfer of *GLUGIA* *STEPHANI* from Hunterston to Heidart indicates the need for caution with movements of farm stock. Concurrent infestations of *TECHNOBIA* *BOREALIS* and *CRIPTOCOTYLE* *UNICOMULA* appear to be more detrimental to farm plaice stocks than either species alone. Bearing benthic flatfish in "floating cages avoids some common infestations involving parasites with benthic intermediate stages. (Auth)

<327>

McLachlan, J., and T. Ebelstein, Life-History and Culture of *SPACILABIA* *POLYPERA* (Rhodophyta) From South Devon.

1977. Jour. Mar. Biol. Assn. U.K., 57, 577-586
(National Research Council of Canada, Atlantic Regional Laboratory, Halifax, Nova Scotia, Canada)

In laboratory culture, the life cycle of the red alga, *SPACILABIA* *POLYPERA*, starting from both tetraspores and carpospores, was completed in about 8 months. Gametophytes from tetraspores yielded female and male plants about equally. Females alone failed to form cystocarps, implying the necessity for fertilization. At 25 C growth appeared similar to that at 20 C although reproductive maturation occurred much more quickly; growth was depressed at 15 C and ceased at 10 C with thalli becoming necrotic. Relative doubling rate was about once/yr in small-scale tanks with running sea water at 20 C. Detached plants grew well, and readily propagated vegetatively from fragments. In culture, characteristic morphology and pigmentation were maintained. (JPC)

<328>

McMahon, R.P., and W.D. Russell-Muster, Temperature Relations of Aerial and Aquatic Respiration in Six Littoral Snails in Relation to Their Vertical Location.

1977. Biol. Bull., 152, 182-198 (University of Texas, Department of Biology, Arlington, TX)

Respiration rates in seawater over a range of natural temperatures were determined for *ACHAEA* *TESTUDINALIS*, *HITRELLA* *LUNATA*, *LACUNA* *VINCTA*, *LITTORINA* *OBTUSATA*, *LITTORINA* *LITTOREA*, and *LITTORINA* *SAXATILIS*. (ST)

<329>

McMillan, C., Experimental Studies on Flowering and Reproduction in Seagrasses.

1976. Aquatic Botany, 21, 87-92 (University of Texas, Plant Biology Research Laboratory, Austin, TX)

The flowering and reproduction of seagrasses in laboratory cultures as related to salinity, temperature and photoperiod were compared with responses of the same clones in Redfish Bay, Texas. *HALOPHILA* *ISCHLAEHNI* flowered continuously in the laboratory from January to September but only from April to mid-June in the bay with temperature apparently the chief control. No flowering of *THALASSIA* *TESTUDINUM*, *SYRINGOIDEA* *FILIPPORE*, *RUPPIA* *HARTINGII* or *HALOGETON* *SPICATUM* was observed in the laboratory but the flowering (from May to August) and fruit *HALOGETON* in the bay suggested a response to higher temperatures than indicated for *HALOGETON*. (JPC)

<330>

McNaught, B.C., Recovery of Entrained Zooplankton Populations: A Model to Predict Impact on Great Lakes Communities.

1977. In Third National Workshop on Entrainment & Impingement: Section 316(b)--Research and Compliance, L.D. Jensen, Ed. Ecological Analysis, Inc., Melville, NY (State University of New York at Albany, Department of Biological Sciences, Albany, NY)

A simple growth model is used to estimate the recovery time of entrained zooplankton populations, where recovery rate is due both to their naturally high intrinsic growth rates and to mixing with unentrained animals. In addition, the distance of influence of an electric generating station has been estimated. Actual growth rates were measured in the receiving body of water, and all calculations apply only to generating stations situated on large lakes. Biological recovery was estimated at 11 days at ambient temperatures above 20 C. However, mixing with unentrained populations was very rapid in comparison, and obscured condenser losses of zooplankton in 1 to 2 hours, or in terms of distance, within 1 to 3 km of a large nuclear plant (2200 MW) with a high-speed discharge. (Auth)

<331>

McNeely, D.L., and W.D. Pearson, Food Habits of Channel Catfish in a Reservoir Receiving Heated Waters.

1977. Hydrobiologia, 52, 203-209 (North Texas State University, Department of Biological Sciences, Denton, TX)

The diet of channel catfish captured near the mouth of a channel carrying heated waters from an electric generating station (North Lake, Texas) was not significantly different from the diet of catfish captured elsewhere in the same reservoir during the cool months of the year. In summer months, however, the diet of catfish captured near the effluent was significantly different from the diet of catfish from other locations and seemed to indicate that catfish were foraging in cool, deeper waters beneath the thermal plume. (Auth)

<332>

Redvick, P.A., Temperature Selection and Growth

<332> COST.
of Three Hawaiian Reef Fishes and Their
Distributions in an Area of Reputed Effluent.

1976. Ph.D. Thesis, University of Hawaii
(University of Hawaii, Honolulu, HI)

The selected temperatures of three species of Hawaiian reef fish were determined under several experimental regimes. Median selected temperatures over a period of 72 hr were as follows: juvenile to adult *CHAETODON VILPILICTUS*, 26.9 C; adult *ADGDEPUS*, 25.9 C; juvenile *A. ADGDEPUS*, 20.2 C; adult *ACANTHURUS TROSTIGUS*, 29.2 C; and juvenile *A. TROSTIGUS*, 20.3 C. Shelter and food level influenced the selected temperature of some species and age groups. Growth rates of fish fed ad libitum were highest at the two highest temperatures tested, 29.2 and 32.2 C. At the two lower feeding levels, fastest growth occurred at 26.2 C. Growth rates in cyclic temperature regimes were not significantly different from expected rates calculated from constant temperature. No significant difference was found between the temperatures at locations of fish in the field and their laboratory-selected median temperatures. Substrate was of overriding importance in determining spatial distribution. (ST)

<333>
Merriman, D. (Ed.), and L.V. (Ed.) Thorpe, The
Connecticut River Ecological Study: The Impact
of a Nuclear Power Plant.

1976. Amer. Fish. Soc. Monograph No. 1, 252 p.
American Fisheries Society, Bethesda, MD
(Connecticut River Ecological Study, Connecticut
Yankee Atomic Power Company, Hartford, CT)

The monograph presents a detailed description of the results of an ecological study, 1965-1973, of the effects of the warm-water effluent from the Connecticut Yankee Atomic Plant on the lower reaches of the Connecticut River. The nine papers cover a broad range of aquatic impacts: hydrography, oxygen balance, benthic fauna, entrainment, fish, planktonic fish eggs and larvae, and a detailed examination of effects on the American shad. An introductory section by the editors provides details of the background of the study and discusses microbiological studies, fish impingement, and environmental radiation effects. The major conclusion of the study is that, although local effects were noted, there were no broad-scale, significant impacts of the Connecticut Yankee Plant on the biota of the Connecticut River. (ST)

<334>
Merriman, J.V., Aspects of the Reproductive
Biology of the Weakfish, *Cynoscion REGALIS*
(Sciaenidae), in North Carolina.

1976. Fish. Bull., 74, 18-26 (Virginia Institute of
Marine Science, Gloucester Point, VA)

The weakfish, *CYNOSCION REGALIS*, has an extended spawning season in North Carolina's inshore waters. Peak spawning activity occurs from late April through June. (ST)

<335>
Miller, C.B., and J.E. Johnson, Growth Rates in
the Marine Copepod Genus *ACARTIA*.

1977. Limnol. & Oceanogr. 22, 326-335 (University
of Maryland Center for Environmental and

Estuarine Studies, Chesapeake Biological
Laboratory, Solomons, MD; Oregon State
University, School of Oceanography, Corvallis, OR)

Several species of the copepod genus *ACARTIA* are shown from existing data to complete each molt-to-molt phase of the life cycle in a constant time period at any fixed temperature. This molting pattern is termed isochronal development. Increase in mass at each stage is a nearly constant fraction of the weight at the beginning of the stage (with the exception of the late nauplius stages). Coupled with isochronal development this implies that growth in *ACARTIA* is exponential in time through most of the life cycle. Under isochronal development a proportionately shorter part of the total development is spent in the copepodite stages than in forms with stages of progressively greater duration. This may be a response to preference of the predators of *ACARTIA* for the older stages or a general adaptation leading to a shorter life cycle and higher rates of population increase. (Auth)

<336>
Miller, D.L., and D.N. Ouilvie, Temperature
Selection in Brook Trout (*SALVELINUS FONTINALIS*)
Following Exposure to DDT, PCB or Phenol.

1975. Bull. Environ. Contam. Tox., 14, 545-551
(University of Western Ontario, London, Ontario,
Canada)

Underyearling brook trout were exposed for 24 hours to DDT (10 to 50 ppb), phenol (0.75 to 10 ppm), or polychlorinated biphenyls (PCB's) (25 to 100 ppm) prior to placement in a multichannel thermogradient device (4 to 29 C). Controls were exposed to the carrier. In the DDT experiments the mean temperatures selected by fish which had been exposed to the acetone vehicle only were relatively constant, ranging from 12.9 to 13.3 C. The lowest dose of DDT used (10 ppb) significantly depressed the mean selected temperature, while the highest dose (50 ppb) significantly increased the selected temperature by more than four degrees. The 24-hr LD50 was estimated to be 50 ppb. Despite an unexplainable increase in the mean temperature selected by some control fish, it was found that exposure to phenol produced a consistent downward shift in selected temperature. The decrease was significant at doses of 7.5 and 10 ppm. The 24-hr LD50 for phenol was estimated at 11.7 ppm. The temperature selection shift associated with both the DDT and phenol exposures represented a sublethal effect. In contrast, all doses of PCB had no effect on the selected temperature of brook trout and produced no mortality. In further experiments it was found that PCB dose sufficient to cause mortality (100 ppm) had no effect on the selected temperature of survivors. (ST)

<337>
Miller, D.W., Factors Affecting Uptake and
Retention of Manganese-54 in Fish

1976. Ph.D. Thesis, Purdue University, 127 pp.
(Purdue University, Lafayette, IN)

The uptake and retention of manganese-54 in bluegill (*LEPOMIS MICROCHINUS*) fingerlings at various dissolved oxygen and temperature levels was measured over time. The direct and food chain uptakes of manganese-54 in largemouth bass (*MICHOPTERUS SALMOIDES*) were also compared. Bluegill fingerlings were placed in water containing 1 ppm manganese

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<117> CONT.

and 0.2 $\mu\text{Ci/l}$. The effect of 10, 20, and 30 C temperature levels, 0, 0, and 10 ppm dissolved oxygen levels, and 4, 20, 90, and 100 h sampling times on manganese uptake were tested. Results showed a moderate temperature effect, a negligible oxygen effect, and a strong sampling time effect on the uptake of manganese by bluegill fingerlings. Findings suggest that most of the manganese present in the tissues of fingerlings is not readily available for exchange with manganese present in water surrounding the fingerlings. (57)

<118>

Waller, S., The Impact of Thermal Effluents on Fish.

1977. Environ. Biol. Fish., 1, 219-222
(University of Guelph, Department of Zoology, Guelph, Ontario, Canada)

A general review on the effects of increased temperature on spawning, development, feeding, growth, and general activity of fish is given. Temperature tolerance, temperature selection, and body temperature are also briefly discussed. (57)

<119>

Viras, D., C. Shilo, and T. Shah, Further Observations on the Effects of Salinity and Temperature Changes on MYGIL CEPHALUS and MYGIL CEPHALUS.

1976. Fish. Fishbreed. Isr., 11, 44-52 (Not given)

Young mullet fry caught in littoral areas and river estuaries and transferred to fish ponds are subjected to extreme changes of temperature and salinities, and suffer heavy mortality. Tests were carried out to evaluate the importance of these factors and their influence on the high percentage of mortality. MYGIL CEPHALUS and M. CEPHALUS fry were subjected to sudden changes of salinity and temperature. M. CEPHALUS suffered high mortality when transferred from 20,000 mg/l to 822 mg/l . Survival was higher when they were transferred gradually through ranges of salinity from 2000 mg/l to 90 mg/l . M. CEPHALUS suffered heavier losses when transferred from 6900 mg/l to 1342 mg/l at lower temperatures (10 C) than at higher temperatures (17 C). M. CEPHALUS, which were previously adapted to fresh water, survived when transferred from sea water to fresh water and vice versa, at various temperatures while M. CEPHALUS, which were recently caught, did not survive sudden changes of temperature and salinity. (Both)

<120>

Wakana, S., A Biological Study of the Anadromous Dolly Varden SALVELINUS MALMA (Walbaum) Distributed in the West Coast off the Kamchatka in Summer Season, 1972-1976.

1975. Bull. Fac. Fish. Hokkaido Univ. (Jap.), 26, 154-168 (Hokkaido University, Research Institute of North Pacific Fisheries, Hokkaido, Japan)

Migration of Dolly Varden (SALVELINUS MALMA) off the west coast of Kamchatka, USSR, appeared to be related to seawater temperatures. Warmer temperatures in 1974 accelerated and cooler sea temperatures in 1972 delayed the migratory period. (57)

<121>

Wolfe, R.F., Life History, Ecology, and Population Dynamics of CHAMON SEPTENTRIONALIS (Say) (Decapoda: Caridea) in the Mystic River Estuary, Connecticut.

1976. Ph.D. Thesis, University of Connecticut (University of Connecticut, Storrs, CT)

Laboratory and field data taken in the Mystic River Estuary, Connecticut, indicated that larvae of the sand shrimp, CHAMON SEPTENTRIONALIS, survived best at 10 C and 26 ppt salinity. (57)

<122>

Wofford, H.H., Thermal Effects on the Survival and Development of Embryonic Crustaceans, LEUCOSTEUS SABIDUS and L. TYPUS

1977. Ph.D. Thesis, University of Arizona (University of Arizona, Tucson, AZ)

The embryonic development of the Gulf grunion, LEUCOSTEUS SABIDUS, and the California grunion, L. TYPUS, were highly temperature dependent between 10 and 25 C. A reduced temperature dependence was noted at laboratory incubation temperatures above 25 C. At temperatures greater than 20 C, Gulf grunion embryos hatched earlier than California grunion, whereas at temperatures less than 20 C, the opposite was true. At 20 C both species hatched in 10.2 days. The thermal tolerance limits of embryonic development of the Gulf grunion were 15 to 32 C, whereas those of the California grunion were 10 to 30 C. These factors are related to the habitat of the two species. (57)

<123>

Wolfe, J.R., Laboratory Studies on the Larval Biology of SIMULIUM VENUSTUM Say (Diptera: Simuliidae).

1976. Can. Jour. Zool., 54, 1657-1663 (Memorial University of Newfoundland, St. John's, Newfoundland, Canada)

Larvae reared from field-collected eggs of SIMULIUM VENUSTUM were found to pass through six larval instars. Temperature strongly affected both the growth rate of larvae and their survival. At 5, 10, and 12 C all S. VENUSTUM larvae died before reaching the 6th instar. At 15 C, larvae were found to be able to complete development to the 6th instar, although only 10.5% survived to this stage. Increases in temperature led to increases in survival and rate of growth, with the best survival (20.4%) at 22 C; most larvae required 22 days to reach this stage. Above 22 C, survival decreased (5.7%), although the growth rate continued to increase. A growth model for simuliid larvae simulating natural conditions was constructed using temperature-growth curves obtained in laboratory trials and comparing these data with stream temperature profiles. (Both)

<124>

Moore, J.B., and I.C. Potter, A Laboratory Study on the Feeding of Larvae of the Brook Lamprey LAMPETRA PLANEI (Bloch).

1977. Jour. Anim. Ecol., 45, 81-90 (University of Bath, School of Biological Sciences, Claverton Down, Somerset, England)

In experiments done at 5 and 15 C to determine to what extent algae, detritus and

[305] COST.

organic substances dissolved in the water can be utilized for larval growth of the lamprey, *LAMPREY PLUMBER*, larvae at 15 C increased in weight while no growth was observed at 5 C under any regime. Assimilation efficiency was related to temperature and was highly variable, a feature possibly due to difference in the activity of individuals in the period prior to experimentation. (PWC)

[305]

Wojan, V.I.C., and R.J. Roberts, The Histopathology of Salmon Tagging. IV. The Effect of Source Exercise on the Induced Tagging Lesion in Salmon Parr at Two Temperatures.

1976. Jour. Fish Biol., 8, 209-292 (University of Stirling, Unit of Aquatic Pathobiology, Stirling, Scotland)

Hatchery-reared Atlantic salmon (*Salmo salar*) parr were tagged with the standard ICES/ICFAP salmon tag at water temperatures of 15 and 6 C. They were then subjected to swimming trials in a tunnel respirometer. Following this treatment the 15 C fish developed necrotic infarcts around the tag insertions. Provided they did not become infected these lesions healed, but if the fish were retested 9 days later, the wound enlarged, became extremely inflamed, and the fish died soon after. This effect was not seen in 6 C fish. (Ruth)

[306]

Poss, S.A., R.C. Leggett, and R.A. Poyd, Recurrent Mass Mortalities of the Blueback Herring, *Alosa Aestivalis*, in the Lower Connecticut River.

1976. In the Connecticut River Ecological Study: The Impact of a Nuclear Power Plant, D. Harrison and L.W. Thorpe (Eds.), Amer. Fish. Soc. Monograph No. 1, American Fisheries Society, Bethesda, MD (Connecticut River Ecological Study, Connecticut Yankee Atomic Power Company, Hartford, CT)

Five mass mortalities of blueback herring (*Alosa Aestivalis*) occurred in the lower 40 km of the Connecticut River in the latter part of June and/or the first half of July in 1965, 1966, 1967, and 1971. These mortalities each involved 50,000 to 100,000 fish. Three of these, in the general area of the Connecticut Yankee facility, occurred before the plant went into operation. The mortalities occurred in the early morning when dissolved oxygen fell in the ranges below 1.3 mg/liter at 24.5 C and 3.6 mg/liter at 27.6 C. No substantial mortality of blueback herring occurred in the Connecticut River in 1968, 1969, 1970, and 1972—all years that the plant was in operation, but years in which water temperatures and dissolved oxygen values remained outside the apparent zone of lethality during the blueback spawning run. (Eds.)

[307]

Pothen, G., R. Keschel, and S. Scheffler, The Warming Effect of a Power Station on a Lake's Biological Production and Phosphorus Balance.

1976. Limnologica (Ger.), 10, 409-501 (Akademie der Wissenschaften der DDR, Zentralinstitut für Mikrobiologie und Experimentelle Therapie, Jena, GDR)

Warming of the Stechlinsee up to 20 C in

winter stimulated plankton production, suppressed winter stagnation, and produced an earlier than usual spring algal production. Periphyton production was initiated earlier than usual in the thermally-affected parts of the lake. In summer, warming to greater than 17 C led to damage of plankton biomass and a release of orthophosphate. The consequences were alterations in the phytoplankton and in the appearance of planktonic diatom populations. Periphyton production was also damaged. At 20 C the populations were not damaged to the same degree. The heterotrophic bacterioplankton appeared to form an extremely active community. (Ruth) (57)

[308]

Weller, R., Investigations on the Body Temperature of Freshwater Fishes.

1976. Arch. Fisch. Wiss. (Ger.), 27, 9-20 (Eidgenössische Anstalt für Fischereiforschung, Abwasserreinigung und Gewässerschutz, Dübendorf, Switzerland)

Body temperatures of brown trout, rainbow trout, perch, pike, chub, barbel and eel were measured using orally and surgically implanted temperature transmitters. Temperature of resting fish did not differ significantly from the temperature of the ambient water. Vigorous struggling in a net caused the muscle temperature to rise to a maximum of 0.72 C above ambient. During continuous swimming in the fish wheel the body temperature did not rise substantially, but after swimming, moderate temperature rises were usually observed. Adjustment of body temperature after activity to the water temperature took place within 20 to 100 minutes. Feeding increased the body temperature solely in conjunction with swimming activity. Time for body temperature adaptation in living fish after thermal shock was two thirds of that observed in dead fish, which again depends on a body weight relation. Blood circulation intensity is essential for thermal exchange in large fish and can be influenced by an anaesthetic (Hf 227). Under normal conditions, no specific differences in thermal regime were found among the fish species tested. (Ruth)

[309]

Weller, R., Temperature Selection of Goldfish (*Carassius Auratus* L.) and Brook Trout (*Salvelinus Fontinalis* Mitch.) after Heterogeneous Temperature Acclimation.

1977. Jour. Thermal Biol., 2, 5-7 (University of Toronto, Department of Zoology, Toronto, Ontario, Canada)

Goldfish and brook trout were acclimated heterogeneously to temperature by exposing the head and tail simultaneously to different temperatures. The temperature selection of heterogeneously acclimated fish were tested in a vertical temperature gradient and compared to that of homogeneously acclimated fish. All fish selected temperatures essentially corresponding to the state of acclimation of their head. It is concluded that the brain acts as the main control of temperature selection in fish. (Ruth)

[310]

Murphy, P., and A.H. Houston, Temperature, Photoperiod, and Water-Electrolyte Balance in Rainbow Trout, *Salmo Gairdneri*.

<353> CONT.

1977. Can. Jour. Zool., 55, 1377-1388 (Brack University, Department of Biological Sciences, St. Catharines, Ontario, Canada)

The influence of temperature and photoperiod upon water-electrolyte balance was considered in animals acclimated to four combinations of two temperatures (2, 10 C) and photoperiod (10 h light-6 h dark, 6 h light-10 h dark) regimes through evaluation of Na, K, Ca, Mg, and Cl levels in plasma, skeletal, and cardiac muscle and liver. Water content and distribution and approximate cellular ion levels were estimated for skeletal muscle and liver. Evidence of significant influence upon water balance was obtained in one-half of the analyses performed, with effects being particularly pronounced in cold-acclimated, "winter"-photoperiod specimens. Temperature effects were observed in two-thirds of the comparisons made with respect to electrolyte levels. These were not biased in relation to photoperiod. Most significant photoperiod-correlated variations in electrolyte levels (over one-half of the total considered) were observed at low temperature. These observations are discussed in relation to compensation of rainbow trout for temperature perturbation of the osmoregulatory and ionoregulatory systems, and the possible basis of photoperiodic influence upon these responses. (Auth)

<354>

Musick, J.A., and L.P. Mercer, Seasonal Distribution of Black Sea Bass, *CENTROPRISTIS STRIPATA*, in the Mid-Atlantic Bight with Comments on the Ecology and Fisheries of the Species.

1977. Trans. Amer. Fish. Soc., 106, 12-25 (Virginia Institute of Marine Science, Gloucester Point, VA)

Black sea bass in the Middle Atlantic Bight spawn in the summer, at depths of 10 to 85 m, primarily from Virginia to Montauk, Long Island. Young of the year become demersal at 13 to 28 mm total length and enter estuarine nursery grounds. In fall black sea bass migrate south and offshore to the Chesapeake Bight where the entire population spends the winter. Larger and older fish move offshore sooner than do young of the year and winter in deeper water (73 to 165 m). Black sea bass may tolerate temperatures as low as 6 C but are captured in larger numbers and move frequently in waters 9 C and above. In the spring sea bass migrate inshore and to the north; adults to their coastal spawning areas, juveniles to estuarine nursery areas (including lower Chesapeake Bay). (Auth) (ST)

<355>

Magabushanan, P., and G. Azostonnisa, Temperature Relations of the Freshwater Paludate, *LYMBEA ACUMINATA*.

1976. Jour. Animal Morphol. Physiol., 23, 52-29 (Marathwada University, Department of Zoology, Aurangabad, India)

The median heat tolerance limit of *LYMBEA ACUMINATA* taken from environmental temperature (26.5 to 28.5 C) was 30.5 C. When the snails were acclimated at 9 to 11 C a loss in their heat tolerance was noted from 32.2 to 29.5 C at the end of the 12th day. The second group of snails acclimated at 31 to 33 C for 12 days displayed a median heat tolerance limit of 30.1 C. Amongst the chemical constituents, water content and

proteins were directly related to acclimation temperature, whereas fat and glycogen values decreased with the increase of acclimation temperature. (Auth)

<353>

Sakanishi, T., Studies of the Effect of the Environment on the Heart Rate of Shellfishes. 1. Effect of Temperature, Salinity and Hypoxia on the Heart Rate of Scallops.

1977. Bull. Hokkaido Reg. Fish. Res. Lab., 82, 9 pp. (Not Given)

Two-year old scallops were kept for one week at seven temperature levels starting at a low of -1.8 C and increasing at 5 C intervals. At the low temperature (-1.8 C), the heart rate was about four/min and went up with the temperature. This increasing rate changed noticeably at 8 C. At 23 C the rate was maxima. At 28 C every scallop studied died. (HAF)

<354>

Shakata, Y., and P. Otsawa, Temperature-Sensitive Behavior of *PARAMECIUM CAUDATUM*.

1977. Jour. Protozool., 24, 575-580 (Osaka University, Department of Biophysical Engineering, Osaka, Japan)

The effect of temperature on swimming behavior of *PARAMECIUM CAUDATUM* was investigated by photographic analyses of their tracks in a temperature gradient. The frequency of discontinuous directional changes of cells swimming toward the optimum temperature was much lower than that of cells swimming in the opposite direction, resulting in an accumulation of cells at the optimal temperature (25 to 27 C). (ST)

<355>

Neave, P., T. Yonemori, and E.G. Bakula, Distribution and Origin of Chin Salmon in Offshore Waters of the North Pacific Ocean.

1976. Bull. IHPFC, 35, 79 pp. (Fish. Res. Serv., Dep. Fish. Environ., Pac. Biol. Stn., Nanaimo, British Columbia, Canada)

Chin salmon (*Oncorhynchus keta*) spawn in streams along the Asian coasts from Japan and Korea to the Lena River on the Arctic Ocean, and on the North American side, in watersheds from Oregon to the Mackenzie River in the Arctic Ocean. Offshore distribution extends throughout all waters lying within latitudes of spawning places. Seasonal shifts in the boundaries of ocean regions occupied by chin salmon agree in general with changing positions of surface isotherms. Total known range of surface temperatures occupied extends from 1 to 15 C. Details of food of juvenile and adult salmon in the sea are given. Tagging studies, indicating ocean distribution and migrations of salmon originating in particular areas, are summarized. (Auth) (HU)

<356>

Nelson, L.G., D.A. Armstrong, A.W. Knight, and H.V. Li, The Effects of Temperature and Salinity on the Metabolic Rate of Juvenile *MEGALOPTERUS ROSEMEYERI* (Crustacea: Palaemonidae).

1977. Comp. Biochem. Physiol., 56A, 533-537 (University of California, Davis, CA)

The respiration of juvenile *MEGALOPTERUS*

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OSTREID were monitored in response to combinations of temperature and salinity encompassing temperatures of 20, 27, and 30 C and salinities of 0, 7, 10, 20 and 28 ppt. Both oxygen consumption rate and QO₂ were influenced by the body weight of the individual prawns. Metabolic rates were determined to be influenced by temperature and salinity and the temperature-salinity interaction. The Q₁₀ values for metabolic rate were influenced by the temperature range considered but there was no obvious response of Q₁₀ to salinity. The metabolic responses to temperature and salinity may determine the distribution and migration of the species in natural habitats. (Auth)

<357>

Novy, E., T. Shimoov, and E. Libni, Thermal Selection of Allozyme Polymorphisms in Barnacles.

1977. Nature, 267, 699-701 (University of Haifa, Department of Biology, Haifa, Israel)

Barnacles (*BALANUS ANPHITRITE*) from cool and warm canals were compared for numbers, size, and for allozyme variation at 11 scorable gene and eight differentiating gene loci. Results are shown in tabular form. It is suggested that strong thermal selection is operating on barnacles living in the warmer environment. The data support the hypothesis that both allozymes and size are positively selected by natural selection as adaptations to warm environments. (ST)

<358>

Sevelli, R.C., L.G. Johnson, and L.H. Keford, Adjustment of the Components of Energy Balance in Responses to Temperature Change in *OSTREA EDULIS*.

1977. *Oecologia* (Ger.), 30, 97-110 (Odense University, Institute of Biology, Odense, Denmark; Augustana College, Dept. of Biology, Sioux Falls, SD)

Routine oxygen consumption by specimens of *OSTREA* acclimated to temperatures between 5 and 25 C increased with exposure temperature throughout much of the range 5 to 30 C. Little evidence was observed of a relative suppression of the acutely-measured rate: temperature curves for routine oxygen consumption following warm acclimation. Energetic costs thus rose sharply with increase in environmental temperature. The clearance rate of *PHARODACTYLUS* measured synchronously showed a marked thermal optimum at 15 to 20 C followed by a decline toward high exposure temperatures. Maximal clearance rates of 600 to 750 ml water/hr occurred about 5 C above the temperature to which the animals had been acclimated and were adjusted according to environmental temperature. The changes in filtration efficiency in *OSTREA* following thermal acclimation were controlled by compensatory responses of the irrigation rate rather than by a relative reduction of energy losses from metabolism. Because the clearance rate declined in animals acclimated to 25 C and the metabolic losses increased throughout temperatures from 5 to 30 C, maximal filtration efficiency was achieved at 20 C. Calculation of the energetic cost of filtration suggested that the improvement of filtration following warm acclimation offset metabolic energy losses even at low food concentrations. Even if energy losses not accounted for in this study were substantial, a positive index of energy balance could be maintained during the summer months at ration

levels commonly occurring in inshore waters. (Auth) (BFC)

<359>

Sevelli, R.C., and L.H. Keford, The Energetics of Suspension-Feeding in the Gastropod *CREPIDULA FORSTNERI* L.

1977. Jour. Mar. Biol. Assoc. U.K., 57, 161-180 (Odense University, Institute of Biology, Odense, Denmark)

The rate of oxygen consumption of the slipper limpet in water is dependent upon temperature, food availability and external oxygen. In filtered seawater or at extreme temperatures, *CREPIDULA* showed one or more minimal rates which were not associated with filter-feeding. These rates approximate the 'standard rate' and are replaced by a much faster rate of oxygen consumption during filter-feeding. The latter is the 'routine rate' and is highly variable from individual to individual. Simultaneous measurement of the clearance rate of the alga, *PHARODACTYLUS*, showed that the filtration of animals acclimated to 10 C reaches a maximum at 15 C but declines with increasing temperature. There is a good correlation between oxygen consumption and filtration rate at 10 and 14 C, but thereafter the oxygen consumption increased, despite a decrease in filtration rate. (ST)

<360>

Silsson, L.H., Incubation Time, Growth and Mortality of the Amphipod *GAMMARUS PULEX* Under Laboratory Conditions.

1977. *Oikos*, 29, 93-98 (University of Lund, Department of Animal Ecology, Lund, Sweden)

Developmental rates during all reproductive phases of the amphipod, *GAMMARUS PULEX*, were closely related to temperature. Incubation of Phase II varied from 21 days at 15 C to 111 days at 1 C and precopulation from 1.5 days at 15 C to 25 days at 1 C, respectively. The observed data were multiplied by the coefficients of Krogh. However, the predicted development curve differed depending on from what temperature it was made. (BFC)

<361>

Hobbs, R.L., R.D. Germany, and C.B. Hall, Interactions of Blue Tilapia and Largemouth Bass in a Power Plant Cooling Reservoir.

1975. Proc. 29th Ann. Conf. Southeast. Asm. Game Fish Comm., 247-251 (Texas A&M University, Department of Wildlife and Fisheries Sciences, College Station, TX)

In the presence of a dense population of blue tilapia, the population of northern largemouth bass declined in three years to one-third its 1972 abundance in Trinidad Lake, Texas. A pond experiment with Florida largemouth bass indicated that bass failed to reproduce successfully at a tilapia density of 2000 lb/acre, but at 1000 lb/acre some bass spawning occurred. Trends in gonosomatic indices suggest that eggs were retained by bass at high tilapia densities. (Auth)

<362>

Bowers, T., and H. Kawatsu, Variation of Hematocrit Values of Rainbow Trout Blood Samples Incubated under Different Conditions.

<362> CONT.

1977. Bull. Jap. Soc. Sci. Fish., 43, 381-386
Freshwater Fisheries Experimental Station, Hoide
Branch, Niigata Prefecture, Japan

Hematocrit values of rainbow trout incubated at different temperatures were determined at zero time and 30, 60, 90, 120, and 180 min after transfer to various temperatures. The change in hematocrit values became smaller at lower temperatures, becoming stable for 60 min after transfer to 9.1 C. (57)

<363>

Norihv, O., Optimal Conditions for Neiotic Spore Formation in *ULVA HUTARELLIS* Pavn.

1977. Act. Mar., 20, 19-29 (University of Oslo, Zoology Institute, Oslo, Norway)

The optimal conditions for the induction of neiotic spore formation were studied. It was found that maximal sporulation (nearly 100%) occurs within 48 hr when single-layered thallus fragments, obtained from more than 3 weeks old growing algae, are transferred to fresh medium at a density of less than 3×10^6 cells/40 ml. Other optimal conditions are: a light intensity above 3000 lux, a day length of at least 15 h, a temperature of 21 to 22 C, pH 8.0 to 8.5, osmolarity 800 to 900 mOsmol and enrichment of the seawater with nitrate, phosphate and iron-EDTA. (Auth)

<364>

Drilling, T., Seasonal Regulation in *LEUCORHINIA RUBRA* (Vander Linden) (Anisoptera: Libellulidae).

1974. Odonatologica, 5, 245-263 (University of Lund, Department of Systematics, Institute of Zoology, Lund, Sweden)

The life-cycle duration of the insect, *LEUCORHINIA RUBRA*, in bog ponds in Southern Sweden was generally three years. In tests of 11 combinations of photoperiod and temperature, the growth of later larval instars (except the final one) was retarded at LD 13:11 at all temperatures (15, 20 and 25 C), while LD 19.3:0.7 and LI produced a higher growth rate which was positively correlated with temperature. Different results were obtained for 20 C and LD 16:8 and 17.7:6.3 at different times of the year. During the first third of the final instar, the degree of developmental retardation occurring when this instar was reached in constant or decreasing day-lengths, strongly increased with photoperiod in the interval LD 13:11 to 19.3:0.7 and the difference between long and short-day responses increased with temperature from 15 to 25 C. (RPC)

<365>

Vorse, E.A., Aspects of the Zoogeographic Distribution of *CALLINECTES* (Brachyura - Portunidae).

1977. Bull. Mar. Sci., 27, 840-847 (University of Iowa, Department of Zoology, Iowa City, IA)

Three aspects of the geographic distributions of swimming crabs in the genus *CALLINECTES* are examined. The larvae of *C. SAPIDUS*, the species most successful in temperate waters, can neither hatch nor molt such below 27 C, and females in the northerly part of the range spawn only during the warm season. Latitudinal distribution is apparently limited by the effects of summer temperatures on larvae, rather than winter temperatures.

(3PC)

<366>

Morton, T.A., The Growth and Development of *SARGASSUM MUTICUM* (Yendo) Fensholt.

1977. Jour. Exp. Mar. Biol. Ecol. (Beth.), 26, 41-53 (University of Glasgow, Department of Botany, Glasgow, Scotland)

Pace of development of *SARGASSUM MUTICUM* in laboratory culture was observed to be related to water temperature and was very rapid at 25 C. Detached branches grew at the same rate in culture as in the sea at Friday Harbor, San Juan [Island], Washington. Growth rate was inversely proportional to the degree of fertility, vegetative branches growing up to five times faster than fertile ones. A very rapid growth rate was observed in the sea in the spring, falling markedly as the plants become fertile in July and August, soon after which the fertile portions were shed and drifted away, probably constituting an efficient mode of dispersal. (MFC)

<367>

Morton, T.A., Ecological Experiments with *SARGASSUM MUTICUM*.

1977. Jour. Mar. Biol. Assn. U.K., 57, 33-43 (The University, Department of Botany, Glasgow, Scotland)

In culture the growth of both gametophytes and vegetative branches of *SARGASSUM MUTICUM* was negligible at a water temperature of 0 C. Growth increased with water temperature over the range 5 to 25 C. (57)

<368>

Not given, Analysis of the U.S. Environmental Protection Agency Chlorine and Temperature Quality Criteria for Water, Volume 1.

1977. Report prepared by Ecological Analysts, Inc. for Edison Electric Institute, New York, NY (Ecological Analysts, Inc., Middletown, NY)

The report summarizes the results of an analysis of the chlorine and temperature sections of the U.S. Environmental Protection Agency's "Quality Criteria for Water" (Red Book, 1976). Approximately 250 publications and documents were reviewed. These review summaries are provided in Volume II. The authors concluded that (1) information drawn from the literature in the Red Book rationals sections had little direct relation to the promulgated criteria, (2) there is little guidance on the utilization of the standards on a site-specific or generic basis, and (3) there are many citation inconsistencies in the rationals section. The actual effect on the efficacy of the proposed criteria is difficult to assess, however. Important, non-cited material is pointed out. (57)

<369>

Not given, Effects of Heated Discharges from Gulf Power on the Temperature and Biota of the Lower Escambia River.

1971. PB-257 960, National Technical Information Service, Springfield, VA (Environmental Protection Agency, Surveillance and Analysis Division, Athens, GA)

Temperature and biological studies of the Escambia River and Bay, Florida, were conducted by personnel from EPA's

<364> (337)

Surveillance and Analysis Division during 1972. On July 20, 1972, discharges from the Gulf Power steam electric facility flowing into the Escambia River increased surface water temperature to 33.9 C at a transect 100 yards downstream from the point of discharge. This represented a 6.1 C increase over ambient temperatures recorded upstream from the point of discharge. In September, at sampling stations downstream from the point of discharge, there were significant reductions in the diversity of the invertebrate fauna and the flora as compared with diversity at upstream stations. Invertebrate organisms known to be intolerant of heated water were entirely absent from samples collected 100 yards downstream from the Gulf Power point of discharge. The periphytic flora at this same sampling area was dominated by heat-resistant blue-green algae of the genus *OSCILLATORIA*. At the Gulf Power point of discharge and for distances up to 1 mile downstream, the heated discharge from Gulf Power increased Escambia River water temperatures to a level which was lethal to fish life. It is concluded that discharges from the Gulf Power steam electric facility are causing damage to the aquatic flora and fauna of the Escambia River and therefore are subject to abatement under state and federal standards for heated water discharges into the public waters of the state of Florida. (ST)

<370>

Sybert, H., The Effects of Some Detergents on the Growth of *WITSCHEIA HOLSATICA* Hust. (Diatomeae).

1976. Ann. Bot. Fenn. (Fin.), 13, 65-68
(University of Helsinki, Department of Botany, Helsinki, Finland)

Growth of the planktonic diatom *WITSCHEIA HOLSATICA* was slower at 15 C than at 25 C in experiments exposing the organism to four detergents used either alone or in two-component mixtures (1:1). The more inhibiting of the two temperatures is closer to that of Finnish waters in summer. Higher concentrations of sodium dodecyl sulfate and sodium lauryl sulfate were tolerated than of cetyl trimethylammonium bromide. Combinations were generally more harmful than only one at the same concentration. (BPC)

<371>

C'Brynn, G.K., Aspects of Reservoir-Power Station Interactions: Some Effects of Heat on Physico-Chemistry, Benthic Ecology, and Plankton Metabolism.

1976. Ph.D. Thesis, University of Missouri
(University of Missouri, Columbia, MO)

An investigation of 26 physico-chemical parameters, plankton metabolism, and the accrual, composition, and metabolism of benthos (periphyton) was carried out from May 1970 until October 1972 at Thomas Hill Reservoir, an 1870 ha cooling reservoir. Water temperature was raised an average of 7.5 C across the power station, with a 2 C increase in the arc of the reservoir receiving the discharge. The heated effluent resulted in a moderate increase in turbidity, an increase in the percent saturation of dissolved oxygen, and maintenance of about 30 ha of permanently ice free water. A reduced plankton production detected in 1972 was attributed to condenser passage of the plankton. The benthos in the heated area had a larger percentage composition of

blue-green algae than the unheated water community. Diatoms were the dominant algae. Benthic metabolism data indicated that the control station had a significantly lower specific respiration rate than either the heated water or a limnetic station. Community differences may have been the cause. Based on the chemical and production data, Thomas Hill Reservoir was considered mesotrophic. (ST)

<372>

Odenweller, D.B., The Life History of the Shiner Surfperch *CYRTOGASTRUS AGGREGATUS* Gibbons, in Anaheim Bay, California.

1975. Fish. Bull., 165, 107-115 (California Department of Fish and Game, Stockton, CA)

The shiner surfperch population in Anaheim Bay, Calif., ranges throughout the bay and appears limited only by high temperature. Shiner surfperch left the upper reaches of the bay when the temperature began to exceed 18.5 C. In the laboratory shiner surfperch maintained in an aquarium died when the temperature accidentally exceeded 18.5 C. (ST)

<373>

Ogilvie, D.H., and D.L. Miller, Duration of a DDT-Induced Shift in the Selected Temperature of Atlantic Salmon (*Salmo salar*).

1976. Bull. Environ. Contam. Tox., 16, 86-89
(University of Western Ontario, London, Ontario, Canada)

Control Underyearling salmon exposed to acetone-containing water for 24 hr had a mean selected temperature of 19.1 C, whereas fish that had been similarly exposed to 50 ppb DDT had a mean selected temperature of 23.4 C. The DDT-induced elevation in selected temperature persisted for at least one month. At six and seven weeks there was no difference between the mean temperatures preferred by the DDT-exposed and control fish. The gradual return of temperature selection to control levels may reflect the time necessary to detoxify DDT stored in the tissues. (ST)

<374>

Olla, B.L., and A.L. Studholme, Environmental Stress and Behavior: Response Capabilities of Marine Fish.

1975. In Second Joint U.S./USSR Symposium on the Comprehensive Analysis of the Environment, USEPA, Washington, DC (Not given)

Changes in behavior were used to measure the effects of temperature stress on two pelagic species of fish, bluefish (*POCAONUS SALTATRI*) and Atlantic mackerel (*SCORPAENUS SCORPAENUS*), and one demersal species, tautog (*TAUTOGA ONITIS*). The response of both pelagic species to both a gradual increase and decrease in temperature was an increase in swimming speed. Maximum cruising speeds were reached by juvenile bluefish at 32 to 33 C and by Atlantic mackerel at 20 to 22 C, several degrees below lethal levels. As temperature reached stress levels the fish schooled at high speed both day and night. In contrast to these species, activity of tautog decreased and association with shelter increased as temperature increased from acclimation levels of 19.0 to 21.1 C to 28 C. At 30 C activity diminished still further and aggressive behavior was readily

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reduced. (ST)

(375)
Ditt, P.C., and J.O. Rice, Responses of a
Freshwater Sculpin (*COTTUS COGNATUS GYACILIS*) to
Temperature.

1977. Trans. Amer. Fish. Soc., 106, 89-96 (The
Johns Hopkins University, Chesapeake Bay
Institute, Baltimore, MD; Salco Environmental
Sciences, Northbrook, IL)

Temperature tolerance, avoidance and
preference of a freshwater sculpin, *COTTUS*
COGNATUS GYACILIS are described for fish
acclimated to constant temperatures ranging
from 5 to 20 C. Critical thermal maxima
varied from 23.5 C for fish acclimated to 5 C
to 29.4 C for fish acclimated to 20 C.
Incipient upper lethal temperatures ranged
from 18.5 C to 23.5 C. The ultimate upper
lethal temperature was approximately 26.5 C.
Avoidance temperatures ranged from 15.2 C at
5 C to 21.5 C at 15 C. Preferred
temperatures for 5 C and 15 C-acclimated fish
were 9 and 12 C, respectively, and the final
preference was about 10 C. (Auth)

(376)
Cra, S.V., Culture Studies on Infection of
Tetrasporos and Their Subsequent Development in
the Red Alga *PALKEBERGIA PUPULANOSA* (Harvey)
Schmitt.

1977. Botan. Mar., 20, 29-32 (Central Salt &
Marine Chemicals Research Institute, Bhavnagar,
India)

The transition from the tetrasporangial
PALKEBERGIA PUPULANOSA phase to the
oostegial phase of *ASPARAGOPSIS ARNATA* was
studied in unialgal culture. *PALKEBERGIA*
was induced to form tetrasporangia in
quantity by a medium low in nitrate or
phosphate under short day conditions i.e. 6
to 10 and 8 to 16 light: dark cycles at 3500
lux fluorescent light and a temperature of 15
C. At the liberation the tetrasporos
germinated to give rise to a
PALKEBERGIA-like thallus, the apical cells
of which produced segments that resembled
those of *ASPARAGOPSIS* after two weeks. (Auth)

(377)
Paladino, P.V., The Effect of Arsenic on the
Thermal Tolerance and Survival of Newly Hatched
Muskegon Fry (*ESOX MASQUINONGE*).

1976. M.A. Thesis, State University College
(State University College, Buffalo, NY)

Newly hatched muskegon fry were raised in
tanks containing 0.00, 0.05, 1.0 and 5.0 ppm
arsenic as sodium arsenite (NaAsO_2) at a
temperature of 15 C ($\pm$ or - 0.5 C) and a
photoperiod of 12 hours of light alternating
with 12 hours of dark (L:D. 12:12).
Temperature tolerance of fry, Critical
Thermal Maximum (CTM), was significantly
reduced by exposure to arsenic. Fry raised
at arsenic concentrations of 0.05 ppm or
greater suffered 100% mortality during or
shortly after swim-up. Control (0.00 ppm)
fry had a sharp drop in CTM during swim-up,
became active feeders and continued to
develop normally. (Auth)

(378)
Pandey, B.N., Haematological Studies in Relation
to Environmental Temperature and Different

Periods of Breeding Cycle in an Air Breathing
Fish, *HETEROPNEUSTES FOSSILIS*.

1977. Folia Zool., 100, 69-76 (Gaya College,
Department of Zoology, Gaya, Bihar, India)

Investigations were made on different
haematological parameters in *HETEROPNEUSTES*
FOSSILIS at two environmental temperatures
(10 and 32.5 C) and different periods of the
breeding cycle. The red and white blood cell
counts, hemoglobin concentration, hematocrit,
MCH, total blood volume, and percent blood
volumes gave significantly high values but
MCV and erythrocyte surfaces gave low values
at the higher temperature and during the
breeding period. The higher values at higher
temperatures and during the breeding period
may reflect greater physical activity and
higher metabolic rates. (Auth) (ST)

(379)
Paperna, I., and D.E. Iwerner, Studies on
ENGASILUS LABRACIS Kröyer (Cyclopidae:
Ergasilidae) Parasitic on Striped Bass, *MORONE*
SAXATILIS, from the Lower Chesapeake Bay. I.
Distribution, Life Cycle, and Seasonal Abundance.

1976. Can. Jour. Zool., 54, 889-892 (Virginia
Institute of Marine Science, Gloucester Point, VA)

Information on the distribution, life cycle,
and seasonal abundance of the copepod,
ENGASILUS LABRACIS, parasitic on the gills of
lower Chesapeake Bay striped bass, *MORONE*
SAXATILIS, is presented after a 12-month
survey. The overall prevalence of *E.*
LABRACIS was 96% in all localities sampled
and it was found to be an euryhaline as its
host; it has been found in salinities from
0.1 to 32.0 ppt. *ENGASILUS LABRACIS* was
present and reproductively active throughout
the year, suffering only a temporary slowdown
in egg production at the beginning of the
winter. Peak invasion of striped bass gills
by infective larvae occurred during April and
May; minor peaks were also recorded during
July and October. The free-living stage was
estimated to last as long as six weeks during
early spring. Duration of other
developmental stages was also extrapolated.
Attempts to rear larvae in the laboratory
past the metanauplius stage failed. Larvae
could be kept for a maximum of 23 days after
hatching if fed nauplioplankton and kept at 20
C in river water of 16 to 18 ppt salinity.
(Auth)

(380)
Pavani, J.P., and Y. Croech, Resistance of Roach
(*Rutilus Rutilus* L.) to Sudden Decrease of
Temperature.

1977. Cah. Lab. Hydrobiol. Brestons (Fr.), 5,
59-72 (Universite Paul Sabatier, Laboratoire d'
Ecophysiologie Animale, Toulouse Cedex, France)

Variations of some physiological factors were
investigated in roach after cold shock, delta
 $t = -5$ C (from 15 to 10 C) or delta $t = -10$ C
(from 20 to 10 C). The cold shock delta $t =$
5 C was easily endured. Nevertheless, during
the acclimation process, the fish would be
particularly subject to asphyxiation. The cold
shock delta $t = -10$ C caused an important
mortality. The sublethal thermal effects are
characterized by carbohydrate and
hydro-mineral metabolism disturbances. (Auth)

(381)
Parker, B.N., Response of the Mosquito *Aedes*
DORSALIS Meigen (Diptera: Culicidae) to

(301) CONT.

Temperature and Salinity of Larval Rearing Media.

1977. Ph.D. Thesis, 121 pp. (University of Illinois at Urbana-Champaign, Urbana, IL)

The mosquito, *ATOPS DORSALIS*, reared at a constant temperature of 25 C showed a uniformly high rate of survival, little stress induced by lower concentrations of salts, rapid growth of aquatic stages, and minimum change in reproductive potential. A constant temperature of 21 C delayed development by about 4 days, and prolonged exposure to the injurious effects of NaCl. A constant 30 C accelerated development by one day and imposed a moderate heat stress. At 25 and 30 C, larvae developed to adults in media with 20,000 ppm NaCl, but died within 24 hr in media containing 30,000 ppm NaCl. (BPC)

(302)

Porter, R.C., R.S. Bolt, and R. Strawn, The Potential for Soft Shell Crab Production Utilizing Heated Effluents from Power Plants in the Galveston Bay System.

1975. Proc. 29th Ann. Conf. Southeast. Assoc. Game & Fish Comm., 215-222 (Texas A&M University, Department of Wildlife and Fisheries Sciences, College Station, TX)

Blue crabs, *CALLINectes sapidus*, stocked in cages at two different densities both with and without artificial habitats were compared for growth and survival in a power plant discharge canal and in a pond. Survival was higher for crabs in the pond but growth was significantly greater for those in the discharge canal. Artificial habitats increased survival of crabs cultured in the discharge canal but had no effect on those caged in the pond. In the laboratory no significant differences were found in weight, carapace width, or survival of crabs selected at random in regard to molting cycle and placed in individual molting chambers at 30 C and ambient temperatures (21 to 29 C). In 35 days the greatest increases in carapace width for individual crabs were 32, 33, and 10% for small, juvenile, and sub-adult crabs, respectively. Crabs, all sizes pooled, molted earlier at 30 C than at ambient temperatures (22.2 vs 25.0 days to first molt). A raft holding wire cages with individual molting chambers is proposed for the commercial production of soft shell crabs in heated effluents. (Auth)

(303)

Porter, R.C., and R. Strawn, Aufwuchs and Sediment Fouling Rates in Flow-Through Aquaria Receiving a Heated Effluent from Upper Galveston Bay, Texas.

1976. In A.W. Arvult, (Ed.), Proc. Ann. Meet. World Maricult. Soc., 7, 543-559 (Texas A&M University, Department of Wildlife and Fisheries Science, College Station, TX)

Water of either 20, 25, 30, 35 C or ambient from the discharge canal of a power plant on upper Galveston Bay was added to greenhouse, flow-through aquaria used to culture estuarine and marine organisms. Aufwuchs accrual was influenced by temperature, salinity, and species cultured. Sedimentation rates due to the supplemental feeding of organisms and sloughing from the aufwuchs community were up to 7 ml/day. Biological fouling and accumulation of sediments limited growth and production of intensively cultured

organisms by lowering dissolved oxygen levels and producing anaerobic substrates. Organisms which feed by grazing can be effectively used to minimize substrate fouling in mariculture operations. (Auth) (BPC)

(304)

Putten, R.C., Short-Term Thermal Resistance of Larvae of 16 Species of Crabs from Puget Sound, Washington.

1977. Fish. Bull., 75, 555-559 (National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Seattle, WA)

Larvae of 16 species of crabs were subjected to tests that simulated thermal stress associated with steam-powered electric stations. In heat exchanger tests, the most sensitive species, the Dering hermit crab, *PAGURUS BERINGIANUS*, and the porcelain crab, *PETROLISTUS ERMENEGUS*, became torpid at 26 C. Their TL50's were also at 26 C. The TL50 of the Dungeness crab, *CANCER MAGISTER* was 30 C. The TL50's of other species ranged from 30 to 34 C. In a simulated thermal plume test the TL50 of larvae ranged from 26 to 30 C for a 1-hr exposure and 26 to 32 C for a 2- to 4-hr exposure. (ST)

(305)

Pedersen, P.L., *POLYTRETUS BEINOLBII*, a New Brown Alga in Culture (Detonacarpales, Sarcocarpaceae fam. nov.).

1977. Botan. Not. (Swed.), 130, 35-40 (Institut for Sporeplanter, Copenhagen, Denmark)

POLYTRETUS BEINOLBII (Beinke) Sæviqvaas has shown a direct type of life history through several generations under various sets of culture conditions. The best development of erect filaments is obtained at low temperature (0 to 5 C), while higher temperature (15 C) strongly inhibits the formation of erect filaments and also affects their morphology. There is not an opening at each loculus along the surface of the plurilocular sporangia as previously assumed, but Beinke's sporangium must be considered a series of sporangia. The taxonomic position is rather close to the genera *BHAKIA* and *SAROCARPUS*. A new family, Sarcocarpaceae, is proposed to contain these three taxa, all of which have true helix and sympodial branching. (Auth)

(306)

Possale, P.A., Macrophyte-Epiphyte Biomass and Productivity in an Seagrass (*ZOSTERA MARINA* L.) Community.

1977. Jour. Exp. Mar. Biol. Ecol. (Beth.), 26, 215-220 (North Carolina State University, Raleigh, NC; Atlantic Estuarine Fisheries Center, Beaufort, NC)

Biomass above-ground biomass of the seagrass, *ZOSTERA MARINA*, and its epiphytes was measured in March. Variations in productivity of seagrass and epiphytes with season probably was caused by factors associated with tidal heights. Rates of photosynthesis of both seagrass and epiphytes increased with increasing temperature to an asymptotic value at which the system was light saturated. Optimum for both was less than 29 C. Increasing summer temperatures decreased seagrass biomass. A close relationship was apparent between primary productivity cycles of macrophytes and

<196> COYT.
epiphytes. (NFC)

<197>
Pewhale, P.A., Primary Productivity, Dissolved
Organic Carbon Fraction, and Nutrient Transport
in an Epiphyte-Polygrass (ZOSTERA MARINA) System.

1976. Ph.D. Thesis, North Carolina State
University (North Carolina State University,
Raleigh, NC)

The biomass, productivity, and photosynthetic
response of eelgrass to light and temperature
was measured in a shallow estuarine system
near Beaufort, North Carolina.
Photosynthetic rates of both eelgrass and
epiphytes increased with increasing
temperature to an asymptotic value where the
system was light saturated. Both eelgrass
and epiphytes exhibited a temperature optimum
of less than 20°C. A negative response to
higher temperature was also reflected in
biomass measurements which showed decreasing
values with increasing summer temperatures.
Peak biomass was measured in March. (ST)

<199>
Peters, J.J., and J.S. Fent, Dissolved Oxygen,
Temperature, Survival of Young at Fish Spawning
Sites.

1974. WPA-499/3-76-113, Environmental Research
Laboratory, Duluth, MN, 36 pp. (North Dakota
State University, Department of Zoology, Fargo,
ND)

Fluctuations of dissolved oxygen
concentrations and water temperatures in
their natural spawning sites were measured
during embryo through larva stages of
northern pike (Esox lucius), and during
embryo and sac larva stages of bluegills
(Lepomis macrochirus) and pumpkinseeds
(Lepomis gibbosus). At northern pike sites,
dissolved oxygen concentrations from combined
measurements 1 and 10 cm from the bottom
ranged from 0.0-16.6 mg/liter, and water
temperatures from 2.5-23.0°C; average daily
fluctuations were 3.0 mg/liter and 1.6°C.
For bluegill and pumpkinseed nests, dissolved
oxygen concentrations 1 cm from the bottom
ranged from 2.0-10.7 mg/liter and water
temperatures from 15.0-27.5°C, with average
daily fluctuations of 6.8 mg/liter and 3.3°C.
In field experiments to determine acute
effects of a single exposure to low dissolved
oxygen concentrations, tolerance decreased
from embryo to larva stages for northern pike
and from embryo to sac larva stages for
bluegills and smallmouth bass (Micropterus
dolomieu). (Auth)

<199>
Peters, G., The Papillomatosis of the European
Eel (Anguilla anguilla L.): Analysis of Seasonal
Fluctuations in the Tumor Incidence.

1977. Arch. Fischereiwiss. (Ger.), 27, 251-263
(University of Hamburg, Institut für
Hydrobiologie und Fischereiwissenschaft, Hamburg,
Germany)

Eels of the lower Elbe River showed a high
incidence of epidermal papillomas during the
summer months. Tumor incidence was low in
spring and fall. Under experimental
conditions tumor growth showed a definite
temperature dependence: at 8°C growth
stopped and some tumors regressed; at 15 and
22°C growth was rapid. (ST)

<199>
Peters, G., and E. Peters, Temperature-Dependent
Growth and Regression of Epidermal Tumors in the
European Eel (Anguilla anguilla L.).

1977. Ann. N.Y. Acad. Sci., 290, 265-268
(University of Hamburg, Institute for
Hydrobiology and Fisheries and Zoological
Institute, Hamburg, Germany)

Eels in the Elbe estuary, Germany, showed a
high incidence of epidermal papillomas.
Distinct seasonal fluctuations were observed
in the frequency of occurrence and tumor
size. In spring and autumn, the frequency
was low, and the tumors were relatively
small. In summer, tumors reached a maximum
in both frequency and size. In the
laboratory temperatures of 15 to 22°C caused
rapid tumor growth. Temperatures of 5 to 10°C
inhibited tumor growth and caused tumor
regression. (ST)

<191>
Peterson, B.C., Ultrasonic Tracking of Three
Species of Black Basses, Micropterus spp., in
Center Hill Reservoir, Tennessee.

1975. M.S. Thesis, Tennessee Technological
University (Tennessee Technological University,
Cookeville, TN)

Minimum and maximum temperatures encountered
by five largemouth bass, three smallmouth
bass, and two spotted bass fitted with
temperature-sensing tags were 11.5 and 31.6°C,
9.0 and 30.9°C, and 9.4 and 27.9°C,
respectively. (ST)

<192>
Peterson, B.C., S.C.E. Spinney, and A.
Sreedharan, Development of Atlantic Salmon (Salmo
salar) Eggs and Alevins under Varied Temperature
Regimes.

1977. Jour. Fish. Res. Bd. Can., 34, 31-43
(Department of the Environment, Fisheries and
Marine Service, Biological Station, St. Andrews,
New Brunswick, Canada)

Atlantic salmon (Salmo salar) eggs and
alevins were raised under conditions where
the temperature was systematically varied
either at fertilization, at the eyed egg
stage, or at hatching. Mortality was more
than 20% in eggs started immediately after
fertilization at constant incubation
temperatures of less than 4°C as compared
with 5% or less at temperatures of more than
4°C. Alevins that eyed at 4°C and higher
were progressively smaller the higher the
temperature. The optimum temperature for
fertilization to eye pigmentation was near 6°C.
Eyed eggs reared at lower temperatures
until hatching were larger than those hatched
at higher temperatures. This size
differential was maintained until the yolk
was completely absorbed at all posthatching
temperatures investigated. Sudden decreases
in temperature at the eyed egg and hatching
stages induced severe edema of the alevin
yolk sac, resulting in slower growth and
increased mortality. (Auth)

<193>
Phillips, G.S., and R.S.S. Noorhouse,
Respiratory Behaviour of Larvae of Four Species
of the Family Polycntrropodidae (Trichoptera).

1976. Freshwater Biol., 6, 347-353 (University
of Newcastle upon Tyne, Department of Zoology,

(391) CONT.
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Larvae of *ELECTROCHENIA CONSPERSA* and *POLYCHETIDOPUS FLAVOACULATUS* from flowing water and *CYBUS FLAVIGUS* and *HYPOCHETIDOPUS PICICORNIS* from still water were selected for study. These larvae are associated with increasing ranges of temperature in their natural habitats in the same sequence as above. Experimental determination of lethal temperatures, over a temperature range of 10 to 30 C, and investigations on ventilation frequency indicated that the larvae were increasingly tolerant of temperature in the same sequence. Temperatures at which 50% mortality occurred were *P. CONSPERSA*, 30.2 C; *P. FLAVOACULATUS*, 32.3 C; *C. FLAVIGUS*, 30.6 C, and *H. PICICORNIS*, 35.2 C. *CYBUS FLAVIGUS* and *H. PICICORNIS* showed infrequent ventilation which was little affected over wide ranges of temperature and dissolved oxygen but was stimulated erratically by water flow. *ELECTROCHENIA CONSPERSA* and *P. FLAVOACULATUS* showed more active ventilation which was more sensitive to changes in temperature and dissolved oxygen and was decreased by water flow. (both) (57)

(396)

Phillips, B.V., R.A. Campbell, and B.A. Roe, Laboratory Growth of Early Juveniles of the Southern Rock Lobster *PHYLLOSCYLLUS LONGIPES* CYBUS.

1977. Marine Biol. (P. Ser.), 39, 31-39 (CSIRO, Division of Fisheries and Oceanography, Western Regional Laboratory, North Beach, Western Australia; CSIRO, Division of Mathematics and Statistics, Wembley, Australia)

Growth in the laboratory of early juvenile *PHYLLOSCYLLUS LONGIPES* CYBUS from the last larval (puerulus) stage to approximately three years of age is described. Specimens were held either in isolation or in groups of three or five rock lobsters per tank, at constant temperatures of 20 or 23 C or at the temperatures of incoming seawater, which ranged annually between 10.9 and 25.9 C. The fastest observed growth was at 23 C for a 450 day period. At ambient temperatures growth rates decreased in winter and increased in summer. (57)

(395)

Pierce, R.J., Life History and Ecological Energetics of the Gizzard Shad (*Dorosoma cepedianum*) in Acton Lake, Ohio.

1977. Ph.D. Thesis, Miami University (Miami University, Oxford, Ohio)

A continuous-flow, autostated respirometer was used to determine the rate of oxygen consumption of 40 gizzard shad, *DOROSOMA CEPEDIANUM*, ranging in size from 0.7 to 256.9 g wet mass (W) in water ranging from 9.1 to 20.5 C. The daily routine metabolic rate (R_D) was described by the regression equation: $R_D = 0.0031(W^{0.6117})$ ($R^2=0.63$). Resulting respiratory values were considerably greater than expected. The number of days in May in which mean daily air temperature was 15 C or more accounted for 30% of the variability associated with year-class success. Energy budgets were detailed for 3 age-groups from two years showing that in general, growth efficiencies increased and assimilation efficiencies decreased with age. (BFC)

(396)

Piotch, J.P., and B.F. Amend, Survival of Infectious Hematopoietic Necrosis Virus Held Under Various Environmental Conditions.

1977. Jour. Fish. Res. Bd. Can., 34, 1360-1364 (N.S. Fish and Wildlife Service, Western Fish Disease Laboratory, Seattle, WA)

Dehydration of infectious hematopoietic necrosis virus (IHNV) from water at 4 and 10 C resulted in only partial inactivation, but dehydration from Munk's balanced salt solution (BSS) and homogenized fish tissue resulted in total loss of virus infectivity within 7 days. Survival was not affected by pH between 6 and 8, but virus infectivity was significantly reduced at pH 5 and 9. Water hardness from 20 to 250 mg/l (as CaCO₃) did not significantly reduce virus infectivity. Salinity distinctly affected IHNV survival: storage in artificial seawater, filtered ocean water, BSS, and Earle's balanced salt solution (BSS) equally reduced virus titers. The addition of protein to deionized water and BSS and BSS resulted in increased survival. Survival of IHNV was inversely proportional to BSS concentration and was highest when it was frozen in media supplemented with 10% calf serum. Virus survival was good at -70 and -20 C, but virus infectivity decreased sharply with an increase of temperature above 4 C; increasingly poor survival occurred at 15, 21, 28, and 32 C. Freezing and thawing of IHNV had no effect if the media contained 10% protein; however, freezing in deionized water resulted in a significant loss of virus infectivity. (both)

(397)

Pimentel-Souza, F., J.B. Pereira, and B.F. Alvares, Behavioral Thermoregulation and Water Acclimation in an Electric Fish *GYNOSTOMUS*.

1977. Cienc. Cult., 29, 940-944 (Dept. Fisiol. and Biofis., Belo Horizonte, MG, Brazil)

The ideal temperature was determined in a vertical gradient for the fish *GYNOSTOMUS* in three series of experiments, acclimated at 26 C (Series I and II) and at 30 C (Series III). In series I, the animals received food ad libitum. In series II and III the food was controlled. Acclimated at 26 C the ideal temperatures were 24.20 and 20.37 C, significantly different for series I and II respectively. Acclimated at 30 C the ideal temperature was 24.81 for series III, significantly different from the ideal temperature when acclimated at 26 C in series II. The fishes under thermal gradient were less aggressive in territory maintenance and less dispersive in the ideal temperature. There was greater resistance of *GYNOSTOMUS* to get out from the bottom of the aquaria than to sink, when they had fixed their territory during acclimation at 26 C and 30 C respectively. (both)

(398)

Potekhina, L.V., and N.V. Sukhovova, Some Data on the Biology of the Seaweeds *OMONTHALIA CORYMBIFERA* and *O. TITIS* in Primor'e (the Sea of Japan).

1975. Izv. TINRO, 90, 202-210 (TINRO, Vladivostok, U.S.S.R.)

The active growth of *OMONTHALIA CORYMBIFERA* and *O. TITIS* along the coast of the Sea of Japan on stony and rocky grounds at 5 or 6 to 20 m depth occurring in April to June slows

<199> C987.
down in summer at water temperatures of 10 to 15 °C and stops entirely at higher temperatures. (59C)

<199>
Powers, D.A., Physiology of Fish Impairment: Role of Hemoglobin and its Environmental Modifiers.

1977. In Third National Workshop on Environmental Impairment: Section 116(B)—Research and Compliance, L.B. Jensen (Ed.). Ecological Analysis, Inc., Solville, NY, pp. 701-750 (Johns Hopkins University, Department of Biology, Baltimore, MD)

Fish adapt physiologically to increasing environmental temperature and/or decreasing oxygen by increasing the number of circulating erythrocytes, lowering erythrocyte organic phosphates and thereby increasing their hemoglobin oxygen affinity, shifting the pH anion of their hemoglobin subunit cooperativity, lowering blood pH to enhance the other physiologic parameters, and increasing or maintaining oxygen unloading at the tissues because of the net decrease in tissue pH and the excreted effect of organic phosphates at low pH values. Power plant intakes can have different effects on the same species, depending on the level of environmental saturation by the species in question. Initial impairment by many species can be the result of an inability to provide adequate oxygen to aerobic tissues either because of a temporary drop in the environmental oxygen or because the animal is forced into anaerobiosis. In the latter case, increasing oxygen debt in the face of lactic acid accumulation and/or depletion of ATP can result in suffocation of fish. (Auth)

<207>
Pribil, S., and P. Sarvas, Accumulation of Uranium by the Chlorococcal Alga *SCENODINUS GONDIICUS* (1979).

1976. Arch Hydrobiol. (Ger.)/Suppl. 49, 210-225 (Czechoslovak Academy of Sciences, Institute of Potosy, Trebon, CSFR)

The highest accumulation of uranium by the green alga, *SCENODINUS GONDIICUS*, tested from 0 to 50 °C, was between 29 and 30 °C. (57)

<201>
Price, A.W., II, C.T. Mass, and C.V. Smith, Observations of *CRASSOSTREA VIRGINICA* Cultured in the Heated Effluent and Discharged Radionuclides of a Nuclear Power Reactor.

1976. Proc. Natl. Shellfish. Assn., 66, 50-60 (University of Maine, Orono, ME)

American oysters (*CRASSOSTREA VIRGINICA*) were rafted for 26 months at four sites in the effluent waters near Maine Yankee Nuclear Power Reactor in Newsway Bay and at a control site in the adjacent Merrimack River. In an evaluation of the thermal effluent for aquaculture, comparisons are made among the sites of the effects of heated effluent on oyster growth and condition, and the uptake and retention of gamma-ray emitting radionuclides. Growth and uptake of radionuclides were observed to be accelerated at the warmer water sites. Observed variations in concentrations of gamma-ray emitting radionuclides in the biological component of this study are compared with a

pulse driven relaxator model and an existing concentration factor model. Results show that although the concentration factor model is adequate for simple laboratory studies, the pulse driven relaxator model is necessary to describe both the amplitude and time variation observed in this field study. Both experimental results and calculations for Co-58 and Mn-54 are presented. (Auth)

<202>
Pringle, G.S., and D.C. Krohn, Characteristics of a Northern Pike Spawning Population.

1975. Wis. Dept. Nat. Resources Tech. Bull., No. 66, 10 p. (Wisconsin Department of Natural Resources, Madison, WI)

The northern pike spawning population in Gilbert Lake was studied in 1968 and 1969 to determine characteristics of northern pike spawning habitat, gain additional knowledge on early life history, describe characteristics of the spawning population, and determine the extent of angler harvest of the spawning population. The combined northern pike spawning population in Gilbert and Big Cedar lakes consisted of 2,500-3,000 fish with about one-half spawning in Gilbert Lake. Immigration into the spawning areas began in mid-March and varied directly with water temperature and ice breaking on Gilbert Lake. The average sex ratio ranged from 1 female to 2.0-2.3 males. (Auth) (57)

<203>
Quist, J., R.E. Weber, A.L. DeVries, and V.H. Zapel, pH and Hemoglobin Oxygen Affinity in Blood from the Antarctic Cod *GISOSOTICUS MANDUCI*.

1977. Jour. Exp. Biol., 67, 77-88 (Montefiore Hospital, Hellerup, Denmark; University of Aarhus, Aarhus, Denmark; Scripps Institute of Oceanography, La Jolla, CA; Massachusetts General Hospital, Boston, MA)

Blood pH in the antarctic cod (*GISOSOTICUS MANDUCI*) and in two *TRACHINOTUS* species, occurring at -1.0 °C, is extremely high (pH 7.2 to 8.3). This supports and extends Buh's (1966) model for the temperature-pH relationship in cold-blooded vertebrates. The blood of *G. MANDUCI* showed a low oxygen affinity (P₅₀ 50 of 19.5 mm Hg at pH 8.16 and -1.9 °C). Despite normal in vitro temperature and pH sensitivities, blood P₅₀ increased only slightly when live fish were temperature stressed (+0.8 °C), or became acidotic as a result of agitational stress (blood pH 7.71), primarily as a result of compensatory decreases in blood ATP levels. Oxygen-binding properties of "stripped" (cofactor-free) solutions of *G. MANDUCI* hemoglobin were measured in attempts to elucidate the molecular mechanisms involved in the function of the pigment. (Auth)

<204>
Rajagopal, P.K., Respiratory Metabolism and Energy Requirements of Embryo, Larval and Juvenile Mountain Whitefish, *PROSOPRUS WILLIAMSONI*.

1975. Ph.D. Thesis, Utah State University, 112 p. (Utah State University, Logan, UT)

The upper optimum temperature for embryonic development of mountain whitefish was 4 °C, and for the post yolk sac stage was 9 to 12 °C. Abnormalities observed in larvae following incubation at higher temperatures

<406> CONT.

were scope jaws, eye abnormalities, and one case of twinning. High mortalities of eggs occurred at 9 C and higher. Energy expenditure showed a deficit at 6 and 9 C or at 6 C only, depending upon the method of measurement. Active metabolism and scope for activity were high at 9 and 12 C compared with 6 and 15 C. Standard metabolism steeply increased at 15 C. There was little scope for activity at 15 C. (ST)

<405>

Fauson, T.V., Jr., Population Biology of Parasites of Striped Mullet, *MUGIL CEPHALUS* L. I. Monograph.

1976. Jour. Fish Biol., 9, 185-194 (University of Georgia, Cooperative Extension Service, Athens, GA)

The pattern of development of monogenean trematode parasites of yearling mullet from a Georgia salt marsh was studied. *HYPOXYPHYLUS VASSERENII* was most abundant on mullet in November when the minimum pit temperature was 15 C. The parasites appeared to increase as the fish approached spawning condition in fall. *POLYCLITUM MUGILIS* intensity was high in early spring, reaching a peak in mid-March when estuarine temperatures were 15 C or less. Infection was lowest during the warm months. *GYODACTYLUS MUGILIS* appeared consistently in late summer. *HYPOXYPHYLUS VASSERENII* was observed on young-of-the-year mullet in early summer and *STANICHOCCOTIA MACRACANTHA* in October. The last two species occurred at a low intensity on yearling mullet. (ST)

<406>

Deef, C.C., Species Diversity in Aquatic Microecosystems.

1976. Ph.D. Thesis, 73 pp. (University of Northern Colorado)

The relationship of environmental complexity, increased plant nutrient levels, and environmental stability to the successional species diversity of aquatic microecosystems was studied at 26 C with 12 hr/8 of fluorescent and incandescent light for five months. After 20 weeks, 56 kinds of organisms were present. Unstable systems were cooled to 12 C at random intervals of 1 to 5 days. This caused no effect on species diversity. Diversity calculated using the Shannon-Wiener index showed that increased plant nutrients decreased species diversity and environmental complexity increased species diversity. (BPC)

<407>

Reichenbach-Klinke, H.H., Heated Effluents and Their Effect Upon the Biosphere Water.

1976. In the Influence of Environmental Factors upon the Health of Fishes, Reichenbach-Klinke, H.H. (Ed.), G. Fischer Verlag, Stuttgart, Germany (University of Wuerzburg, Institute of Zoology and Hydrobiology, German Federal Republic)

Seasonal high temperature limits for maintenance of coarse fish in open waters are proposed. These are 15 C in winter and 23 C in summer in salmonid waters, 17 C in winter and 24 C in summer in niled waters, and 18 C in winter and 27 C in summer in cyprinid waters. Short term heating up to 30 C should not last longer than 5 hr a day. (ST)

<408>

Reichenbach-Klinke, H.H., Temperature and Fish Disease.

1976. Arb. Stsch. Fischereiforsch. (GDR-), No. 10, 109-107 (University of Wuerzburg, Zoology-Parasitology Institute, Germany)

The development and course of fish diseases are correlated with water temperature. Most fish parasites and agents of infection develop within optimum temperature ranges. These optimum temperatures are dependent upon dissolved oxygen concentration and water pollution. The immune response of the fish also has an optimum temperature. (ST)

<409>

Bestor, J.H., An Environmental Evaluation of a Nuclear Power Plant on Lake Erie: Some Aquatic Aspects.

1976. Ph.D. Thesis, Ohio State University (Ohio State University, Columbus, OH)

Over 2000 fish from Lake Erie, representing 20 species, were tested to determine their final temperature preferences. Final preferences varied by species, season, and age. All species tested preferred temperatures above ambient during fall, winter, and spring and, therefore, would be attracted to thermal discharges during these seasons. Summer temperature preferences were approximately ambient lake temperature or slightly higher, indicating indifference or slight attraction to the periphery of thermal discharges and repulsion from the hottest areas. A total of 852 fish representing 33 species was tested in heat shock, and 863 fish representing 22 species were tested in cold shock experiments. Results indicated that the absolute value of the shock temperature was more important than the size of the temperature change. Results of these tests were used to predict the effects of thermal discharges from the Davis-Besse Nuclear Power Station on the Lake Erie fishery resource. Phyto- and zooplankton populations and water quality parameters were also measured. (ST)

<410>

Reynolds, W.E., Temperature as a Proximate Factor in Orientation Behavior.

1976: 1977. CONF-760499: Jour. Fish. Res. Bd. Can., 34, 730-739 (Pennsylvania State University, Biology Department, Wilkes-Barre, PA)

Temperature serves as a proximate factor (cue, guidepost, sign stimulus, or directive factor) affecting locomotor responses of fishes. Although temperature can also serve as an ultimate ecological factor, as in behavioral thermoregulation, nonthermal factors may in some cases provide the ultimate adaptive or ecological value of a temperature response: some examples are habitat selection, intraspecific size segregation, interspecific niche differentiation, isolating mechanisms, predator avoidance, prey location, escape reactions, and migrations (thermoperiodic, diel, seasonal, spawning). Conversely, nonthermal variables such as light intensity or water depth may act as accessory proximate factors in thermoregulation. In spawning migrations, thermal requirements of eggs and larvae may take precedence over the (often different) preferences or optima of adults. Although thermal responses of fishes are

<019> CONT.

largely innate and species specific, ontogenetic and other changes can occur. Since temperature can serve as an unconditioned reinforcer in operant conditioning, thermal responses are not limited to simple kineses or taxes. Extrathermal factors such as photoperiod, circadian rhythms, currents, social and biotic interactions, stresses, infections, or chemicals can affect thermal responses, and may account for some lack of conformity between laboratory preferences and field distributions and behaviors. (Auth)

<011>

Reynolds, W.W., Thermal Equilibration Rates in Relation to Heartbeat and Ventilatory Frequencies in Largemouth Blackbass, *MEGALOPOTRUS SALMOIDES*.

1977. Comp. Biochem. Physiol., 56B, 195-201 (Pennsylvania State University, Wilkes-Barre, PA)

Relative heating and cooling rates were determined simultaneously with heart and opercular beat rates in bass subjected to sudden increases or decreases of 10 to 20 C in ambient water temperature. Cooling rates exceeded heating rates up to 90% of the equilibrium temperature, but equilibrium was usually reached sooner during heating. Heart and opercular beat rates were closely synchronized (1:1) during heating and cooling. Heart and opercular beat rates were greater for a given temperature during heating than during cooling; however, the initially greater rates during cooling may contribute to initially faster cooling. (Auth)

<012>

Reynolds, W.W., and T.E. Casterlin, Temperature Preferences of Four Fish Species in an Electronic Thermoregulatory Shuttlebox.

1977. Progressive Fish Culturist, 39, 123-125 (Pennsylvania State University, Biology Department, Wilkes-Barre, PA)

Temperature preferences of four fish species were studied in an electronic thermoregulatory shuttlebox. The non-temperature preferences (final preferences) of the four species were: black crappie (*POMOXIS NIGROMACULATUS*), 26 C; carp (*CYPRINUS CARPIO*), 29 C; chain pickerel (*ESOX VIRGATUS*), 24 C; and pumpkinseed (*LEPOMIS GIBBOSUS*), 26 C. The species differed in thermoregulatory precision as well as in final preferred temperature, indicating the species-specific nature of thermal behavior. There was little intraspecific variation among individuals tested. The results agree well with those of other investigators using different methods and apparatus. (Auth)

<013>

Reynolds, W.W., D.A. Thomson, and T.E. Casterlin, Responses of Young California Grouper, *LEUOSTEUS TEDES*, to Gradients of Temperature and Light.

1977. Copeia, No. 1, 168-169 (Pennsylvania State University, Biology Department, Wilkes-Barre, PA; University of Arizona, Department of Ecology, Tucson, AZ)

In a laboratory temperature gradient, young California grouper, *LEUOSTEUS TEDES*, exhibited a final modal preference of 25 C, 7 C lower than the final preference of young *L. SARDINI* from the Gulf of California. No circadian rhythms in thermal preference were

found, and the final preference was unaffected by acclimation temperature. Like *L. SARDINI*, young *L. TEDES* were strongly attracted to bright light (10000 lux). In a simultaneous opposed gradient of temperature and light, the fish spent more time at the preferred temperature than at the preferred light intensity. The laboratory results are discussed in relation to observed field distribution and geographic range. (Auth)

<010>

Sho, T.G., Studies on the Seedling Production of the Top Shell, *TURBO CORNUCULUS* Solander.

1976. Bull. Fish. Res. Dev. Agency, Bureau (Kor.), No. 15, 21-31 (Not given)

Top shell from Ulman Bay spawned from May to mid-October. The main spawning occurred from the latter part of July to the end of October when the water temperature ranged from 28 to 24 C. (ST)

<015>

Richards, F.P. (Ed.), W.W. (Ed.) Reynolds, and E.W. (Ed.) McCoolley, Temperature Preference Studies in Environmental Impact Assessments: An Overview with Procedural Recommendations.

1976: 1977. CONF-760499: Proceedings of a Symposium and Panel Discussion held at the Northeast Fish and Wildlife Conference (Northeast Division, American Fisheries Society), Hershey, Pa., April 27, 1976: Jour. Fish. Res. Bd. Can., 34, 720-761 (American Fisheries Society, Northeast Division)

The symposium was held to help facilitate standardization of the methodologies used in environmental impact predictions. It is intended to serve as a primer for those unfamiliar with temperature preference studies and as a source of up-to-date information for those actively working in this area of research. The five formal papers cover the following basic areas: physiological responses to changing temperature, theoretical background of behavioral responses to temperature, a tabulation of published results, application of these results to impact assessments, and a review of laboratory apparatuses and methodologies. Bibliographies were collated to eliminate redundancy and to provide easy reference. General recommendations for the future conduct of temperature preference studies are proposed. Points to be considered are: acclimation, final preference determination, seasonal effects, circadian (diel) rhythms, water quality, group vs individual testing, size/age of test specimens, feeding schedule, shape and size of test tanks, control "x" position effects, adjustment of fish to experimental conditions, observation intervals, and statistical reporting of data. (ST)

<016>

Rieger, P.W., An Evaluation of the Introduction of Florida Bass into an Oklahoma Reservoir Receiving a Heated Effluent.

1976. M.S. Thesis, Oklahoma State University (Oklahoma State University, Stillwater, OK)

Growth and survival of Florida and northern largemouth bass introduced into a 102 hectare cooling reservoir, Beaver Lake, Oklahoma, were compared. Although diel rhythms in growth and survival of the two subspecies were observed, small sample sizes and

<316> CONT.

conflicting results between years made comparisons difficult. Overwinter mortality during both years of the study was greater in the Florida bass populations than in the northern bass populations. Survival was better during the warmer of the two winters. A substantial difference was observed in the distribution of the two subspecies. During the winter, Florida bass were collected only in the vicinity of the heated effluent, while northern bass were collected in all areas of the lake. Catch rates of Florida bass were higher than for northern bass during the warmer months, but lower during the colder months, indicating differential behavioral responses to water temperatures within the same reservoir. (ST)

<317>

Pitcher, L.D., Systematics and Meristic Variation in the Butterfish, *COAX PULLUS* (Forster).

1976. New Zealand Minist. Agric. Fish., Fish. Tech. Rep. No. 165, 46 pp.; Sport Fish. Res., 21, 111 (New Zealand Minist. Agric. Fish., Whangarei, New Zealand)

A historical review of the systematic literature of *COAX PULLUS* (Forster) in Bloch and Schneider, 1801 and *COAX VITTATUS* Sclander in Richardson, 1843 is given, and these nominal species are synonymized. *COAX PULLUS*, the New Zealand butterfish, is described and its form, color, and behavioral changes with growth are discussed. Variation in the number of fin rays, scale rows and vertebrae is shown to have significant negative correlation with sea surface temperature. (Auth)

<319>

Roberts, R.J., and R.J. Hill, Studies on Ulcerative Dermal Necrosis of Salmonids. V. The Histopathology of the Condition in Brown Trout (*Salmo trutta* L.).

1976. Jour. Fish Biol., 8, 89-92 (University of Stirling, Unit of Aquatic Pathobiology, Stirling, Scotland; R.A.P.P. Fish Diseases Laboratory, The Rothe, Weymouth, England)

The clinical signs and histopathological findings of an ulcerative dermal necrosis in brown trout were compared with those observed in salmon and sea trout suffering from DUN. There were close similarities in the lesions shown by both types of fish, but more brown trout recovered and the rate of healing was temperature dependent. At low water temperatures (less than 8 C) healing of lesions required two to three weeks or longer; at higher temperatures (12 to 14 C) the process was completed within seven to ten days. In the wild the disease occurred in sexually mature fish in fall. (Auth)(ST)

<319>

Robertson, S., and J. Levin, Blooms of Surf-Zone Diatoms along the Coast of the Olympic Peninsula, Washington. VIII. Effect of Temperature and Oxygen Concentration on Respiration of *CHAETOCEROS ARRATUS* in the Natural Environment.

1976. Intl. Rev. Gesamten Hydrobiol. (Ger.), 61, 201-210 (University of Washington, Department of Oceanography, Seattle, WA)

Dark respiration rates of the surf diatom species, *CHAETOCEROS ARRATUS*, were measured in field experiments throughout a year-round study. Measurements of dissolved oxygen were

made by employing the Winkler oxygen technique. Oxygen concentration in the ambient water had a significant positive effect upon respiration rate at all temperatures encountered during the period of study (4.6 up to 13.8 C). Above 8 C, respiration rate increased with increasing temperature up to about 12.5 C. Above 12.5, temperature had a detrimental effect. The relationship between the concentration of dissolved oxygen and respiration rate was confirmed experimentally by artificially lowering or raising the oxygen concentration. (Auth)

<320>

Seels, O.P., S. Laurence, L. Van Nesselrodt, and A.P. Ames, Potential Mariculture Yield of Planting Sea Thermal Power Plants. Part I--General Statement.

1976. In Kohl, J. (Ed.), Proceedings of a Conference on Energy from the Ocean--Fact or Fantasy? held in Raleigh, North Carolina, January 27-28, 1976. North Carolina State University Center for Marine and Coastal Studies, Raleigh, North Carolina, (pp. 47-52); Report No. 76-1 (Lamont-Doherty Geological Observatory of Columbia University, Palisades, NY; The City University of Marine and Atmospheric Sciences, Bronx, NY)

Mariculture is not only compatible with electrical power production in sea-thermal power plants, but it is a highly desirable and economically feasible approach to the energy and food situation currently facing the world. The technical feasibility of maintaining the proper mixing of deep and surface water, and keeping this mixed layer at an optimum depth within the euphotic zone, remains to be demonstrated, as does a simple and inexpensive means of growing and harvesting shellfish in the open sea. Increasing cooperation between the power engineers, economists and mariculturists interested in OTEC plants is obviously needed. No sea-thermal power plant design which excludes the possibility of mariculture should be adopted until the relative contribution of the energy-production and biological potential of OTEC plants is examined carefully and in detail. (Auth)

<321>

Sosbough, P.J., and E.T. Garside, Hypoxial Death Inferred from Thermally Induced Injuries at Upper Lethal Temperatures, in the Banded Killifish, *FUNDULUS DIAPHANUS* (LeSueur).

1977. Can. Jour. Zool., 55, 1705-1719 (Dalhousie University, Department of Biology, Halifax, Nova Scotia, Canada)

Banded killifish, *FUNDULUS DIAPHANUS* (LeSueur), acclimated to 25 C were subjected to upper lethal temperatures using a 10000 min bioassay procedure. The incipient upper lethal temperature (LT50) was about 36.5 C. Histologic examination of heat-treated fish revealed no obvious injury to the heart, spleen, trunk musculature, eye, ear, intestine, or digestive tract. Histopathology at upper lethal temperatures is described. (Auth)(ST)

<322>

Rosenberg, A., The Isolation and Characterization of *PSEUDONAS HALODURANS*, Sp. Nov. Selected from the Great Bay Estuary as a Halotolerant Species.

1977. Ph.D. Thesis, University of New Hampshire

(822) CONT.

[University of New Hampshire, Durham, NH]

Halotolerant bacteria isolated from the Great Bay Estuary, New Hampshire, had a temperature range for growth between 5 and 35 C with an optimum temperature between 20 and 25 C. (ST)

(823)

Fueller, R., Reproductive Cycle and Fecundity of White Bass in Lewis and Clark Lake.

1977. Trans. Amer. Fish. Soc., 106, 67-76 (U.S. Fish and Wildlife Service, Southeast Reservoir Investigations, Clemson, SC)

The spawning period of white bass (*Morone chrysops*) in Lewis and Clark Lake extended from May to early June; spawning activity was most intense during the last week in May and the first week in June. Minimum, maximum, and mean water temperatures during the spawning periods were, respectively: 13.4, 27.2 and 20.3 C in 1969; 12.3, 19.6, and 15.9 C in 1970; and 12.2, 18.9, and 14.7C in 1971. (ST)

(824)

Fueller, R., W. Lorenzen, and J. Oliver, Population Dynamics of Young-of-the-Year Fish in a Reservoir Receiving Heated Effluent.

1977. In Assessing the Effects of Power-Plant-Induced Mortality on Fish Populations Held in Gatlinburg, Tennessee, May 3-6, 1977, W. Van Winkle (Ed.). Pergamon Press, New York (U.S. Fish and Wildlife Service, Southeast Reservoir Investigations, Clemson, SC)

Limnetic young-of-the-year fish populations were sampled by trawl in 1973, before significant heated discharges began from a South Carolina nuclear power plant, and in 1974-1976, after the plant was in operation. Three endemic forms were yellow perch (*PERCA FLAVESCENS*), black crappie (*POMOXIS NIGROMACULATUS*), and sunfishes (mostly bluegill, *Lepomis macrochirus*). Threadfin shad (*Dorosoma petenense*) were introduced in early 1974 and were included in the study. Increases in water temperatures were in direct proportion to the amount of power generated by the plant and were greatest in the deeper water. Catches of yellow perch, black crappies, and sunfishes declined between 1973 and 1975. Catches of yellow perch and black crappies were highest at the control station and lowest at the heated water discharge. Sunfish catches were low at all sampling stations after power generation began, but it is unclear whether the decrease in numbers resulted from aging of the reservoir and other natural changes or from the man-induced increase in water temperatures. Threadfin shad catches did not change noticeably during the study. (Auth)

(825)

Pullison, R., Temperature and Water Velocity Effects on the Swimming Performances of Young-of-the-Year Striped Mullet (*MUGIL CEPHALUS*), Spot (*Leiostomus xanthurus*), and Pinfish (*Lagodon rhomboides*).

1977. Jour. Fish. Res. Bd. Can., 34, 2316-2322 (North Carolina State University, Department of Zoology, Raleigh, NC)

Swimming performances of young-of-the-year striped mullet (*MUGIL CEPHALUS*), spot (*LEIOSTOMUS XANTHURUS*), and pinfish (*LAGODON RHOMBOIDES*) were tested by examining the

combination of physical endurance and swimming behavior to provide information on potential fish entrainment and impingement problems at industrial intakes. Tests were conducted at three temperatures (15 to 25 C) and six water velocities (12 to 60 cm/s). Fish lengths ranged from 1.0 to 7.0 cm TL. Fish tested at higher temperatures exhibited increased time for steady swimming and for impingement avoidance. Temperature was also positively correlated with maximum swimming speeds and with the number of bursts performed during drift-burst activity (drifting with the current and returning upstream with a burst of swimming). Increased water velocities resulted in decreased times of steady swimming and impingement avoidance, and reduced drift-burst activity. Larger fish avoided impingement longer and had faster maximum swimming speeds; however, smaller fish showed stronger rheotaxis and swam steadily for longer periods at equal water velocities. Abnormally heavy mucus and spot had reduced capabilities for position maintenance (steady swimming) which may decrease their ability to avoid impingement. (Auth)

(826)

Depprecht, R., The Dependence of Emergence Period in Insect Larvae on Water Temperature.

1976; 1975. In Congress in Canada, V. Sladecek (Ed.). Schweitzerbart'sche Verlagshandlung, Stuttgart, Germany; Verh. Intl. Ver. Theor. Angew. Limnol., 19 (Not given)

The larval development of aquatic insects is accelerated by increases in water temperature. Even small temperature increases (2 C) can lead to seasonally inappropriate adjustments and therefore to the extinction of species (*PERLA NARCISSA*, *HEPTENIA CYANEA*). In the setting of lethal limits concerning temporary peaks in water temperature or oxygen consumption, the laboratory survival value alone is not critical but thresholds which can alter the animal's behavior should be taken into consideration. (Auth)

(827)

Sakaguchi, H., and K. Tanada, Temperature Effect on the Photo-Accumulation and Phobic Response of *Volvox aureus*.

1977. Jour. Protozool., 24, 288-290 (Kyushu University, Department of Biology, Faculty of Science, Fukuoka, Japan)

The green alga, *VOLVOX AUREUS*, showed positive phototaxis at room temperature and negative at low temperature. When stimulated with light of intermediate intensity (about 5 x 10³ lux), the algae responded with a decrease in the frequency or cessation of flagellar movement in the anterior cells. At room temperature, an increase in light intensity elicited the phobic response which lasted only a few seconds, while at low temperature a decrease in light intensity was the effective stimulus. The positive and negative responses of the algae resulted from the brief cessation of flagellar movement in the anterior cells, elicited by an increase of stimulus light at room temperature or a decrease of stimulus at low temperature. (WPC)

(828)

Sakshaug, E., Limiting Nutrients and Maximum Growth Rates for Diatoms in Narragansett Bay.

(424) 1977.

1977. Jour. Mar. Biol. Ecol. (Beth.), 20, 129-133 (The University of Treadbeir, Biological Station, Treadbeir, Soc-17)

Dialysis cultures of *SKELETONA COSTATA* (Cuv.), *Cleve* and *ASTROSTELLA JAPONICA* Cleve & Treadbeir on glass were grown in tanks in running sea water pumped from a depth of 6 m during March-June, at 50% of the surface light intensity, and at a temperature range of 2 to 17°C. The exponential growth rate was exponentially related to temperature at surface light intensities of 350 to 500 ly/day, with a maximum of 2.0 div./day for *SKELETONA* and 1.9 div./day for *ASTROSTELLA* at 17°C. Surface light intensities below 200 ly/day gave a decrease in the growth rate. The growth rates found for *SKELETONA* seemed to encompass all those measured in the Bay, the maximum ones in the Bay being close to those observed in the dialysis cultures. All cultures showed clear physiological signs of nitrogen deficiency, as indicated by changes in the ratios between chlorophyll-a, ATP, nitrogen, and carbon, when going from the exponential phase to the starvation phase. The chl/ATP ratio showed a 4-fold temperature-dependent increase from March to June for both starved and exponentially growing cells of both species. In *SKELETONA* this was mainly due to an increase in chlorophyll content, but in *ASTROSTELLA* to a decrease in ATP which was accompanied by a decrease in carbon per cell. A comparison of dialysis-cultured populations of *SKELETONA* (to 17°C, growth rate = 2.0 div./day and a natural population of the same species (to 15°C, growth rate = 1.0 div./day) showed that they were identical in chemical composition. (Auth)

(429)

Sandifer, P.A., and P.J. Eldridge, A Study of the Distribution and Abundance of *PEVAEUS* Larvae off the Southeastern United States in an Attempt to Identify Spawning Grounds of the Brown Shrimp.

1976. South Carolina Wildlife and Marine Resources Department Report, 26 pp. (South Carolina Wildlife and Marine Resources Department, Charleston, SC)

PEVAEUS larvae and postlarvae were most abundant and widespread in spring and fall and least numerous in winter. They occurred primarily south of 32 degrees North latitude and in the mid-shelf region. The only station where *PEVAEUS* larvae were relatively abundant was in the mid-shelf area between Jacksonville and Cape Canaveral, Florida, where a concentration of 207 larvae/1000 m³ of water was recorded. Mean surface temperature and salinity conditions for stations positive for *PEVAEUS* were 25.2°C and 36.33 ppt. (Auth) (MW)

(430)

Sartore, H.T., and R.C. Hay, Some Effects of Temperature and Salinity on Laboratory-Reared Eggs and Larvae of *POLYDACTYLUS SENPILIS* (Pisces: Polydactylidae).

1977. Aquaculture, 10, 341-351 (Hawaii Institute of Marine Biology, Kaneohe, HI)

Effects of temperature and salinity on eggs and yolk-sac larvae of *POLYDACTYLUS SENPILIS* (Cuvier and Valenciennes) were examined in laboratory experiments. Data on developmental rates as influenced by temperature are presented. Larval length at 95% yolk-sac absorption was maximized between

21.9 and 28.6°C. Based on the development of functional eyes and jaws, larvae were judged capable of feeding before the yolk was completely absorbed. Larvae incubated at intermediate temperatures also had larger amounts of yolk remaining when eyes and jaws were judged functional. Temperature and salinity effects on hatching success, survival at the end of the yolk-sac stage, and morphological abnormalities were studied in a 10 x 1 (temperature x salinity) array of treatments. In 30 ppt sea water, unsalinated larval survival at the end of the yolk-sac stage was greater than 50% between temperatures of 21.9 and 28.6°C. Larval survival decreased at lower temperatures and salinities. Proportions of abnormal larvae increased at temperature and salinity extremes, and normal development was maximized between 26 and 30 ppt. Larvae (70 h after fertilization) were more tolerant to extreme high temperatures than were newly fertilized eggs. Upper salinity tolerance limits of 42-h larvae were greater at 28.2°C than at 23.5°C or 29.2°C, and lower salinity was less tolerated at the two extreme temperatures. Based on the results, recommended temperatures and salinities for rearing *P. SENPILIS* eggs and early larvae are 24 to 28°C and 26 to 35 ppt. (Auth)

(431)

Sarker, A.L., Feeding Ecology of the Bluegill, *LEPOMIS MICHECHINUS*, in Two Heated Reservoirs of Texas. III. Time of Day and Patterns of Feeding.

1977. Trans. Amer. Fish. Soc., 106, 596-601 (Bangladesh Agricultural University, Faculty of Fisheries, Mymensingh, Bangladesh)

The times and patterns of feeding of 1,366 bluegill in two heated reservoirs of Texas were studied by the "points" method for over a year. Fish were collected on alternate hours from an electric power plant discharge canal and an open-water station in each reservoir over 24-hour periods. Both average index of fullness of the stomachs and average points per fish showed a similar diel pattern of feeding. The fish were largely diurnal feeders with a nocturnal component. The stomachs contained least food during the period from 0200 to 0800 hr. Feeding increased after sunrise, and the fish showed a minor peak by 0900 to 1000 hr and a major peak by 1800 to 1900 hr. A gradual decline in food volume began after 1900 hr and continued until 2200 hr, followed by a sharp decline at 2300 hr. A diverse range of food organisms was consumed by the fish during the daylight hours. Planktonic crustaceans and nonaquatic organisms were rarely found in the stomachs of the fish taken at night. In the discharge canal fish, 75% fullness of the stomachs occurred by 0900 hr, but in fish from the open waters, comparable stomach fullness did not occur until 1400 to 1600 hr. (Auth)

(432)

Sauer, D.H., and G. Halder, Enzyme Activities in the Serum of Rainbow Trout, *Salmo gairdneri* Richardson: The Effects of Water Temperature.

1977. Jour. Fish Biol., 11, 605-612 (Universität Stuttgart, Institut für Siedlungsökologie, Abteilung Biologie, Stuttgart, German Federal Republic)

Activities of lactate dehydrogenase, hydroxybutyrate dehydrogenase, glutamic oxaloacetic transaminase, glutamate dehydrogenase, creatinine kinase, alkaline phosphatase, and

lucine amino peptidase were determined in the sera of rainbow trout. The animals had previously been adapted to temperatures of 1, 3, 6, 8, 12, 15, 17, 19, 21.5 and 23°C. 75% of the enzyme activity increased with the rise in temperature. The activity of alkaline phosphatase decreased in the range 6 to 19°C, while the changes in the glutamate isohydrogenase activity took a complex course. The results are compared with the findings of other authors. (Auth)

Fauver, P.S., An Outbreak of "Typhobacterial Disease in Coho Salmon (*Oncorhynchus kisutch*) Escaped in a Maine Estuary.

1974. *Trans. Wildlife Diseases*, 12, 575-578
University of Maine at Portland-Gorham, Center
for Research, Portland, ME

An enzootic of a vibriobacterial infection in salt water, *AEROMONAS HYDROPHILA*, caused the death of 5,000 fish, 10% of a salmon farm population. Cartilage in the nose, mouth and lower jaw was eroded, and yellow sheets of bacterial growth were observed in the mouth, pharynx and mesenteric lumen. Mortalities increased from 1 fish/1000 fish/week to 20 fish/1000 fish/week with increase in water temperature from 14 to 17 C. Pathogenicity trials were inconclusive for the two of 18 experimentally infected fish succumbing to the disease, although lesions and absence of other pathogens suggested that the vibriobacteria was responsible. (Auth) (BPC)

Schell, S.C., The Life History of *YETPERCELLA*
EVANSI Schell: 1974 (Treatatoda: Oocoeelidae), a
 Parasite of the Northern Seaanfish, and the
 Gallgrouth Bass.

1974. Jour. Parasitol., 62, 890-898 (University of Idaho, Department of Biological Sciences, Moscow, ID).

272722CULLA LEWISI is an intestinal parasite of *PTYCHOCHILUS OPPOGHEYSII* and *MICROPTERUS DOLOMIEUXII* in Idaho. The miracidium develops and hatches within 12 to 18 days at 22 to 26 °C or within 50 to 60 days at 12 to 15 C. *Cyliconmicrogaster caracae* develops in fishier sporocysts in *LITOPENUS VIRGATUS* and encysts in fry of *PICHDARCONIUS BALTEATUS*, *HEMICHROMIS CATAPRAE*, *M. OSCELOS*, *PTYCHOCHILUS OREGONENSIS*, *COTTUS BACCHUS*, and *SALMO GAIRDNERI*. Natural infections with metacercariae were found in all of the above fishes except speckled dace and trout. Squawfish were fed fry of experimentally infected rainbow shiner and squawfish and partially developed specimens of *M. LEWISI* recovered 8 weeks later. The larval stages are like those of trematodes in the family *OPPOCELIDAE* to which the species is transferred. (auth)

Scherer, F.O., Analysis of Factors Affecting Passage of American Shad (Alosa sapidissima, Wilson) at Holyoke Dam, Massachusetts and Assessment of Juvenile Growth and Distribution above the Dam.

1975. Ph.D. Thesis, 262 pp. (University of Massachusetts, Amherst, MA)

Stepwise multiple regression computer analyses indicated river flow and water temperature were the most important factors

explaining variation in daily lift numbers of American shad entering the passage facility at Holyoke Dam, Massachusetts. Weekly sampling above the dam indicated that upstream catch declines were first noted at water temperatures ranging between 10.2 and 15.5 C (early October); juveniles began to leave the study area as temperatures approached 16.0 C, and emigration was generally complete when water temperature reached 19 C. (52)

Schlicht, P.G., Entailment Impact Predictions:
An Overview of the State of Texas.

1977. In Third National Workshop on Entertainment & Impingement: Section 316(h) - Research and Compliance, L.D. Jensen, Ed. Ecological Analysis, Inc., Belville, KY (Houston Lighting & Power Company, Houston, TX)

Stratagem study methods and results for three estuarine-sited power plants on the Texas coast are discussed. It is noted that at one of these plants, where a 2,600-acre cooling pool is part of the once-through system, large numbers of young shrimp are apparently surviving summer passage through a 6-mile-long discharge canal. A review of Texas Parks and Wildlife Department reservoir fishery management survey data for five heated and ten unheated reservoirs reveals no decline in sport fishery in the heated reservoirs, one of which has been heated for more than 25 years. (Auth)

Schoenherr, A.A., Density Dependent and Density Independent Regulation of Reproduction in the Tila Topminnow, *POECILIOPSIS OCCIDENTALIS* (Baird and Girardi).

1977. Ecology, 58, 430-444 (Arizona State University, Department of Zoology, Tempe, AZ)

Studies of the Gila topiannow, *POECILIOPSIS OCCIDENTALIS*, indicate that onset of reproduction, proportion of reproducing females, and numbers of embryos carried by females, are influenced by water temperature, photoperiod, food, and predation. Water temperature and photoperiod act upon the fish regardless of population density, whereas, nutritional influences and predation are proportionate to population density. Therefore, density dependent and density independent factors operate to regulate reproduction and neither is actually exclusive. Reproduction is a constant (20 C) spring was year-round, whereas females from a variable temperature pond (12 to 24 C) carried no embryos throughout the winter months. (Arth) (ST)

Schrau, W.L., Jr., Temporal Aspects of Feeding Behavior of the Largemouth Bass, *MICROPTERUS SALmoides* (Lacepede).

1977. Ph.D. Thesis, Southern Illinois University
(Southern Illinois University, Carbondale, IL)

Average daily ration of largemouth bass from a power plant cooling lake was significantly higher in the laboratory at 24 to 25 C than at 18 to 19 C. There were significant differences in average daily ration in different seasons. Growth rate was not higher at the warmer temperatures. (ST)

(819)

Schabel, J.A., C.F. Smith, and T.S.Y. Kuo, Thermal Effects of Power Plant Effluent on Survival of Lake Fishes: A Laboratory Assessment.

1977. Chesapeake Sci., 18, 290-298 (State University of New York, Marine Sciences Research Center, Stony Brook, NY; University of Maryland, Chesapeake Biological Laboratory, Solomons, MD)

Blueback herring (*MOSA AESTIVALLIS*), American shad (*MOSA SAPIDISSIMA*), and striped bass (*MORONE STRIPATUS*) larvae from the Chesapeake Bay region were subjected in the laboratory to time-excess temperature histories typical of those experienced by organisms entrained by power plants with a variety of design and operating criteria. The maximum excess temperature ranged from 7 to 20 C above the base temperature (the average surface water temperature on the spawning grounds); the time of exposure to a maximum excess temperature from 8 to 60 minutes; and the period of cooling to the final temperature from 60 to 300 minutes. An excess temperature of 20 C resulted in virtually total mortality of larvae of all three species. Striped bass larvae were the most tolerant of the three species and could withstand excess temperatures of up to 10 C with no significant increase in mortality. The response patterns of the other two species were more complicated. (Auth)

(820)

Sewer, G.L., A.S. Brooks, and D.L. Latimer, The Effects of a 30-Minute Exposure of Selected Lake Michigan Fishes and Invertebrates to Residual Chlorine.

1977. In Jensen, L.D. (Ed.), Biofouling Control Procedures Technology and Ecological Effects, Marcel Dekker, Inc., New York, pp. 97-99 (Center for Great Lakes Studies, University of Wisconsin-Milwaukee)

Laboratory bioassays were conducted on five species of fish and two invertebrate species to determine the effects of a 30-minute exposure of chlorine to these organisms. Yellow perch demonstrated a decreasing tolerance to chlorine with increasing temperature. The 30-minute LC50 values for the perch were 7.7 mg/l at 10 C, 4.0 mg/l at 15 C, 1.1 mg/l at 20 C, and 1.0 mg/l at 25 C. The 30-minute LC50 values for four other species of fish tested at 10 C were 1.25 mg/l (coho salmon), 2.0 mg/l (rainbow trout), 2.25 mg/l (alewife), and 3.2 mg/l (spottail shiner). Behavioral observations indicated that exposure to lethal concentrations of chlorine caused these fishes to gulp for air and swim in a noticeable lethargic manner. Loss of equilibrium and death followed usually in less than or equal to two hours. Violent swimming was only infrequently seen. Two species of copepods, *LEPOCALANUS NAUPOUS* and *CYCLOPS BICUSPIDATUS THOMASI*, exhibited quite different responses to 30-minute chlorine exposures. The 30-minute LC50 value determined for *L. NAUPOUS* was 1.54 mg/l at both 5 and 10 C. *C. BICUSPIDATUS THOMASI* was considerably more tolerant of 30-minute chlorine exposures. The 30-minute LC50 values determined at 10, 15, and 20 C were 18.66, 15.61, and 5.76, respectively. Field evidence is presented, which shows that the maximum chlorine levels observed at power plant effluents on Lake Michigan (0.3 mg/l) are considerably below the LC50 values determined for any of the organisms tested. (Auth)

(821)

Servizi, J.A., and J.L.T. Jensen, Resistance of Adult Sockeye Salmon to Acute Thermal Shock.

1977. International Pacific Salmon Fisheries Commission Progress Report No. 38, 11 pp. (International Pacific Salmon Fisheries Commission, New Westminster, British Columbia, Canada)

The upper lethal temperature due to acute thermal shock was about 24 C for adult sockeye. Adult sockeye were slightly less resistant to temperatures causing acute thermal stress than were juvenile sockeye. The thermal exposure causing acute thermal stress exceeded that which led to mortality caused by infections of *PLECTONECTES COLUMNARIS*. (Auth)

(822)

Shabica, S.V., The Natural History of the Antarctic Limpet *PATINIGERA POLARIS* (Mousson and Jacquinet).

1976. Ph.D. Thesis, Oregon State University (Oregon State University, Corvallis, OR)

PATINIGERA POLARIS is the only large invertebrate commonly found in the littoral zone of Arthur Harbor, Antarctica. From January 1970 through March 1971 the general ecology and physiological ecology of this patellid limpet was studied. At its natural temperature (-1 to +1 C) *PATINIGERA POLARIS* can tolerate salinities of 0‰ and 22.5‰ normal sea water for eight hours. An LD50 of 15 hours was found for 0‰ normal sea water and 11.7 hours for 22.5‰ normal sea water. *PATINIGERA POLARIS*, an osmoconformer, demonstrates limited osmoregulation at lower salinities. When exposed to thermal extremes of +15 or -15 C, *PATINIGERA POLARIS* exhibits a negative thermotaxis. It can tolerate water temperatures of 11 C for 50 hours. For short periods *P. POLARIS* can tolerate internal core temperatures of 17.5 C. On vertical surfaces *P. POLARIS* responds to ice, and high water and air temperatures by releasing its attachment and falling into the sublittoral or to the bottom of a rock pool. (Auth) (ST)

(823)

Shofler, D., and K. Reich, Growth of Silver Carp (*HYPOPHthalmichthys molitrix*) in Lake Kinneret in 1969 - 1975.

1977. Benidqeh, 29, 3-16 (Ministry of Agriculture, Fisheries Department, Israel; The Hebrew University, Department of Zoology, Jerusalem, Israel)

Rapid growth began in early spring when the temperature of Lake Kinneret (Israel) upper water layers reached 17 to 19 C. During the first spring, the fish grew at the rate of 4 to 5 g/day. As the temperature of the water rose and the weight of the fish increased, their growth rate also increased to about 8 g/day. During the winter, the growth decreased, but even at temperatures of 15 to 16 C, did not cease entirely. During the second summer the growth rate accelerated and by winter most of the fish reached a weight of 5 to 6 kg. (M7)

(824)

Sherberger, F.P., L.V. Benfield, L.L. Dickson, and J. Cairns, Jr., Effects of Thermal Shocks on Drifting Aquatic Insects: A Laboratory

<001> CONT.
Simulation.

1977. Jour. Fish. Res. Bd. Can., 34, 529-536
(Virginia Polytechnic Institute and State University, Department of Biology and Center for Environmental Studies, Blacksburg, VA)

Effects of temperature shocks from thermal plumes on drifting ISOPTICHA (Ephemeroptera: Baetidae) and HYDROPSYCHE (Trichoptera: Hydropsychidae) larvae were examined in a laboratory simulation. Groups of both insects were collected at various seasons and acclimated in the laboratory at temperatures comparable to those in the field. Groups were exposed to thermal shocks of varying duration and observed for periods of 10 days afterward. Consistent statistically significant differences in mortality between treatment and control groups were not evident until shock temperatures neared the respective upper lethal limits for the two insects. For HYDROPSYCHE no effects were observed below a shock temperature of 20 C. Preliminary tests demonstrated that a total shock temperature (ambient plus increment) of 39 C killed all HYDROPSYCHE exposed 10 min or longer; 30 C was chosen as the maximum shock temperature. For ISOPTICHA no significant mortality was observed below a shock temperature of 26.5 C. Preliminary tests demonstrated that a total shock temperature of 36 C killed all ISOPTICHA exposed 10 min or longer; 35 C was chosen as the maximum shock temperature. While consistent treatment relating differences in molting frequency in ISOPTICHA were not obtained, changes in the patterns of molting were observed. Behavioral tests with ISOPTICHA indicated no discernable treatment effects on rheotaxis, phototaxis, and substrate orientation. No discernable effects of treatment on susceptibility of ISOPTICHA to predation by COTTUS CAROLINAE were observed. (Auth.) (ST)

<005>

Sheridan, R.P., and T. Wlik, Adaptive Photosynthesis Responses to Temperature Extremes by the Thermophilic Cyanophyte SYNECHOCOCCUS LIVIDUS.

1976. Jour. Phycol., 12, 255-261 (University of Montana, Botany Department, Missoula, MT)

Optimum temperature for growth of the thermophilic cyanophyte SYNECHOCOCCUS LIVIDUS was 45 C. Optimum temperature for photosynthesis increased from 50 to 55 C when cells were grown at 57 C; a decrease occurred from 50 to 45 C for C-14 labeled CO2 uptake in cells grown at 35 C. These changes were assigned to be adaptive. The decrease in chlorophyll-a, plastocyanin, and activity of ribulose-1,5-diphosphate carboxylase and was associated with a reduced O2 yield correlated with a reduced ferricyanide photoreduction capacity. Since the decrease in photosynthesis which occurred at more than 55 C was accompanied by a rapid decrease in RuBP carboxylase activity, the cause must have been due to damage to ferricyanide reducing systems and reduced enzyme activity, whereas low photosynthesis rates at sub-optimal temperatures were probably due to a rate limiting effect of low temperatures on RuBP carboxylase activity with no evidence of damage to ferricyanide photoreducing systems. (NPC)

<006>

Shin, S.U., S. Morie, S. Okuzumi, and T. Kobayashi, Seasonal Variation of the Bacterial Flora in Coastal Sea-water in Relation to the Occurrence of VIBRIO PARAHAEOLYTICUS.

1974. Bull. Jap. Soc. Sci. Fish., 42, 1049-1053 (Tokyo University of Fisheries, Minato-ku, Tokyo, Japan)

In summer months, high numbers of VIBRIO PARAHAEOLYTICUS were collected in coastal sea water while, in winter, the organisms disappeared. The seasonal variation in plate counts with a 7 day incubation at 25 C was quite random. At 25 C, only two genera isolated, VIBRIO and PSEUDONAS, were dominant independent of seasonal variations in water temperature, although their growth temperature ranges correlated with the seasons in which they were isolated. Most of the summer isolates grew at 35 C while winter isolates failed to do so. Comparisons of different incubation temperatures (25, 37, 40, 42 and 44 C) with seasonal variations showed a close correlation between the level of incidence of V. PARAHAEOLYTICUS and the plate counts obtained at 42 C. At 42 C, VIBRIO and PSEUDONAS constituted a relatively large percentage of the summer population, while gram positive rod bacteria predominated from October to December. Most VIBRIO strains isolated at 42 C were V. ALGIVOLYTICUS. V. PARAHAEOLYTICUS in coastal sea water was accompanied by greater numbers of V. ALGIVOLYTICUS during the summer season. (R.C)

<007>

Shrode, J.S., Genetic and Temperature Effects on Development of the American Pupfish.

1975. Ph.D. Thesis, 70 pp. (Arizona State University, Tempe AZ)

Adult CYPRINODON B. BEVAERENSIS were collected from Saratoga Springs, Death Valley National Monument, California, and bred in the laboratory at 20 C, 16L:8D. Eggs were incubated at constant temperatures and at diel fluctuating temperatures. Greater than 50% normal hatch occurred between constant temperatures of 20 and 36 C and at fluctuating temperatures of 20 to 20 C, 36 to 26 C, and 30 to 30 C. Eggs were able to withstand a daytime high temperature, 30 C, when the temperature was allowed to drop at night. This temperature was not tolerable under constant conditions. The tolerance limits for normal egg development paralleled the temperatures reported in the literature for breeding behavior observed in the field. Critical thermal maxima of young fish were significantly higher than those of older fish acclimated under the same conditions. The tolerance to high temperature is apparently lowest during the egg stage, highest in young fish, and intermediate in large adults. There was no significant difference in number of vertebrae among any of the following experimental groups on which counts were made: fish which had been incubated at 1) constant temperatures 20 through 36 C, 2) diel fluctuating temperatures of 20 to 20 C, 36 to 26 C, and 30 to 30 C, 3) photoperiods 16L:8D, 20L, 20D, at temperatures of 20, 20, and 36 C, and 4) adults collected from the marsh and spring pond at Saratoga Springs. It may be advantageous for the pupfish to have reduced sensitivity to temperature in affecting vertebral number by reducing developmental abnormalities which might otherwise occur under widely fluctuating temperatures in the natural habitat. (Auth)

<009>

Shrader, J.B., and S.B. Gerhine, Effects of Constant and Fluctuating Temperatures on Reproductive Performance of a Desert Pupfish, *CYPRINODON N. NEVADENSIS*.

1977. *Physiol. Zool.*, 50, 1-10 (Arizona State University, Department of Zoology, Tempe, AZ)

Reproductive temperature tolerance tests were performed in the laboratory on an inbred stock of *Ancistrus pupfish*, *CYPRINODON N. NEVADENSIS*. Egg production was optimal at constant temperatures 24 through 32 C and at fluctuating temperatures 32 to 28 and 36 to 29 C. The reproductive tolerance range, defined as the range of optimal egg production with at least 50% hatchability, was 24 through 30 C, which is one-fifth of the range for normal activity and one-seventh of the critical thermal tolerance range. Temperature also affected the quality of eggs produced; temperature and yolk diameter were inversely related. The tolerance limits for oogenesis were narrower than the limits for successful hatching of healthy eggs exposed to temperature stress after spawning. (Auth)

<009>

Shyamshankari, K., and T. Rajbuddhi, Experimental Investigations of Salinity and Temperature Effects on Early Developmental Stages in *DESMONOPHIS (DESMONOPHIS) NISIATA* (Alder & Hancock) (Gastropoda Opisthobranchia).

1976. *Ann. Zool. Ital.*, 10, 93-104 (Madras University, Department of Zoology, Saltair)

Development of *DESMONOPHIS NISIATA* occurred over the temperature range 9 to 35 C. The highest percentage of development took place at 29 C and a salinity of 30 ppt. Shelled veligers appeared in 5-7 days at 29 C and in 18.5 days at 9 C. (ST)

<053>

Sidell, B.D., Turnover of Cytochrome C in Skeletal Muscle of Green Sunfish (*LEPOMIS CYANELTIS*, W.) During Thermal Acclimation.

1977. *Jour. Exp. Zool.*, 239, 233-250 (Johns Hopkins University, Chesapeake Bay Institute, Baltimore, MD)

The concentration of cytochrome c in the skeletal muscle of green sunfish acclimated to 5, 15, and 25 C decreased with increasing acclimation temperature (1.51, 1.17, and 0.90 nmol/mg wet wt, respectively). Based on change in concentration, the half-life of cytochrome c was 7.1 days at 25 C and 13.7 days at 5 C. Transfer of fish from 25 to 5 C resulted in a rapid decrease (40%) in rates of synthesis of skeletal muscle cytochrome c and a concomitant decrease in the degradation rate constant of the molecule of 60%. This led to an approximately 50% net increase in the concentration during acclimation. In transfer from 5 to 25 C, the converse occurred, resulting in the observed decrease in cytochrome c content. (ST)

<051>

Siripont, U., Growth of the White Crappie in a Reservoir Receiving a Thermal Discharge, Thomas Hill, Missouri.

1977. M.S. Thesis, University of Missouri (University of Missouri, Columbia, MO)

The study was undertaken to determine the effects of a hotwater discharge on the growth

of white crappie (*POGONIS ANNUABIS*) in Thomas Hill Reservoir. After an analysis of body-scale relationships, length-frequency distributions of year-classes, growth in length and weight, time of annulus formation, and condition of 2054 white crappie collected during 1968-1970, it was not possible to determine the effect of the thermal effluent on the growth rate. (ST)

<052>

Smith, A.G., Some Aspects of Trophic Relations of Gizzard Shad, *PARACHanna CYPEDALUS*.

1976. Ph.D. Thesis, Virginia Polytechnic Institute and State University (Virginia Polytechnic Institute and State University, Blacksburg, VA)

Best-fit metabolism-weight relations of gizzard shad were found to be $W = 0.052 U(E \pm 0.008)$ at 10 C, $W = 0.659 U(E \pm 0.04)$ at 15 C and $W = 0.769 U(E \pm 0.937)$ at 20 C in a siphon-equipped respirometer. (ST)

<053>

Smith, H.W., Temperature Adaptation in Fish.

1976. *Biochem. Soc. Symp.*, 41, 43-60

(Agricultural Research Council, Institute of Animal Physiology, Babraham, Cambridge, England)

Altering the body temperature of fish causes immediate changes in both the functional and biochemical properties of secretory epithelial tissues. The present account describes how the intestinal tract of the goldfish (*CARASSIUS AURATUS*) adapts to regulate its function after a sudden exposure to a change in environmental temperature. Adaptation can be seen to take place in three distinct steps. The 1st stage, occurring 15 to 20 hr after the change in environmental temperature, alters the ability of actively transported non-electrolytes to increase the microvillar membrane permeability to Na. The passive permeability of the cells to Na is also regulated at this stage. The 2nd adaptive change involves changes in membrane phospholipids and amino acid transport. This occurs after about 32 to 48 hr. However, the intracellular Na remains low and the intracellular K remains high for two to three weeks. There is then a final regulation of Na-pump activity. This change, which is concerned with pump turnover rather than with number of pump sites, is probably connected with the synthesis of new cells. These changes are discussed in detail, and an attempt is made to relate fine changes in phospholipid fatty acid composition to known changes in membrane function. (Auth)

<054>

Smith, H.W., Productivity Measurements and Simulation Models of a Shallow Estuarine Ecosystem Receiving a Thermal Plume at Crystal River, Florida.

1976. Ph.D. Thesis, University of Florida (University of Florida, Gainesville, FL)

The effects of the heated discharge of two power plants on the receiving estuarine ecosystem near Crystal River on the west coast of Florida were investigated with measurements and simulation models to help understand relationships and predict the consequences of a third power plant under construction. Energy circuit models emphasizing diurnal and seasonal aspects of ecosystem responses were used to assess the

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effect of power plant operation on estuarine ecosystems. Field measurements were taken in the discharge-affected and -unaffected areas nearby. Benthic populations dominated total metabolism in both systems. Community gross primary production varied seasonally in the unaffected areas. In the discharge area it was relatively constant. Total biomass and standing stock of primary producers and benthic organisms were lower in the discharge area. Diversity was lower in the discharge bay than in the unaffected area. Nined macroalgae and seaweeds were the dominant benthic producers in the unaffected areas, while the seaweed *SAPIOLE WRIGHTII* was virtually the only species in the discharge bay. Species diversity was lower for estuarine reef organisms, and fewer species of fish were caught in trap nets in the discharge bay than in the unaffected bay. (ST)

<455>

Soska, A., and G.J. Soska, Biocenosis Reaction to Heated Water.

1975. Wlad. Wskol. (WS58), 22, 117-135 (Zaklad "Rybnictwa i Ochrony Wod, Institute Wzrostowania Srodowiska, Warsaw, Poland)

The article consists of a review of literature on biocenosis reaction in reservoirs and lakes receiving heated waste water from traditional and atomic power stations. The results are given of studies on phytoplankton, algal biomass, periphytic algae, macrophytes, zooplankton, fauna associated with macrophytes and bottom fauna. A discussion is given of the occurrence, species composition, abundance, biomass and production of aquatic organisms. Physical, chemical and biological changes in heated waters depended on the type of habitat. Character of biocenoses, climatic zone, time of year and distance from discharge of heated water. It was concluded that changes are complex and site specific. (ST)

<456>

Spath, W., and F. Grocki, Reactions of the Goldfish (*CARRASSIUS AURATUS AURATUS* L.) to Quantified Technical and Thermal Stimuli.

1975. Experimentia (Switz.), 32, 1253-1255 (Doct. Allgemeine Zool., Ruhr-Univ. Bochum, Postum Ouerenberg, German Federal Republic)

Goldfish can differentiate between mechanical and thermal stimuli components in combined stimulations. Reactions to heated thermode ($\Delta T = +3^\circ C$) differ from those to isotherm thermode by up to 30%. Additional pretension ($1.5 g$) increases the reaction more than double; at simultaneously varied temperature ($\Delta T = +3^\circ C$ and $+5^\circ C$), there is a further increase in reaction of 25% and 35%. The significance for the organism of the two stimuli components is discussed. (A.th)

<457>

Sporber, O., J. Frow, and P. Sparre, A Method to Estimate the Growth Rate of Fishes, as a Function of Temperature and Feeding Level, Applied to Rainbow Trout.

1977. Medd. Dan. Fisk. Havunders. (Den.), No. 7, 275-317 (Danish Trout Culture Research Station, Fross, Denmark)

Estimates of the parameters in a physiological growth equation were provided

by aquaria experiments utilizing young rainbow trout. Emphasis is on the numerical prediction of growth patterns when the weight of the trout, food ration, and water temperature is known. (ST)

<458>

Späler, R.E., and T.A. Foenke, Diel Variations in Sensitivity of Fish to Potentially Lethal Stimuli.

1977. Progressive Fish-Culturist, 39, 100-107 (University of Wisconsin-Milwaukee, Center for Great Lakes Study, Milwaukee, WI)

Pimephales promelas (PIMEPHALES PROMELAS) exhibited differences in sensitivity to potentially lethal levels of heat depending on the time of day. Critical thermal maxima were determined at six different times of day following acclimation to $14.5^\circ C$. The period of maximum susceptibility was in late afternoon and evening (1800 and 2200 hr). At 2200 hr the critical thermal minimum was $32.4^\circ C$; the next highest susceptibility was 1800 hr ($33.3^\circ C$). The susceptibility of fish tested at 0200 hr did not differ from those tested at 0600, 1000, or 1400 hr (34.0 , 33.8 , 33.9 , and $34.0^\circ C$). (ST)

<459>

Späler, R.E., T.A. Foenke, V. de Vlaming, and A.M. "ier, Effects of Thermocycles on Body Weight Gain and Gonadal Growth in the Goldfish, *CARRASSIUS AURATUS*.

1977. Trans. Amer. Fish. Soc., 106, 840-846 (Milwaukee Public Museum, Milwaukee, WI; Marquette University, Milwaukee, WI; Louisiana State University, Baton Rouge, LA)

Goldfish subjected to increased temperatures at one of six different times of day had significant differences in weight gain and testicular growth depending on the time of treatment. Depending on the time of day the thermocycle was initiated, weight gain and testicular growth could be either stimulated, inhibited, or equal to that in fishes subjected to constant heat or constant cold. Heat applied during the last 4 hr of darkness was particularly conducive to weight gain and testicular growth. The results of this study may have important implications for aquaculture. (Anth)

<460>

Spigarello, S.A., and R.M. Thomas, Sport Fishing at a Thermal Discharge into Lake Michigan.

1976. Jour. Great Lakes Res., 2, 99-110 (Argonne National Laboratory, Radiological and Environmental Research Division, Argonne, IL)

Sport fishing censuses were conducted during 1972 and 1973 at the Point Beach Nuclear Plant on Lake Michigan (Two Rivers, Wisconsin). The objectives of this study were to describe the fishery at a typical shoreline thermal discharge into the upper Great Lakes and to make comparisons with reference fisheries in unheated areas. Extensive sport fishing at this power plant resulted in a relatively large catch of trout (four species) and sporadic catches of salmon and non-salmonid species. Species composition of the catch and catch per-unit-effort varied daily and seasonally and generally reflected trends in reference fisheries. A comparison between years showed increased fishing effort, total catch, and proportion of trout in 1973, while success

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(catch-per-unit-effort) decreased. Despite this heavy fishing pressure, catch-per-unit-effort was generally higher at Point Beach than in reference shoreline fisheries. The economic value of thermal discharge fisheries on Lake Michigan is estimated using available value and expenditure data. (Auth)

<461>

Spicerelli, S.A., H.V. Thomas, and L.L. Feitiner. The Influence of Body Weight on Heating and Cooling of Selected Lake Michigan Fishes.

1977. Comp. Biochem. Physiol., 56A, 51-57 (Argonne National Laboratory, Radiological and Environmental Research Division, Argonne, IL)

Kinetics of change in body temperature are given for eight species of Lake Michigan fish exposed to instantaneous change in water temperature. Seven independent variables were tested by least squares to develop models to predict heating and cooling half-times and rate coefficients. Fish body weight was the best predictor of temperature change and explained up to 96% of the variability between individuals. Cooling half-times were significantly longer than heating half-times for live fish; no differences were found between heating and cooling of dead fish. Significantly longer half-times for dead fish and a direct relationship between the ratio of heating-cooling times and body weight demonstrated the relative importance of circulatory heat exchange. (Auth)

<462>

Spindler-Barth, V., A Bacterial Infection in the Common Shore Crab *CARCINUS MAEMIS* and the Piddler Crab *PCA PUGILATOR*.

1976. Marine Biol. (B. Ger.), 36, 1-8 (University of Kiel, Institut für Meereskunde, Kiel, Germany)

An infection of *CARCINUS MAEMIS* and *PCA PUGILATOR* by Gram-negative bacteria and its effects on the molting cycle, the concentrations of some chemical constituents, and the coagulation process of the hemolymph are described. The percentage of infections recorded in the field was between 0 and 10%, depending on season. Percentage of infection in *PCA PUGILATOR* was highest in July. In the laboratory the bacteria grew faster at 27 C than at 37 C. (ST)

<463>

Stainken, D.H., The Effect of Oil Pollution on the Physiology of *HYA ARETHAIA L.*, with Special Reference to the Effect upon Respiration and Mode of Accumulation.

1975. Ph.D. Thesis, Rutgers University (Rutgers, The State University of New Jersey, New Brunswick, NJ)

The acute toxicity of No. 2 fuel oil on the soft shell clam was tested at 0 and 10 C. A temperature-dose effect was observed. There was little mortality at 0 C; toxicity increased at 10 C. A dose dependent standardized pattern of behavior of the clams was recorded. (ST)

<464>

Stauffer, J.R., J. Cairns, Jr., D.S. Cherry, B.F.

Jeoncourt, and E.L. Dickson, The Influence of Temperature on the Fish Community Structure of the New River, Glen Lyn, Virginia.

1976-1976. Rev. Biol. (Port., Br.), 10, 21-60 (Virginia Polytechnic Institute and State University, Center for Environmental Studies, Blacksburg, VA; York College, Department of Biology, York, PA)

The influence of temperature on a fish community, via a comparison of diversity indices, changes in number of species, and changes in percent species composition, was evaluated. In 1973, comparison of rotenone diversity indices with temperature intervals showed that above 26.7 to 30.6 C diversity index values decreased with an increase in temperature. Comparison of diversity indices by station from February-October 1973, indicated that community structure as determined by diversity indices was stable throughout the study area. During certain times of the year, the fish community as a whole was affected by the increased water temperature. However, because the impact of the heated discharge resulted mainly in an increase in abundance of some species (notably the spotfin shiner) rather than a major reduction in the total number of species, and the fact that the heated discharge was small compared to the average flow of the New River, it was concluded that the overall maintenance and function of the New River ichthyofauna in the vicinity of Glen Lyn, Virginia, was not impaired by the heated discharge. (ST)

<465>

Stearns, L.C., A Comparison of the Evolution and Expression of Life History Traits in Stable and Fluctuating Environments: *CANBOSIA AFFINIS* in Hawaii.

1976. Ph.D. Thesis, University of British Columbia (University of British Columbia, Canada)

By raising *CANBOSIA AFFINIS* in the laboratory under controlled conditions of density, food, and temperature, differences as large as those observed in Hawaiian reservoirs were produced. The differences among stocks in reproductive traits were, with two exceptions, in the same direction in the laboratory as in the field. Long periods of low water and restricted food favored large fish (greater than 20 mm) in both laboratory and field. Short-term fluctuations in the field seemed to favor small fish (less than 22 mm). Since 1965 life history traits of *CANBOSIA* in Hawaii have evolved in different directions, depending on the stability of the reservoir. (ST)

<466>

Steffensen, D.A., The Effect of Nutrient Enrichment and Temperature on the Growth in Culture of *ULVA LACTUCA L.*

1976. Aquatic Botany, 2, 337-351 (University of Canterbury, Botany Department, Christchurch, New Zealand)

The growth response of *ULVA LACTUCA* to temperatures between 6 and 25 C was tested on plants from two localities which differed in water temperature. Growth of plants from the area with the higher mean monthly temperature increased to an optimum of 19 C. Those from the other area increased at a faster rate to an optimum at 16 C. In both cases growth rates decreased above 20 C and were completely inhibited at 25 C. (ST)

<067>

Stewart, R.J., S.E. Brandt, J.J. Reagen, and J.C. Mitchell, Distributional Response of Fish to a Thermal Front in the Atlantic Ocean Near Cape Hatteras.

1976. Presented at the 99th Annual Meeting, Am. Soc. Limnol. Oceanogr. held in Savannah, Georgia, June 27-28, 1976; Spec. Fish. Abs., 21, 86 (University of Wisconsin, Madison, WI)

A thermal front between Gulf Stream and Virginian water masses was located north of Cape Hatteras off Oregon Inlet in June 1975. Bottom water temperature changed 12 C in 5 km at the interface. Distribution of fishes was studied by intensive trawling in selected temperature strata of the thermal gradient and by trawling in sample grids. The thermal defined a boundary between northern cold water and southern warm water fish faunas of the continental shelf and resembled an ecotone with relatively high fish abundance and diversity. Nineteen taxa (out of 90), were found only at the front. Midwater acoustic estimates of fish abundance correlated with trawl catches and showed fish concentrated at the thermal front. Temperature seemed of greater importance than the ecological configuration of Cape Hatteras as a regulator of fish distribution. (Auth) (TM)

<068>

Stranzo, R.J., C.B. Schreck, and J.T. Golden, Corticoid Stress Responses to Handling and Temperature in Salmonids.

1977. Trans. Amer. Fish. Soc., 106, 213-218 (Oregon State University, Oregon Cooperative Fishery Research Unit, Corvallis, OR)

Plasma corticoid concentrations in juvenile chinook salmon (*Oncorhynchus tshawytscha*) netted and confined in a small live-cage rose from approximately 100 ng/ml to about 500 ng/ml in 20 hr, then fell to 250 ng/ml at 40 hr. In juvenile chinook salmon dip netted into a bucket containing aerated water and sampled serially at 90-sec intervals, plasma corticoids increased from less than 70 ng/ml to approximately 100 ng/ml in 20 min. In juvenile cutthroat trout (*Salmo clarki clarki*) acclimated to 13 C and subjected to a rapid increase in water temperature to 26 C, plasma corticoid concentration increased from about 20 ng/ml to 70 ng/ml in 25 min and remained elevated for more than 3 hr. Juvenile cutthroat trout acclimated to diurnal temperature cycles (13 to 23 C) had no substantial changes in plasma corticoid concentration throughout the cycles. Juvenile cutthroat trout acclimated to 23 C had the same initial corticoid concentration as cutthroat trout acclimated to 9 C. When both groups were subjected to identical netting and confinement, the corticoid concentrations in fish from the two temperatures responded in a similar fashion until 70 min of confinement when trout from the warmer water failed to maintain increasing corticoid concentrations. (Auth)

<069>

Straw, R., R. Johnson, T. Nelson, J. DeBusk, and G. Williams, Species Diversity and Abundance of the Benthic Fauna, Macroplankton, Commercially Important Shrimp, and Fishes, Before and After the Construction of the Cedar Bayou Generating Station.

1976. Progress Report for 1973 submitted to the Houston Lighting and Power Company, 151 pp.

(Texas A&M University, Department of Wildlife and Fisheries Sciences, College Station, TX; Texas Agricultural Experiment Station, TX)

The four most abundant species, *Leptocottus armatus*, *Stenobosmina benedicti*, *Medicottus californiensis* and *Nacoma mitchelli*, showed an overall increase in abundance since construction of the Cedar Bayou Generating Station. In general, the greatest mean catch-per-effort was during the cooler months. Some general decreases were noted in abundance of some crustaceans such as *Palaeomonetes* sp. and *Pemphigus* *astacus*. Also less abundant were post-larval and juvenile *Leiostomus xanthurus*, *Brevortia patonius*, and *Microgobius undulatus*. The most abundant group collected, the brachyuran zoea increased in abundance. In general the limited data indicated that populations of brown, white and grass shrimp and blue crab sample; in November and December showed little change in pattern. Variations between trips and stations were apparently related primarily to migratory patterns and recruitment. Seepage and frame sampling was done in Tabbs Bay, Cedar Bayou, Trinity Bay and the discharge area in Trinity Bay. (RJC)

<070>

Sade, J.R., R.B. Sharitz, and D.O. Stramey, Morphological Aberrations in TYPHA Populations in a Post-Thermal Aquatic Habitat.

1977. Amer. Jour. Bot., 64, 570-575 (Savannah River Ecology Laboratory, Aiken, SC)

Morphological aberrations in *TYPHA* populations inhabiting a once thermally stressed aquatic system on the Savannah River Plant in South Carolina were investigated by using both morphological and enzymatic procedures. No evidence of hybridization or introgression between *T. latifolia* and *T. domingensis* was found. Exposure of these populations to post-thermal conditions and low levels of radiocesium were judged insignificant in contributing to the morphological differences observed. Both genotypic flexibility and plasticity appear to be critical factors in the adaptation of *TYPHA* to varied environments. (Auth)

<071>

Sutcliffe, W.W., Jr., R. Drinkwater, and R.S. Hair, Correlations of Fish Catch and Environmental Factors in the Gulf of Maine.

1977. Jour. Fish. Res. Bd. Can., 34, 19-30 (Bedford Institute of Oceanography, Department of Environment, Fisheries and Marine Service, Marine Ecology Laboratory, Dartmouth, Nova Scotia, Canada)

In an investigation of catches of 17 commercial marine species of fish and shellfish from the Gulf of Maine, 70 showed statistically significant correlations with sea temperatures at St. Andrews, New Brunswick, or Boothbay Harbor, Maine. Most fish records contained at least 40 yr of data. Descriptive equations are produced for four species based first on the correlation between catch and sea temperature and second on the correlation between catch and sea temperature allowing for fishing effort. Inclusion of fishing effort improved the correlations for all of the species examined. The equations permitted the prediction of later parts of the records from earlier parts. The large fluctuations in individual species abundance was interpreted as resulting from a combination of fishing

<871> CONT.

pressure and oceanic climate as represented by sea temperature. (auth) (77)

<872>

Suyasu, I., and T. Iwasaki, Radiation-Induced Life Span Shortening of *ARTEMIA* under Different Temperature Conditions.

1976. Exp. Gerontol., 11, 133-140 (National Institute of Radiological Science, Division of Biology, Chiba, Japan)

Adult life span of *ARTEMIA* by sexual difference was investigated. The mean life span of male-female mixed populations was longer than that of segregated male or female populations. When freshly hatched *ARTEMIA* was irradiated with acute doses of gamma rays, significant reductions in life span resulted after doses of 10 krads and above. When non-irradiated and irradiated *ARTEMIA* were kept at various temperatures, the length of life span in both groups decreased with rise in environmental temperature. Survival time at 15 C was prolonged by 3 times in non-irradiated control group, and by 6 times in irradiated groups as compared with survival at 32 C. From the present data, radiation induced life span shortening was detected. (auth)

<873>

Suzuki, H., and H. Yanouchi, Effect of Temperature on Maturation of a Cyprinid Leach.

1977. Bull. Jap. Soc. Sci. Fish., 43, 367-373 (Freshwater Fisheries Research Laboratory, Oda Branch, Kozaki, Oda, Japan)

Young female leach were reared for two months in aquaria held at 15, 20, 25, and 30 C in both summer and winter. In both groups the highest gonadosomatic index ratios were in the groups kept at 25 and 30 C. Following injection of human chorionic gonadotropin, average fertilization and hatching rates of eggs in the group kept at 25 C were significantly higher than in the other groups. In other studies, females collected during different seasons and maintained at 25 C in the laboratory successfully spawned out-of-season. (ST)

<874>

Sweeney, B.W., The Response of Aquatic Insects to Thermal Variation.

1976. Ph.D. Thesis, 232 pp. (University of Pennsylvania, Philadelphia, PA)

The significance of diurnal and seasonal temperature patterns to the bioenergetics and life history parameters of seven species was evaluated. Rates of egg development and nymphal growth were studied in laboratory and field microcosm streams. Results indicated an immediate response of all species to short-term thermal variation. For summer species, degree-hour accumulations and developmental time for both eggs and nymphs generally decreased with increased magnitude of the diurnal temperature pulse. Acceleration of development was especially significant for environments exceeding 15 C. A consistent pattern of reduced adult body size and fecundity was observed for nymphs reared in non-optimal (i.e., warmer or cooler) thermal regimes. Metabolic response to diel changes in temperature was immediate. The magnitude of the response depended on animal size and range of temperatures. The

energy demand/unit wt of tissue was inversely related to body size for all species at all temperatures. Rates of growth, metabolism, and assimilation generally increased with temperature but decreased with age of the animal. Net growth efficiencies were highest for early instar nymphs, particularly at cooler temperatures. Both net growth efficiencies and production/respiration ratios decreased with rising temperatures above 15 C. This was attributed to a disproportionate shift of assimilated energy away from growth and into maintenance. (BFC)

<875>

Sweeney, B.W., and J.L. Schaeck, Egg Development, Growth, and Metabolism of *SIGAMA ALTERNATA* (Say) (Diptera: Cecididae) in Fluctuating Thermal Environments.

1977. Ecology, 58, 265-277 (Academy of Natural Sciences of Philadelphia, Streeter Water Research Center, Avondale, PA; University of Pennsylvania, Department of Biology, Philadelphia, PA; National University of La Plata, Institute of Limnology, Argentina)

Egg development and growth of *SIGAMA ALTERNATA* were evaluated in six fluctuating temperature regimes with daily maxima ranging from 12.0 to 21.5 C. Developmental rate was positively correlated with increased magnitude of the diel temperature pulse. Developmental acceleration was most apparent for environments pulsing beyond 15.0 C for both stages. A critical temperature region of 11.0 to 12.5 C was observed for initiation and maintenance of egg laying. Metabolic rates were measured using a differential respirometer. The thermal response of metabolism varied with animal size and the range of test temperatures. The energy demand per unit weight of tissue was inversely related to body size at all temperatures. Energy budgets were determined for nymphal development in all thermal regimes. Net growth efficiencies and production/respiration ratios for *SIGAMA ALTERNATA* ranged from 49.7 to 73.4% and 0.9 to 2.7, respectively. Assimilation rates increased with rising temperatures and varied between 1.05 and 3.52 J/mg day (=0.25 to 0.80 cal/mg day). Net growth efficiencies tended to decrease with increased temperatures due to higher maintenance costs. The significance of fluctuating temperatures to the bioenergetics, developmental dynamics, and ecology are discussed. (auth) (ST)

<876>

Strasko, L., and G.C. Teleki, Annual Variations in the Fecundity of Yellow Perch from Long Point Bay, Lake Erie.

1977. Trans. Amer. Fish. Soc., 106, 578-582 (Ontario Ministry of Natural Resources, Nanticoke Project, Port Dover, Ontario, Canada)

From 1974 through 1976 the spawning migration pattern of yellow perch was similar. During the middle of April, as water temperatures rose from 1.5 to 6 C, fish moved inshore (0 to 10-m depth) from deeper water (20 m). Spawning took place from the last week in April through the last week in May; the peak occurred during the first two weeks in May at 8 to 10 C. In late November, when temperatures dropped below 6.0 C, perch returned to their deep-water wintering grounds. (ST)

<477>

Paulson, P., and T.A. Rust, The Effects of Temperature on the Development and Survival of Two Populations of *Aedes campestris* Dyar and Knab (Diptera: Culicidae).

1977. Can. Jour. Zool., 55, 135-137 (University of Manitoba, Department of Entomology, Winnipeg, Manitoba, Canada)

Larvae of *Aedes campestris* from Saskatoon, Saskatchewan, and Churchill, Manitoba, were reared at constant temperatures of 15, 20, 25, and 27 C. Larvae of both populations failed to complete their development to adults at 15 C, although development to third- and fourth-instar larvae did occur and survival at this temperature was greatest in the population from Saskatoon. The optimum development temperature for both populations was found to be 23 C. The development rate and the survival rate was higher in the Churchill population at temperatures above 20 C. At 15 C, contrary to what would be expected, survival of larvae was much greater in the more southern (Saskatoon) population. (Auth)

<478>

Townsend, W., V.M. Hodler, and A.M. Fleming, Infection of Lumpfish (*CYCLOPTERUS LUMPUS*) with Larvae and of Atlantic Cod (*GADUS MORhua*) with Adults of the Copepod, *LEDAEACEPA SPANCHIALIS*, in and adjacent to the Newfoundland Area, and Inferences Therefrom on Inshore-Offshore Migrations of Cod.

1974. Jour. Fish. Res. Bd. Can., 31, 711-731 (Memorial University of Newfoundland, St. John's, Newfoundland, Canada; International Commission for the Northwest Atlantic Fisheries, Dartmouth, Nova Scotia, Canada; Department of the Environment, Fisheries and Marine Service, Biological Station, St. John's, Newfoundland, Canada)

The lumpfish, *CYCLOPTERUS LUMPUS*, was found to be a common intermediate host of the larvae of *LEDAEACEPA SPANCHIALIS* in the Newfoundland and neighboring areas. Large numbers of these larvae occurred on the gills of lumpfish from inshore Newfoundland areas from the latter half of June to the first half of August, whereas only minor infection was found in any month in offshore areas. Some larvae of the year reached the final or 7th stage on the intermediate host in May on the west coast of Newfoundland and in June on the east coast. During May and June development of larvae was much less advanced in the more northerly areas than in the warmer coastal water off the west coast of Newfoundland. (Auth) (ST)

<479>

Terpis, R.H., H.C. Wyllie, and E.B. Holmstrom, Temperature Preference, Avoidance, Shock, and Swim Speed Studies with Marine and Estuarine Organisms from New Jersey.

1977. Ichthyological Associates, Inc., Bulletin No. 17 (Ichthyological Associates, Inc., Brigantine Experimental Laboratory, Brigantine, NJ)

Studies initiated to provide behavioral and physiological laboratory data needed to evaluate the effects of the intakes and heated discharge of the proposed Atlantic Generating Station are reported. Mean preferred temperatures of the fourteen fish species tested were generally higher than, or equal to, the acclimation temperatures.

Seahorse and bluefish usually preferred a narrower range of temperatures than the other fish tested. Black sea bass demonstrated no temperature preference during half of the tests. Low thermal responsiveness was exhibited by Atlantic menhaden, bay anchovy, black sea bass, bluefish, and winter flounder. Temperature preference was related to acclimation temperature. Avoidance temperatures were always greater than preferred temperatures and were generally higher than the highest acclimation temperatures. Results of heat shock experiments with blueback herring, bay anchovy, red hake, black sea bass, bluefish, and Atlantic menhaden and coldshock experiments with bay anchovy and red hake are discussed and reported in tabular form. Results of 95 critical swim speed studies with 16 species of fish are also tabulated. The highest critical swim speed was exhibited by Atlantic menhaden acclimated to 25.6 C. The lowest critical swim speed was exhibited by bay anchovy acclimated at 5.0 C. In most cases an increase in acclimation temperature resulted in an increase in critical swim speed for fish of similar size. Acclimation temperature and fish length had a direct effect on swim speed. (ST)

<480>

Terry, C.B., and J.S. Stephens, A Study of the Orientation of Selected Eubiotocid Fishes to Depth and Shifting Seasonal Vertical Temperature Gradients.

1976. Bull. So. Calif. Acad. Sci., 75, 170-183 (Occidental College, Department of Biology, Los Angeles, CA; Southern California Edison's Thermal Effects Laboratory, Redondo Beach, CA)

The effects of seasonal temperature variation on the depth distribution of five species of eubiotocids in King Harbor, California were studied. Three types of depth distributions were found: *NICHONETUS NICHINUS* was restricted to the intertidal and subtidal margin; *ENBIOTOCA JACKSONI* was abundant at middle depths and declined in abundance in both shallower and deeper water; *HYPSEUS CAVI*, *BRUNOCHEILUS VACCA*, and *PHANEOCOPUS FURCATUS* formed a deeper water group. The depth distributions of all species except *N. NICHINUS* shifted into deeper water during late summer and fall and into shallower water during winter and spring. *NICHONETUS NICHINUS* remained in the top 1.5 m throughout the year. Descent into deeper water corresponded to the period of warmest water. Deeper water species selected water colder than 16 C. *ENBIOTOCA JACKSONI* occupied a middle thermal range. The results of this study support an important role for temperature orientation in the spatial organization of this subtidal community. (Auth)

<481>

Thomson, A.J., J.B. Sargent, and J.M. Owen, Influence of Acclimatization Temperature and Salinity on (Na⁺ + K⁺)-Dependent Adenosine Triphosphatase and Fatty Acid Composition in the Gills of the Bel, (*ARGENTILLA ARGENTILLA*).

1977. Comp. Biochem. Physiol., 56B, 223-228 (N.E.R.C., Institute of Marine Biochemistry, Aberdeen, Scotland)

Microsomal Na/K-ATPase from the gills of natural freshwater eels had an Arrhenius plot discontinuity at 20 C. The corresponding enzyme from natural seawater eels had a discontinuity at 12 C. Fatty acids from

<481> CONT.

total lipids of the gills of freshwater and seawater eels were rich in (n-6) and (n-3) fatty acids respectively. Natural freshwater eels adapted to seawater for three months without a temperature change had an unchanged Arrhenius plot discontinuity and an unchanged fatty acid composition. The situation was unchanged after a further three months in sea water at low temperature. Natural seawater eels adapted to a higher temperature in sea water for three months yielded an Arrhenius plot discontinuity at 20 C and their gills fatty acids were now more saturated. These changes were reversed by re-adapting the eels for a further three months in sea water at a lower temperature. It is concluded that temperature and not salinity determines the degree of unsaturation of gill lipids. The position of discontinuity in the Arrhenius plot of a biomembrane enzyme can be correlated with the degree of unsaturation of membrane lipids under natural conditions reflecting the fluidity of the biomembrane. The (n-3) and not the (n-6) polyunsaturated fatty acids yield fluid biomembranes at low temperatures. (Auth)

<482>

Therkay, A., Tropical Macroalgae as Pollution Indicator Organisms.

1976. Microchemica, 12, 49-65 (University of Miami, Department of Microbiology, School of Medicine, Miami, FL)

Field and laboratory studies were conducted on red and green algae growing at the site of a power plant complex in Biscayne Bay, Florida, to determine optimum and limiting temperatures for growth and the effect of acclimation temperature on these limits. Specimens of the same species obtained from widely varying locations such as the Florida Keys, Jamaica, or Puerto Rico were compared with the Biscayne Bay specimens in the laboratory studies. The results indicated the presence of a long term upper thermal limit within a degree or two of mean summer ambient temperatures. On this basis, it is suggested that the first link in the food web, the sublittoral benthic macroplants, may prove to be the most sensitive link to a whole range of other substances as they have to temperature and therefore prove highly valuable indicator organisms. The implications of the results to the study of species evolution is discussed. (JYC)

<483>

Touber, A.S., and D.M. Ingram, Effects of Thermal Pollution on Certain Aquatic Invertebrates.

1976. Water Resources Research Institute Report No. 65, Clemson University (Clemson University, Department of Zoology, Clemson, SC)

Ecological and ultrastructural data are presented on selected macroinvertebrates from Lake Keowee which receives heated effluent from three nuclear reactors. The ecological data show the effects of depth, station, location and season on density, diversity and taxonomic composition of the collected benthos. Abundance and diversity of invertebrates were lower at the discharge canal and its surrounding areas than in the intake canal and control areas. Composition of the substrate and temperature of the environment have decided influences on the fauna of this relatively young lake. The subtle biological effects of a temperature change were determined by examining

ultrastructurally the nerve cells of the frontal ganglion in *CHAOBORUS PUNCTIPENNIS*. There was a change in the density of nuclear pores and size of the endoplasmic reticulum cisternae in animals exposed to 30 C for three hours and only a change in nuclear pore density in insects held at 25 C for the same time period. (Auth)

<484>

Tanapi, G.T., and K.S.H. Yeo, Effect of Temperature on the Oxygen Consumption in the Larvae of *DIPTERYGUS* Sube (Cynipidae, Coleoptera)...

1977. Hydrobiologia, 53, 113-116 (Poona University, Department of Zoology, Poona, India)

Oxygen uptake of the larvae of the aquatic beetle *DIPTERYGUS* was measured over the temperature range of 26 to 30 C at 1 C intervals and also at 20 and 8 C. Oxygen consumption was low at low temperatures, increased with a rise in temperature, and fell sharply above 30 C. (ST)

<485>

Toner, B.C., and B. Brooks, The Effects of Ozone on the Larvae and Juveniles of the Mussel *MYTILUS EDULIS*.

1977. In Jensen, L.D. (Ed.), Biofouling Control Procedures Technology and Ecological Effects, Marcel Dekker, Inc., New York, pp. 19-22 (Marine Research, Inc., Falmouth, MA)

Larvae of the mussel *MYTILUS EDULIS*, measuring 75µ in one experiment and 15µ in another experiment were cultured at temperatures of 13, 17, and 23 C, and were exposed to various ozone concentrations. The larger larvae were better able to withstand the effects of ozone exposure than were the smaller larvae; 90% to 100% of the larger larvae survived, but only 43% to 78% of the smaller larvae survived, and the survival was temperature dependent, i.e., fewer survived at the higher temperature. Control larvae remained well dispersed throughout the water column for the entire duration of the experiment, but ozone-treated larvae were concentrated on the container bottom, which was interpreted as a sign of distress. Juvenile mussels treated for one hour at 0.8 to 0.9 ppm residual ozone were unaffected by ozone treatment. (Auth)

<486>

Tones, P.I., The Life Cycle of *TRICHOCCIRIA VERTICALIS* Sailer (Hemiptera, Coreidae) with Special Reference to Diapause.

1977. Freshwater Biol., 7, 31-36 (University of Saskatchewan, Department of Biology, Canada)

The life cycle of *TRICHOCCIRIA VERTICALIS* was studied in six Saskatchewan saline lakes. Females oviposited in early August. Shortly thereafter embryonic development was arrested prior to blastokinesis. Diapause lasted for two months, preventing the eggs from hatching in the warm (20 C) water during August and September. In October the low water temperature (7 C) prevented embryonic development until the following spring, when late temperatures again began to rise. Experimental results indicated that exposure to cold is not necessary to break diapause. (ST)

<487>

Trislett, J.A., Seasonal Distribution and Successional Trends of Fish in a New Cooling Reservoir.

1976. Ph.D. Thesis, University of Kansas, 153 p. (University of Kansas, Lawrence, KS)

The fish populations in La Cygne Lake, a 1052 hectare reservoir in eastern Kansas, were studied from November 1971 through October 1976. The reservoir, impounded in 1970, was constructed as a cooling pond for an 840 megawatt power plant. Three locations in the lake were sampled monthly by overnight sets of modified fyke traps in order to characterize changes in the fish populations as the reservoir aged and the power plant began operation. Characteristic of new impoundments, large populations of fish developed during the first two years (1970 and 1971) of impoundment. Severe competition for resources resulted in poor growth of these populations and cropping of the young-of-year 1972 and 1973. Attrition of the dominant 1970 and 1971 year-classes reduced competition and resulted in increased growth and production during 1974. The 1971 year-class of white crappie (*POMOXIS ANURUS*), dominated the fish populations and maintained a competitive advantage by opportunistically partitioning the resources among its adult members. The initiation of power plant operation in 1973 resulted in a nearly continuous congregation of fish in the outfall area. Large piscivores dominated the area in the winter and smaller fish were prevalent in the summer. (Auth)

<488>

Tsai, A.-T.C., and B.D. Beatty, Visual Pigment Changes in Rainbow Trout in Response to Temperature.

1977. Science, 195, 1358-1359 (University of Alberta, Department of Zoology, Edmonton, Alberta, Canada)

Lower water temperature (6 C in comparison to 16 C) favored a higher proportion of porphyropsin in the retina of rainbow trout (*Salmo gairdneri*), regardless of the light conditions (constant darkness or 12 hours of light and 12 of darkness). This response to temperature did not follow a Q10 relation, namely an increase in the rate of a reaction produced by raising the temperature 10 C. (Auth)

<489>

Tuskes, P.N., Observations on the Biology of *PARAGYRACIS CONFUSALIS*, an Aquatic Pyralid (Lepidoptera: Pyralidae).

1977. Can. Entomol., 109, 695-699 (University of California, Department of Environmental Toxicology, Davis, CA)

Overwintering larvae of the aquatic butterfly, *PARAGYRACIS CONFUSALIS*, were active and fed throughout the winter in northern California. Pupation occurred when the water temperature is approximately 12 to 16 C during March or April. Peak larval densities occurred during April and May and decreased steadily as water temperature increased above 20 C. (ST)

<490>

Olvestad, D.L., and J.M. Ear, Preferred Temperature of the Common Shiner, *NOTROPIS COMPTONUS*, in Relation to Age, Size, Season, and

Nutritional State.

1977. Ohio Jour. Sci., 77, 170-173 (Northern Illinois University, Department of Biological Sciences, DeKalb, IL)

Preferred temperature for the common shiner, *NOTROPIS COMPTONUS*, was correlated with age, size, season, and nutritional state and was higher than, and positively related to acclimation temperatures in all groups. Age, size, and starvation did not significantly affect the preferred temperature. Significant seasonal differences in preferred temperature were observed with spring-collected fish preferring higher temperatures than autumn-collected fish kept at the same ambient water temperature. (Auth) (BPC)

<491>

Wager, I.A., Salinity, Temperature, and Growth Regulator Effects on Seed Germination of *SALICORNIA EUROPAEA* L..

1977. Aquatic Botany, 3, 329-335 (Ohio University, Department of Botany, Athens, OH)

Temperature optima for *SALICORNIA EUROPAEA* seed germination at different salinities were investigated. Maximum germination occurred in distilled water at 25 C. Lowest germination percentages for all salinities were at 10 C. Even though *S. EUROPAEA* is the most salt tolerant of the species growing on the salt pan in which it occurs, an increase in salinity stress proved to be inhibitory to seed germination for all temperature regimes investigated. (Auth) (BAP)

<492>

Ushakov, B.P., I.S. Anosova, I.S. Chernoborova, I.N. Dregolskaya, L.N. Pashkova, and E.D. Shkell, The Environmental Temperature and Physiological Polymorphism of Populations. II. The Relation of Changes in the Organismal Heat Resistance to Its Initial Level during Heat Acclimation.

1977. Jour. Thermal Biol., 2, 9-15 (Institute of Cytology, Laboratory of Comparative Cytology, Leningrad, USSR)

The heat resistance of individual genotypes of several organisms was studied by determining the survival time of a series of clones as vibriosis of *HYDRA OLIGACTIS*, *ASELLUS AQUATICUS*, *STROMBYLOCENTROTUS PROKHAKIENSIS*, and *NAUJA TEMPORELLA* at high temperatures following acclimation. An analysis of changes in the heat resistance of progeny of different families revealed a great variety of responses within a population, with some families showing decreased thermal resistance. In *ASELLUS AQUATICUS* all families showed increases in heat resistance, their responses differed only in the extent of increase. It was concluded that the pattern of adaptive changes in the organismal resistance level during environmental temperature fluctuation differs from animal to animal within the same population. There are differences in the rates and amounts of change and also in the direction of these changes. (ST)

<493>

Ushakov, B.P., I.S. Anosova, I.S. Chernoborova, I.N. Dregolskaya, L.N. Pashkova, and E.D. Shkell, The Environmental Temperature and Physiological Polymorphism of Populations - III. Heat Acclimation and the Population Response to Selection Caused by Heating.

<093> COST.
1977. Jour. Thermal Biol., 2, 17-22 (Institute of Cytology, Laboratory of Comparative Cytology, Leningrad, USSR)

A study was made of the effect of heat acclimation on the resistance level of the progeny (siblings) of several parental pairs of *DROSOPHILA MELANOGASTER*, *ASIELUS AJUTICUS*, *STRONGYLOCENTROTUS DOERMANNIENSIS*, *DAVA TENFORABIA* and clones of *HYDRA GLIGACTIS* reared under constant conditions (ribadaptation method). The population response to thermal selection significantly changes due to heat acclimation. The survival of individuals during heating increases. This process is accompanied by (a) the levelling of genetic differences in the resistance of individuals (phenotypical masking of genetic differences) and (b) changes in the order of elimination of individuals during thermal selection. A coordinated reaction of individuals of the same population to changes in the environmental temperature was accomplished without any interaction of individuals. It is considered to be the result of a specific genetic structure of the population which accounts for functional polymorphism. The data obtained lead us to conclude that non-genetic temperature resistance acclimations are a protective reaction of the population directed against thermal selection. (Auth) (ST)

<094>
Iye, S., and A. Floening, Effects of Various Environmental Factors on Egg Development of Several Species of *ACARTIA* in Southern California.

1976. Marine Biol. (R. Ger.), 30, 253-262 (University of California, Scripps Institution of Oceanography, San Diego, La Jolla, CA)

The hatching of eggs of *ACARTIA TONSA*, *A. CLAUSSI*, and *ACARTIA* sp. spawned in the laboratory and the eggs of *ACARTIA* (species undetermined) isolated from natural bottom sediments was examined under various environmental conditions (temperature, salinity and temperature combinations, oxygen concentration, illumination, and the presence of bottom mud). The range of temperature and salinity in which eggs hatched differed from one species to another. The eggs of *A. TONSA* and *A. CLAUSSI* developed into nauplii at all temperatures tested, 5 to 25 C, whereas the eggs of *ACARTIA* sp. and the eggs from the mud did not develop at around 5 C. The effect of acclimatization to either higher or lower temperatures on hatching success was noted. The range of temperature and salinity combinations tolerated is noted. Habitat separation of planktonic *ACARTIA* populations and the role of dormant eggs during their seasonal absence in the plankton of Southern California coastal waters are discussed. (Auth) (ST)

<095>
Ozanne, J.B., R.A. Cooper, and R.J. Pecci, Migration and Dispersion of Tagged American Lobsters, *DOLOBUS AMERICANUS*, on the Southern New England Continental Shelf.

1977. NOAA Technical Report NMFS SSFV-705, 92 pp. (Northeast Fisheries Center, National Marine Fisheries Service, NOAA, Woods Hole, MA)

A total of 7,326 lobsters were captured, tagged, and released at 52 localities between Cornsair Canyon and Baltimore Canyon.

Recapture of 945 (12.9% recovery) provided a basis for interpretation of seasonal and long-term movements, as well as measurements of growth rate and molt frequency. The distribution of recaptured lobsters by month of capture and mean bottom water temperature demonstrated that the offshore lobster population, through random and/or directed movements, maintained itself within a temperature regime of 8 to 14 C. It was concluded that at least 20% of the offshore lobsters annually engage in directed shoalward migrations in spring and sooner with return to the shelf margin and slope in fall and winter. This conclusion is reinforced by independent analysis of the time/depth/temperature associations of tagged lobsters at recapture which suggests that an even larger proportion of the offshore lobsters annually effect directed migrations in response to seasonal temperature variations. (Auth) (ST)

<096>
Vaillancourt, G., and B. Costere, Decolonization of *STREPTA TENTACULATA* (Linnaeus) (Mollusca, Gastropoda, Prosobranchia) in the Zone Affected by Heated Water Overflows from the Gentilly Nuclear Plant, Quebec, Canada.

1977. Sterkiana, 65-66, 7-10 (Universite du Quebec a Trois-Rivieres, Department of Zoologie-Biologie, Quebec, Canada)

Decolonization by the snail *STREPTA TENTACULATA* was studied for a two-year period following shutdown of the Gentilly Nuclear Generating Plant. Operation of the plant had totally wiped out the molluscan fauna in the area of the St. Lawrence River affected by the thermal effluent. Two years after shutdown snail density in the previously affected area was low compared to control stations and to preoperational conditions. (ST)

<097>
Valenti, R.J., Induced Polyploidy in *TILAPIA AUREA* (Steindachner) by Means of Temperature Shock Treatment.

1975. Jour. Fish Biol., 7, 519-528 (New York Ocean Science Laboratory, Department of Ichthyology, Montauk, NY)

Treating eggs of *TILAPIA AUREA* to a cold shock of from 32 C (ambient) to 11 C for one hour resulted in a 75% incidence of polyploidy. Polyploid fish were found to be larger than diploid siblings when measured at 14 weeks of age. (ST)

<098>
van Bije, J.J., C. van der Meer, and H. Bijmans, The Toxicity of Sodium Pentachlorophenolate for Three Species of Decapod Crustaceans and Their Larvae.

1977. Bull. Environ. Contam. Toxicol., 17, 622-630 (Pharmacological Laboratory, Amsterdam, The Netherlands; Medical Biological Laboratory, Rijswijk, The Netherlands)

The toxicity of sodium pentachlorophenolate (Na-PCP) for the brackish water crustacean *PALAEMONETES VARIEUS* was determined in seawater at 5, 15, and 25 C. Fifty-six hr mortality was significantly lower at 5 C than at 15 C. Mortality was similar at 15 and 25 C. Lethal time at 3.6 ppm Na-PCP could not be estimated at 5 C; at 15 C it was 100 hr and at 25 C 33 hr. (ST)

(499)

Van Winkle, W. (Ed.), Assessing the Effects of Power-Plant-Induced Mortality on Fish Populations.

1977. Proceedings of the Conference on Assessing the Effects of Power-Plant-Induced Mortality on Fish Populations held in Gatlinburg, Tennessee, April, 1977. Pergamon Press, Elmsford, NY (Oak Ridge National Laboratory, Oak Ridge, TN)

The papers presented represent the state of the art in the ability to assess the population-level effects of power plant exploitation on fish populations. Sessions on case histories; estimating abundance, production, and mortality rates of young fish; compensation and stock-recruitment relationships; monitoring programs and data analysis; and the use of population models were held. One paper on population dynamics of young-of-the-year fish in a cooling reservoir was abstracted separately for the data base. (57)

(500)

Vargh, S.L., and A.W. Sastry, Acute Temperature and Low Dissolved Oxygen Tolerances of Brachyuran Crab (*CANCER IMBRICATUS*) Larvae.

1977. Marine Biol. (W. Ger.), 40, 165-171 (University of Rhode Island, Graduate School of Oceanography, Kingston, RI)

Tolerance limits to acute temperature, and temperature and low dissolved oxygen stresses were determined for 5 zoeal stages and megalops of *CANCER IMBRICATUS* Say. The acute temperature limits for a 120 min exposure were all approximately 29.0 C, with little interstage variation, while those for 240 min exposure ranged from 27.3 to 28.5 C. More interstage variation was shown when temperature and low dissolved oxygen stress were combined, with low oxygen tolerance decreasing as temperature increased. The first, second, and fourth zoeal stages displayed similar patterns of response. The third and fifth stages showed a similar response, but were different from the former stages. The megalops was relatively insensitive to changes in oxygen concentration with temperature. The larval stages did not show a progressive increase in tolerance to temperature or low dissolved oxygen with development. Tolerance to these factors may be related to size, stage of development and activity level. The larval stages have capacities to tolerate a wider range of these factors than they require in the natural environment. (Ruth)

(501)

Vechkinov, V.S., Intensity of Respiration of the Silver Carp, *HYPOPHthalmichthys molitrix*.

1976. Jour. Ichthyol., 15, 605-609 (Moscow State University, Department of Ichthyology, Moscow, USSR)

The value of specific intensity of respiration of the silver carp, *HYPOPHthalmichthys molitrix*, in closed vessels, changed with water temperature as did the degree of dependence of the intensity of respiration on weight. The exponent decreased from 0.9 to 0.78 with a decrease in temperature from 24-21 to 13-11 C. (NPC)

(502)

Vedergalkov, V.I., The Effect of Environmental Factors on the Assimilation Number in the Natural

Populations of Marine Phytoplankton.

1976. In S.A. Nilejshovskij, (Ed.), Ecology and Biogeography of Plankton, Nauka, Moscow, U.S.S.R. (1976), (pp. 106-129); Tr. Inst. Okeanol., 145 (Not given)

A review of the literature covering different areas of the World Ocean indicates that in the marine phytoplankton natural populations, the intensity of photosynthesis (assimilation number) estimated/unit of chlorophyll-a is determined mainly by the nutrient supply and by temperature under optimum light conditions. Photosynthetic intensity decreases at the nitrate concentration of less than 2 $\mu\text{g N/l}$ in warm water (more than 20 C) and at less than 3 $\mu\text{g N/l}$ in colder water. Optimum temperature for photosynthesis is between 20 and 30 C. The mean value of temperature coefficient of photosynthesis in waters with different nitrate contents at 0 to 20 C was 2.2. The inhibitory effect of high population density on photosynthetic activity is seen only in highly productive coastal waters with a chlorophyll-a content of more than 16 $\mu\text{g/ml}$. (NPC)

(503)

Veldhuijzen, J.P., and B. Cuperus, Effects of Starvation, Low Temperature and the Dorsal Body Hormone on the in Vitro Synthesis of Galactogen and Glycogen in the Albumen Gland and the Mantle of the Pond Snail *LYMNAEA STAGNALIS*.

1976. Neth. Jour. Zool., 26, 119-135 (Free University, Department of Biology, Amsterdam, Netherlands)

At 6 C the rate of incorporation of C-14 labeled glucose into polysaccharides of the albumen glands declined, but the wet weights and the polysaccharide contents of the glands did not differ significantly from those of glands of snails kept at 19 C. A similar decrease in rate of incorporation was observed in starving snails. The glycogen synthesizing system of the mantle was not markedly affected by starvation, low temperature, or the absence or presence of dorsal body hormone, when measured with the in vitro technique. (ST)

(504)

Velikhanov, E.L., Effect of Temperature on the Sensitivity of Young Sturgeons to Petroleum Poisoning.

1976. Izv. AN Az. S.S.R. (Biol.), No. 1, 92-96 (Not given)

An experimental study was made of the adaptability of RUSSO RUSSO CASPICUS natio karensis Pankuskin and ACIPENSER STELLATUS natio cycensis Berg to elevated temperatures and of their resistance to oil poisoning under thermal load conditions. At 30.30 C 100% mortality of juvenile great sturgeon was recorded while at 21.80 to 27.25 C the mortality was almost 9 times lower. The petroleum concentration of 75 $\mu\text{l/l}$ was found to be lethal for 13-day-old great sturgeon while 47-day-olds showed fairly high resistance to this concentration. A conclusion is drawn that the toxic effect of petroleum is to a great extent temperature-dependent. The experiments showed a decrease in maximum tolerable oil pollution levels with an increase in water temperature. It was also revealed that a combination of oil and thermal pollution had a pronounced effect on the oxygen regime,

(504) CONT.

which explains bass mortality of young stellate sturgeons under conditions of oil pollution with a 6 C increase in temperature. Giant sturgeons that were 87 days old did not survive a temperature increase as low as 3 C. (Auth) (80)

(505)

Vonablen, R.J., Aspects of the Thermal Ecology of Largemouth Bass (*Micropterus salmoides*) in North Central Texas.

1976. Ph.D. Thesis, North Texas State University, 102 p. (North Texas State University, Denton, TX)

The coefficient of body temperature change (α) ranged from -0.53 to -0.077 for bass weighing 73 to 1000 g. The double log regression of α on weight was similar to that reported for other poikilotherms. Flanneling bass were eurythermal, being capable of surviving instantaneous temperature changes over a 70 C range at acclimation temperatures of 15, 20, and 30 C and over a 15 C range at acclimation temperatures of 20 and 35 C. Preferred temperatures for adult bass measured in the laboratory ranged from 27 to 32 C with no relationship to day or night. The overall mean preferred temperature was 29 C. The laboratory determined preferred temperatures were supported by limited field determined body temperatures taken in a vertical temperature gradient near the discharge of a power plant effluent. Routine metabolic rates of bass from a heated reservoir and a nearby hatchery were similar from 10 to 30 C in summer and winter. The weight exponent (0.77) and Q10 (1.6 to 2.9) were similar to those published for more northern bass populations; however, the Texas bass had lower metabolic rates than those published for the northern populations. Bass exposed to rapid temperature increase (0.2 C/min) from 25 to 30 C increased their metabolic rate by 53% but showed no detectable increase in opercular rate. Bass varied from 30 to 35 C and 30 to 33 C increased their metabolic rate by 100%, and their opercular rates increased to over 100 beats per minute before death. (Auth)

(506)

Vonablen, R.J., R.D. Pearson, and L.C. Fitzpatrick, Thermal and Metabolic Relations of Largemouth Bass, *Micropterus salmoides*, from a Heated Reservoir and a Hatchery in North Central Texas.

1977. Comp. Biochem. Physiol., 57A, 93-98 (North Texas State University, Department of Biological Sciences, Denton, TX)

Routine metabolic rates of largemouth bass from a heated reservoir and a nearby hatchery in north central Texas were similar from 10 to 30 C in summer and winter. The weight exponent and Q10's for metabolism in Texas bass were similar to those published for northern populations. Texas bass had lower metabolic rates than those published for northern populations when compared at common temperatures. Results suggest that northern populations have apparently adopted metabolic rate-temperature patterns which enable similar levels of metabolism under colder climatic conditions. (Auth)

(507)

Venkatesan, A., G.J. Lakshmi, and J.D. Vallou, Oxygen Consumption in Brown Shrimp

Penaeus aztecus in the Time Course of Adaptation to Salinity and Temperature (Abstract only).

1976. Jour. Siss. Acad. Sci. 21 (Suppl.), 66 (Gulf Coast Research Laboratory, Ocean Springs, MS)

Oxygen consumption rates of juvenile shrimp were measured in a flow-through respirometry apparatus to determine the time course of salinity and temperature adaptation. Outlines of the apparatus, its advantages and problems were described. Respiratory rates were measured at 0, 1, 2, 4, 6, 10, 25, 40, 72, 96, 120, 144 and 168 hour intervals in 5, 10, 25 (control) and 36 ppt salinities (5) in combination with 10, 25 (control) and 32 C. In conditions other than control the shrimp exhibited an initial shock type response in respiratory rates, followed by stabilization and a new steady state. Changes in temperature influenced respiratory rates more than changes in salinity. In salinity variations the metabolic rates were stabilized faster than in conditions where temperature was involved. At normal temperature (25 C) oxygen consumption increased in the order of 10, 5 and 36 ppt 5 above the level in 15 S. The new steady state in oxygen consumption was maintained at a higher level in 32 C than in control (25 C) and at a lower level in 10 C. Readaptation of shrimp from other salinity and temperature conditions to 15 S and 25 C was a faster process than acclimating them from control to other conditions. (Complete text)

(508)

Vernberg, W.B., P.J. McCourney, N. Kelly, and J.N. Johns, Effects of Sublethal Concentrations of Cadmium on Adult *Palaemonetes pugio* Under Static and Flow-Through Conditions.

1977. Bull. Environ. Contam. Toxicol., 17, 14-20 (University of South Carolina, Belle W. Baruch Institute for Marine Biology and Coastal Research, Department of Biology, and School of Public Health, Columbia, SC)

Survival, molting time, and metabolism were the measurement parameters for adult male grass shrimp (*Palaemonetes pugio*) maintained under different thermal-salinity regimes in either a static or a flow-through system, using CdCl₂ at different concentration levels as the toxicant. Shrimp were acclimated to either cold (15 C) or warm (25 C) conditions for not less than 10 days, not more than 3 weeks. At 15 C, less cadmium was concentrated than at 25 C in both static and flow-through systems, but shrimp in the flow-through system accumulated much more cadmium than those maintained under static conditions. Uptake levels of shrimp in the static system did not show any salinity dependence while uptake of shrimp maintained in the flow-through system followed the same pattern observed at 25 C and increased with exposure to low salinity. (Auth) (80)

(509)

Vigstad, T.J., and L.J. Tilly, Hyperthermal Effluent Effects on Mesoplanktonic Cladocera and the Influence of Submerged Macrophytes.

1977. Hydrobiologia (Den.), 55, 81-85 (University of Rhode Island, Kingston, RI; Savannah River Ecology Laboratory, Aiken, SC)

In July and August, 1976, measurements were made of the standing crops of Cladocera in the littoral zone of Fox Pond (Savannah River Plant, Aiken, South Carolina), which receives

<509> C397.

hypothermal effluent from a nuclear reactor. Crops of *CERATOPHYLLUM* spp. and *DIAPHYLLOPSIS* spp. were greater in the heated than in the ambient area, while *POSSIDIA LONGICORNIS* maintained higher standing crops in the ambient area than in the area receiving hypothermal effluent. In August, 1977, enclosures were placed in the effluent-affected area to test the hypothesis that the high density of rooted aquatic macrophytes in the effluent-affected area influences the standing crop of these Cladocera. The effects of changes in reactor effluent temperature were also determined in the enclosure experiments. The results of the enclosure study support two generalizations: 1) the presence of dense rooted vegetation allows higher standing crops of *CERATOPHYLLUM* spp. and 2) lower temperatures than those usually found at the heated station would favor *P. LONGICORNIS* standing crops, while the higher effluent temperatures favor *CERATOPHYLLUM* spp. and *P. DIAPHYLLOPSIS*. (Auth)

<510>

Villucci, P.R., Distribution of Pelagic Zooplankton within a Thermal Gradient in Lake Columbia, a Cooling Lake near Portage, Wisconsin.

1974. M.A. Thesis, University of Wisconsin (University of Wisconsin, Laboratory of Limnology, Madison, WI)

Zooplankton samples showed that pelagic zooplankton were non-randomly distributed in both the vertical and horizontal planes of Lake Columbia, Wisconsin. These distributions as a function of temperature within a thermal gradient are described. Lake Columbia is an artificial, 794 hectare (800 acre), U-shaped cooling lake whose waters undergo a 10 to 15 C temperature increase when pumped as coolant through a 527 megawatt fossil fuel power plant. A comparison of seasonal abundance data for zooplankton species of Lake Columbia with the same species of Lake Winnebago, a suitable reference lake also in southern Wisconsin, indicated that the Lake Columbia zooplankton seasonal abundance was altered by the thermal environment. Lake Columbia experienced temperatures in excess of 30 C in mid-summer months; during these months zooplankton were rare or absent. Lake Winnebago data do not contain any summer temperatures exceeding 30 C nor any total zooplankton population levels of less than 10 to 20 organisms per liter. Lake Columbia zooplankton levels were highest in November with plant outfall counts of 600 organisms per liter. Entrapment concentrated zooplankton at the plant outfall and at the outfall of the pumping system which maintains lake level. Vertical distribution of zooplankton were affected more by negative phototropism and wind mixing of Lake Columbia than by thermal stratification. (Auth)

<511>

Vivekanandan, E., and T.J. Pandian, Surfacing Activity and Food Utilization in a Tropical Air-Breathing Fish Exposed to Different Temperatures.

1977. Hydrobiologia (Duss.), 50, 105-106 (Madurai University, Zoology Department, Palani, India)

Surfacing activity of *OPHIOCEPHALUS STRIATUS* reared in tubular aquaria of different depths increased with increasing aquaria depth. The amount of time spent at the surface

(breathing frequency) was temperature-dependent. Breathing duration increased from about 1 hr/day at 17 C to 6-10 hr/day at 27 C, depending upon feeding ration. With increasing temperature and depth, feeding rate increased between 17 and 27 C (from 20 to 225 g cal/g live fish/day). Oxygen uptake was also temperature-dependent. (ST)

<512>

Vlaabien, A.G., S.J. Groffma, and J.T.L. Verhoeven, Survival, Osmoregulatory Ability, and Respiration of *POSTER CHLIPES* (Crustacea, Isopoda) from Lake Peere in Different Salinities and Temperatures.

1977. Hydrobiologia, 52, 33-36 (Delta Institute for Hydrobiological Research, Verschoor, Netherlands; Catholic University, Laboratory of Aquatic Biology, Nijmegen, Netherlands)

An ecological and physiological study of *POSTER CHLIPES* from Lake Peere, The Netherlands, was made. Both osmoregulatory capacity and survival decreased with increasing temperature (5, 10, 15 C) as well as with decreasing salinity (20.9 to 3.6 ppt). Respiration experiments suggested that the need of energy by osmoregulatory activity may be supplied at the cost of other physiological processes, at any rate at temperatures of 10 C at 10 ppt. In temperatures higher than 10 C and salinities lower than 10 ppt, populations of *P. CHLIPES* will be negatively affected. (Auth)

<513>

Villucci, P.R., Thermal Acclimation, Upper Temperature Tolerance, and Preferred Temperature of Juvenile Yellowtail Snappers, *CTYPOPS CHRYSTIDUS* (Bloch) (Pisces: Lutjanidae).

1977. Marine Sci., 27, 292-296 (Auburn University, Department of Fisheries and Allied Aquacultures, Auburn, AL)

The rate of acclimation and temperature tolerance of juvenile yellowtail snappers, *CTYPOPS CHRYSTIDUS* (Bloch) was tested using the method of sudden exposure to elevated temperature. Acclimations of up to 10 days at various temperatures did not significantly change the 70-hour lethal temperature from that of a 7-day acclimation. Upper thermal tolerance was tested after 3-day acclimations at 20, 25, 30, and 32 C. Lethal temperatures (for a 7-day exposure) ranged from 32.6 C at a 20 C acclimation to 33.5 C at a 32 C acclimation. No significant relationship was found between acclimation temperature and lethal temperature. The ultimate lethal temperature was estimated to fall between 33.5 and 34 C. Acclimation significantly raised median resistance times at test temperatures of 30 and 35 C. An upper thermal tolerance polygon of 100.0 units was constructed by arbitrarily considering 10 C as the lower temperature limit for juvenile yellowtail snappers. Preferred temperature was tested by acclimating and then exposing fish to a horizontal temperature gradient. Acclimation altered the mean preferred temperature, but the preferred temperature remained within the range normally encountered (20 to 30 C) by *C. CHRYSTIDUS*. (R: h)

<514>

Wells, R.L., Some Uses of Multifactorial Response Surface Analysis in Temperature Tolerance Studies.

<510> CONT.

1976. Aust. Jour. Mar. Freshwater Res., 27, 497-506 (University of New South Wales, School of Zoology, Kensington, Australia)

A multifactorial model using response surface analysis is described for thermal studies directly related to power station cooling systems. It incorporates intake salinity and temperature, temperature shock, exposure time, and mortality responses. Sublethal effects such as delayed mortality, inactivation, and mechanical damage can be included. The postulated area of influence of the Vales Point Power Station based on a temperature model of the tropical tiddler, *TRICHOPTA HIRSUTA* closely agreed with field observations of the species distribution. An analysis of field data for the plankton community subject to entrainment by Bunnarrah Power Station over a yearly cycle of salinity-temperature conditions, following an average temperature shock of 7°C is presented, with and without mechanical damage. Changes due to variations in the species' proportions in the population must be considered due to the species-specific nature of hydrostatic resistance. Results agreed well with laboratory and field data. (auth)

<515>

Wallis, R.L., Some Aspects of the Thermal Tolerance of *TRICHOPTA HIRSUTA* (Mollusca: Pivalvia) of Eastern Australia.

1977. Marine Biol. (N. Ger.), 43, 217-223 (University of New South Wales, School of Zoology, Kensington, N.S.W., Australia)

The upper temperature tolerance range for *TRICHOPTA HIRSUTA* L. is described for acclimation temperatures of 10 to 22°C at 30 ppt salinity. Changes in thermal resistance with time are described along with the incipient lethal temperatures. The eurythermicity for the species is 700.7 C-squared. The ultimate upper incipient lethal temperature is 35.1°C. Definition of the incipient sublethal temperature is given, and is equal to 22°C. Diet effects are shown not to be significant in short-term lethal experiments, but indicate that unfed animals reduce their resistance after prolonged exposure to high temperatures. Size was also shown to have no effect on resistance and tolerance. A comparison of the tolerance triangle of *T. HIRSUTA* with those of the temperate species *HYALUS ADULIS* and *HYA ADULIS* revealed that the 20-h LT50 gives 2.2°C approximates the incipient lethal temperature. The eurythermicity of the temperate species are *HYALUS ADULIS*, 343 C-squared; and *HYA ADULIS*, 415 C-squared. (auth)

<516>

Wallis, R.L., Aspects of the Thermal Tolerance of the Tropical Bivalve *TRICHOPTA HIRSUTA* L. - A Multivariable Approach.

1976. Aust. Jour. Mar. Freshwater Res., 27, 475-486 (University of New South Wales, School of Zoology, Kensington, Australia)

The vessel *T. HIRSUTA* was held in the laboratory at 31 salinity-temperature combinations (ranges: 5-35ppt; 5-38°C). The survival response after 19 days is described by response surface analysis. Salinities less than 15ppt are beyond the tolerance of the species. At higher salinities a thermal range of 10-22°C can be tolerated. The

effect of a sudden temperature increase of 10°C to simulate power station output over the 19-day survival regime is described for exposure periods up to 170 h over 24 salinity-temperature combinations. The area of minimum mortality shifts toward higher salinities along the 17°C temperature axis with increase in exposure time, indicating that high salinities aid thermal resistance. The effect of acclimation on the response surface in the upper temperature region is negligible. The biological reasons for this are discussed with implications for the use of this method as a tool in thermal studies. In relation to thermal addition in Lake Macquarie, Australia, at least 50% mortality is expected with pronounced sublethal effects under summer conditions. No influence of size on thermal resistance was detected. (auth)

<517>

Reeson, L.M., The Ecology of *CAPITELLA CAPITATA* in British Waters.

1977. Jour. Mar. Biol. Assn. U.K., 57, 151-159 (Bedford College, Department of Zoology, London, England)

Laboratory experiments on the upper lethal temperature for *CAPITELLA CAPITATA* indicated that temperatures above 30°C were critical. The upper lethal temperature was 31.5°C for adult worms and a little higher for larvae. Both were tolerant of low temperatures, 50% of the adults and 65% of the larvae surviving at -1°C. (ST)

<518>

Rehder, J., S.T. Reem, and S.A. Ravey, Growth and Speculation of *TRICHOPTA HIRSUTA* and *TRICHOPTA HIRSUTA* in Relation to Temperature.

1976. Trans. Brit. Mycol. Soc., 67, 491-509 (University of Exeter, Department of Biological Sciences, England)

The linear growth of the fungi *TRICHOPTA HIRSUTA* and *TRICHOPTA HIRSUTA* was compared within the temperature range of 5 to 30°C. *TRICHOPTA HIRSUTA* was capable of sporulating at 5°C, but *T. HIRSUTA* was not. The optimum temperature for sporulation of *T. HIRSUTA* was 25°C and for *T. HIRSUTA* it was 20°C. The optimum temperatures for sporulation are above those likely to be encountered in the field in Britain. (ST)

<519>

White, J.P., R.P. Schmitt, J.P. Ondrate, and L.L. Hargan, Factors Affecting Nitrification in situ in a Busted Stream.

1977. Appl. Environ. Microbiol., 33, 918-925 (St. Bonaventure University, Department of Biology, St. Bonaventure, NY)

Nitrification, previously shown to occur in the stream under study, ceased only when the stream received heated (20°C or above) discharges and was negligible when water temperatures were 17°C or lower. The most probable number of ammonia oxidizers in stream bed sediments exceeded nitrite oxidizers by ratios of 43:1 to 1,123:1, and the average rate of ammonia oxidation in this stream, 0.30 mg of NH₄-N/liter/hr exceeded the rate of nitrite oxidation, 0.29 mg of NO₂-N/liter/hr, resulting in an accumulation of nitrite. Nitrification rates were influenced by the dissolved oxygen

<519> CONT.
concentration, increasing during daylight hours and exhibiting seasonal rates during the summer months. (Auth)

<520>
White, J. S., R. S. Woodcock, and W. L. Kirk, A Study of the Fish Community in the Vicinity of a Thermal Discharge in the James River, Virginia.

1977. Chesapeake Sci., 18, 163-171 (University of Richmond, Richmond, VA; Randolph Macon College, Ashland, VA)

The size, species composition and structure of the fish community in a 9.6 km stretch of the James River in the Piedmont Province of Virginia were analyzed. Twenty collections were made by electrofishing from October 1972 through September 1973 from both the north side of the river which received a thermal discharge from an electric power station (delta T of 8 to 14 C at outfall), and the south side where temperatures were ambient. Parameters investigated were number of species, total number of individuals and the Shannon-Wiener and evenness indices of species diversity. Differences were found to exist in community structure among seasons within both the ambient and thermally influenced zones. In the ambient zone all parameters showed significant seasonal change with values lower in the winter. At the outfall station significant seasonal change occurred for only the diversity and evenness indices with values lower in the summer. Because total abundance remained lower within all seasons at the outfall station than in the ambient zone, as temperatures declined downstream from the point of effluent discharge parameter values were closely approached those on the unheated side of the river. (Auth)

<521>
Whittick, A., and R. C. Hooper, The Reproduction and Phenology of *ANTIETHANION CRUCIATUM* (Phaeophyta: Ceramiales) in Insular "refugium".

1977. Can. Jour. Bot., 55, 520-528 (Memorial University of Newfoundland, St. John's, Newfoundland, Canada)

In the laboratory cultures of *ANTIETHANION CRUCIATUM* grew at 10 C and above. (ST)

<522>
Wieser, W., and F. Schiemer, The Ecophysiology of Some Marine Mesozoa from Bermuda: Seasonal Aspects.

1977. Jour. Expl. Mar. Biol. Ecol. (Beth.), 26, 97-106 (Institut für Zoophysiology der Universität, Innsbruck, Austria; Lehrstuhl für Limnologie der Universität, Wien, Austria)

The distribution, temperature tolerance, and oxygen consumption of several species of mesozoa collected from a Bermuda beach in winter were determined. The three most abundant species, *STYDIA SCHWENNI*, *TRYPUSIA SCHWENNI*, and *TRYPUSIA FLORIDANUS* showed distinct patterns of distribution, with the most heat-tolerant species occurring farther up the beach, and distinct survival-time curves when upper lethal temperature was plotted against exposure time. No seasonal resistance adaptation to high temperature occurred in *STYDIA SCHWENNI* and *TRYPUSIA SCHWENNI*, the two species for which comparative summer data are

available. *TRYPUSIA SCHWENNI*, which dominated the flat in summer, is much more heat tolerant than *TRYPUSIA FLORIDANUS* which replaced it in winter. Oxygen consumption at 15 C was twice as high in *TRYPUSIA SCHWENNI* as in *TRYPUSIA FLORIDANUS*, whereas at 22 and 30 C both species consumed approximately the same amount of oxygen. *TRYPUSIA SCHWENNI* was capable of seasonal acclimation of 60%. (Auth) (ST)

<523>
Wilde, R. W., L. L. Glaser, and A. Smith, Some Observations Concerning the Effects of a Power Station's Thermal Effluent on Phytoplankton Dynamics.

1977. Jour. Tenn. Acad. Sci., 52, 10-14 (Illinois Environmental Science, Northbrook, IL)

A limnological study of Lake Wylie Reservoir in North and South Carolina showed that phytoplankton composition and abundance were influenced by the operation of a fossil-fueled electric generating station (Plant Allen). These effects were distinctly localized and no lake-wide effect was observed. Plant Allen utilizes cooling water from one major tributary (Catawba River) to Lake Wylie and discharges it into the other major tributary (South Fork River). The upstream migration of the discharge water (plume) has a dynamic impact on the phytoplankton community of the South Fork. Substantial pulses of phytoplankton were characteristic of the Catawba River were detected approximately two miles (3.2 kilometers) upstream from the discharge point on 4 of 12 sampling dates. Retention time appeared to be a major factor influencing the phytoplankton quantities in the vicinity of the Plant Allen discharge. (Auth)

<524>
Wilkie, G. P., F. B. Cross, W. J. O'Brien, Y. S. Yu, J. Wagner, J. B. Triplett, B. Brunner, D. Gilman, C. Viaroy, and K. O'Quinn, Physical and Biological Effects of Thermal Discharges at La Crosse Lake, Volume I: Project Report, Volume II: Procedures and Selected Field Data, Project Completion Report for July 1972 to June 1975.

1976. Kansas Water Resources Research Institute Contribution No. 174 (University of Kansas, Kansas Water Resources Research Institute, Manhattan, KS)

An interdisciplinary study was conducted at La Crosse Lake, Kansas (1952 ha) in order to determine the physical and biological effects of thermal discharges from an 800 MW power plant. Results cover three years of study, including periods before and after plant start-up. Power generation was intermittent during the study. Temperature distribution and circulation patterns were assessed. Accurate prediction of temperature distribution caused by thermal discharge was not possible with available models. Fish were sampled at several lake stations including the discharge canal. Bluegill were kept in live boxes in the intake and discharge areas in an attempt to assess the effect of the heated discharge. No detrimental biological effects were observed. (ST)

<525>
Winget, R. B., C. E. Spillman, T. Pennels, and P. Austin, Effects of Diet and Temperature on Growth and Mortality of the Blue Crab, *CALLINectes sapidus*, Maintained in a Recirculating Culture

(525) CONT.
System.

1976. Proc. Natl. Shellfish. Assn., 66, 29-33
(University of Baltimore, College of Marine
Studies, Poores, DE)

Blue crab growth parameters were compared over a sixty-day period in a recirculating culture system, with each crab in physical isolation. Independent variables were molt interval, increase in carapace width per molt, percent molt and mortality. No consistent growth differences were detected in animals fed diets ranging from 26 to 75% protein content. A temperature of 30 C generally increased molt frequency and percent of animals molting compared to a temperature of 29 C. Increased temperature appears to depress cuticle expansion and to decrease mortality. (Both)

(526)

Dodd, B.D., Thermal Adaptation in a Snail,
HELIOMA TUBULIFIS, in a Heater Cooling
Reservoir.

1976. Ph.D. Thesis, University of South
Carolina, 79 p. (University of South Carolina,
Columbia, SC)

Spawning, growth rates, and biomass of the planorbis snail, *HELIOMA TUBULIFIS*, from a heated area and a control area of Bar Pond, Savannah River Plant, were similar. Seasonal increases and decreases in shell weight differed between the two areas. Snails were more abundant in the heated area, particularly following the September and November spawning periods. Metabolism-temperature relationships of snails from the heated area differed from those of snails from the control area, and the relationships varied with season. Laboratory-reared snails from the two collection areas were similar in their patterns of oxygen consumption, but the patterns were modified by rearing temperature. (ST)

(527)

Doelcke, W.E., and E.G. Neerstin, The Seasonal
Distribution of Three Minnows (Cyprinidae) in a
Piedmont Section of the James River, Virginia
(Abstract only).

1976. Va. Jour. Sci., 27, 52 (University of
Richmond, Richmond, VA)

An investigation was made of the seasonal occurrence distributions of three species of minnows (Cyprinidae), *NOTHEMIS AULOSTOMUS*, *N. AUREUS* and *N. SUNGUIS* collected in an 8 km stretch of a Piedmont section of the James River near Brown Bluff, Virginia. Fishes were collected by electrofishing from a boat within and outside a heated effluent created by a power station from July, 1973 to June, 1974. Abundance and percent occurrence data were used to analyze the seasonal distributions at nearshore areas for each species. *NOTHEMIS AULOSTOMUS* was equally abundant at ambient and elevated temperature locations throughout the year except in the heated place when temperatures exceeded 30 C during the summer. The greatest abundance of *N. AUREUS* occurred at ambient temperature nearshore areas from early fall to spring. In the heated place, minimum numbers were recorded in late fall. *NOTHEMIS SUNGUIS* was most abundant at ambient temperature areas from the summer through the fall and avoided the place area in the summer and early fall

when temperatures exceeded 30 C. (Both)

(528)

Brown, W.D., Seasonal Occurrence and Diversity of
Fish in a Heated Discharge Channel, Tennessee
River.

1975. Proc. 29th Ann. Conf. S.E. Assn. Game &
Fish Comm., 275-287 (Tennessee Valley Authority,
Division of Forestry, Fisheries, and Wildlife
Development, Dumas, AL)

The fish population in the heated discharge channel from Colbert Steam Plant on the Tennessee River was sampled from January 1972 to December 1973 to determine the effects of temperatures on species composition, relative abundance, and diversity. Electrofishing (700 samples and gill netting (36 samples) yielded a total of 36 species: median number of species per sample for each type of gear was nine. Species that were commonly collected from the discharge channel at various summer temperatures (33 to 35 C) include: spotted cat, gizzard and threadfin shad, carp, bluegill, longear sunfish, spotted bass, largemouth bass, and channel catfish. The occurrence of only three species (spottail herring, sauger, and walleye) was considered temperature dependent; these species apparently avoided the heated effluent at temperatures above 30 C. Mortalities resulting from temperature differences were not observed. Regression analysis of two diversity indices computed for the electrofishing indicated that species diversity was inversely related to temperature in the discharge channel ($R^2 = 0.65$) but that the Shannon index (H') was not temperature dependent. (Both)

(529)

Brown, W.D., Fisheries Studies in Relation to a
Long Heated Discharge Channel (Colbert Steam
Plant, Tennessee River).

1976. Ph.D. Thesis, Virginia Polytechnic
Institute and State University (Virginia
Polytechnic Institute and State University,
Blacksburg, VA)

Cooling water for Colbert Steam Plant, located in northwest Alabama, is pumped from the Tennessee River, heated about 8 C, and discharged into the lower 4.5 km of Case Creek which flows into the Tennessee River about 1.6 km below the plant. The heated effluent comprises approximately 98% of the creek flow. Maximum temperatures in the discharge channel approach 36 C in summer and 15 C in winter; ambient temperatures of the Tennessee River normally range from 8 to 31 C. No direct mortalities resulting from temperature differences were observed. Species diversity was inversely related to temperature in the discharge channel, but the Shannon index H' was not temperature dependent. Perennial summer effluent temperatures (33 to 35 C) did not create a thermal barrier with reference to the movement of *NOTHEMIS AULOSTOMUS*, *N. AULOSTOMUS*, or *PTILOCTETUS OLIVARIUS* in lower Case Creek. *PTILOCTETUS OLIVARIUS* frequently selected temperatures above 30 C. The single *PTILOCTETUS VITREUS* trapped remained in the heated discharge 30 days during which time the effluent temperature increased from 19.2 to 27.4 C. *NOTHEMIS* spp. and *PTILOCTETUS AULOSTOMUS* comprised approximately 98% and 6% respectively of the larval fish entrained by this plant which normally uses about three percent of the total riverflow for condenser cooling. Peak density (1.5/m³) occurred

<529> CB87.
During June. (Both) (ST)

<530>
Worthen, R.A., and C.E. Davis, Effects of Temperature and Ration Level on the Growth and Food Conversion Efficiency of SALMON CHINQUETID, Richardson.

1977. Jour. Fish Biol., 11, 87-98 (Oregon State University, Department of Fisheries and Wildlife, Corvallis, OR)

The effects of temperature and ration size on the growth rate and gross efficiency of food conversion of juvenile rainbow trout SALMO GALTUSID were evaluated during 25-day seasonal experiments. Rations ranged from near-starvation to repletion levels. Test temperatures were 3 and 6 C higher than the controls which fluctuated daily and seasonally. At rations near maintenance, elevated temperatures decreased trout growth. As the feeding rate increased the detrimental effect of temperature on growth was ameliorated. At repletion feeding levels, elevated temperature up to 17 C improved trout growth by increasing the maximum food consumption rate. With a temperature increase from 6.9 to 22.5 C maintenance rations increased from 2.2 to 7.34 body weight per day. Gross efficiency was dependent upon ration level and temperature. As the food consumption rate increased, efficiency increased to a maximum, then generally declined at repletion levels. Elevated temperatures resulted in reduced efficiencies at low consumption rates but temperatures had little effect at high ration levels. A field study provided estimates of the food consumption relationships established in the laboratory, suggested any substantial increase of stream temperature without a concomitant increase of food abundance would result in decreased trout production. (Both)

<531>
Yamamoto, Y., Effect of Some Physical and Chemical Factors on the Germination of Akinetes of ANKINETA CYLINDRICA.

1976. Jour. Gen. Appl. Microbiol., 22, 311-323 (Nagasaki University, Faculty of Agriculture, Itoya, Nagasaki, Japan)

Germination of akinetes of ANKINETA CYLINDRICA is an inorganic medium occurred only in the light after a lag period, and only at a temperature of at least 35 C. This germination required oxygen and was inhibited by the photosynthetic inhibitor, 3,3-dichloro-6-methyl-5-norbornene (DCMU). Optimum pH was 7 to 8. Of several compounds tested, acetate was most effective in stimulating germination and was easily taken up by the akinetes without affecting respiration. Incorporated C¹⁴-acetate was recovered mainly from the glutamate and leucine ethanol-soluble fractions. (ST)

<532>
Yamawaki, T., T. Arai, and T. Ichihara, Distribution and Migration of Salmon (especially Chin Salmon) in the Oyashio Current Waters South of Southern Kuril Islands in Autumn.

1975. Bull. Far Seas Fish. Res. Lab., 13, 39-61 (Far Seas Fish. Res. Lab., Otsu, Shiga, Japan)

The distribution and migration of salmon were investigated in the waters south of Hokkaido

Island in late September and early October 1970. The main object of this investigation was to corroborate the migratory route of chin salmon returning to Nemuro and Kushiro rivers. A contrast was observed between distribution of salmon and anchovy. Salmon were distributed in a narrow range within 10 miles south of Nemuro Island, where the surface water temperature was approximately 10 C. On the other hand, anchovy were distributed widely in the more southern waters warmer than 13 C. (Both) (ST)

<533>
Washida, S., Acceleration of Maturation and Spawning of the Striped Bass MORONE NIGRICANS var. VALLATA.

1976. Bull. Jap. Soc. Sci. Fish., 42, 1199-1203 (Nagasaki Prefectural Fisheries Experimental Station, Nishiki, Nagasaki, Japan)

The maturation of MORONE NIGRICANS was accelerated by the addition of heat. Spawning occurred in a rearing frame in early February when heat was added since December and in mid-April when no heat was added. Controls, reared at room temperature, reached a spawning peak in mid-May at 23 C. The estimated total effective temperature, calculated since hatching time, was 5500 C day. (ST)

<534>
Wangeth, H.-J., Zooplankton Populations in a Polluted, Tropical Bay.

1976. Estuarine & Coastal Mar. Sci., 4, 481-496 (University of Puerto Rico, Puerto Rico Nuclear Center, Mayaguez, Puerto Rico)

During 1973-74 monthly collections of zooplankton were made at three sites in Caguas Bay, Puerto Rico: the intake and receiving waters of a fossil-fueled power plant and in the entrance to the bay. The zooplankton ranged from 79 to 3967 organisms ml. Densities increased two-to-eightfold several times during the study. The largest variations were associated with seasonal wind and rainfall patterns and reflect the short generation times of the dominant species, the copepod NAUPLIIDUS TROPICALIS and the nauplius larvae of the barnacle NARCAUS ANTHUS. Water movements and thermal pollution accounted for regional differences in density and species composition. Zooplankton were more abundant and diverse at the entrance to the estuary where bay and coastal waters mix. Smaller concentrations and numbers of species characterized the assemblages in the shallower intake waters. Consistently lower densities, fewer species and sporadic increases in abundance characterized the zooplankton found in the thermal cove. (Both)

<535>
Yousif, F., and S. Lamlar, The Effect of Some Biological and Physical Factors on Infection of BACTERIAL GLASSIDIA with ANGIOSTOMUS CRYPTUS.

1975. Sci. Parasitol. (Gyr.), 47, 191-201 (National Research Center, Laboratory of Bacteriology Research, Cairo, Egypt)

A temperature of 26 C was found to be optimal for infection of the snail, BACTERIAL GLASSIDIA, with larvae of ANGIOSTOMUS CRYPTUS. (ST)

<336>

Zitko, V., and R.C. Carson, Seasonal and Developmental Variation in the Lethality of Zinc to Juvenile Atlantic Salmon (SMILC SMILC).

1977. Jour. Fish. Res. Bd. Can., 34, 139-141 (Not given)

This research demonstrates that the incipient lethal level (ILL) of zinc changes with the season and size of the fish. Starting at the beginning of November, water temperature for one group of Atlantic salmon (SMILC SMILC) was maintained at 10 C, whereas the other group of fish remained in water of ambient temperature (December to April, 6 C, followed by a slow increase to 15 C between May and July). Toxicity tests were performed monthly from September 1976 to July 1977. The ILL was increased initially and reached a maximum of approximately 1000 ug/l in February. For fish kept at 10 C, the ILL then decreased to about 150 ug/l in April and remained low for the duration of the experiment. Fish at ambient temperature had a minimum ILL of 330 ug/l observed in June. The ILL of 2-yr-old juvenile salmon is approximately 4 times lower than that of the 1-yr-old fish.

Therefore, the possibility of changing the effluent standards to encompass this sensitive life stage, the period from March to August, should be considered. (33)

<337>

Salotavicius, L.A., and L.S. Ruthebeck, The Season for the Formation of Additional Rings on the Scales of the Polych, Commonest Pike, and the Broad Whitefish, Commonest Pike.

1976. Jour. Ichthyol., 16, 157-162 (Siberian Territorial Administration of Fisheries and Siberian Research and Structural Planning Institute, Tyumen', USSR)

The appearance of additional rings on the scales of the polych and the broad whitefish introduced into water bodies south of their range is correlated with the cessation of feeding of these fish when water temperatures rise above 20 C. Errors in age determination of the fish may be overcome by determining the yearly number of sclerites formed on the scales of each species. (37)

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