



# **Research and Development**

## **INDEX AND ABSTRACTS TO PUBLICATIONS**

### **THE EPA-NCI PROJECT: EFFECTS OF CARCINOGENS, MUTAGENS, AND TERATOGENS ON NON-HUMAN SPECIES (AQUATIC ANIMALS)**

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## ABOUT THIS PUBLICATION

THE NATIONAL CANCER INSTITUTE (NCI) FUNDED AN EPA STUDY ENTITLED: "EFFECTS OF CARCINOGENS, MUTAGENS AND TERATOGENS ON NON-HUMAN SPECIES (AQUATIC ANIMALS)" FROM 1978 TO 1982. ASSOCIATED WITH THIS EFFORT WERE DR. H. KRAYBILL (NCI) AND DR. JOHN COUCH (EPA), PRINCIPAL INVESTIGATOR AND PROJECT COORDINATOR.

TO DATE, THE JOINT EFFORT HAS PRODUCED ABOUT 100 REPORTS, SYMPOSIA SECTIONS OR PUBLICATIONS IN THE PEER-REVIEWED, JOURNAL LITERATURE. CONTRIBUTIONS ARE LISTED, WITH ABSTRACTS (WHEN AVAILABLE) AND CROSS REFERENCED BY TITLE-KEY WORDS (SEE PAGE 56). ADDITIONALLY, AN AUTHOR INDEX IS PROVIDED (SEE PAGE 42).

QUESTIONS CONCERNING THE PROJECT SHOULD BE ADDRESSED TO DR. J. COUCH (COMMERCIAL 904-932-5311 OR FTS 686-9011). REPRINT OR REPORT REQUESTS SHOULD BE DIRECTED TO MS. ANDREE LOWRY (COMMERCIAL 904-932-5311 OR FTS 686-9011). THIS PUBLICATION SUPERSEDES SR-103 AND SR-101A.

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ANDERSON, ROBERT S. 1978. BENZO(A)PYRENE METABOLISM IN THE AMERICAN OYSTER CRASSOSTREA VIRGINICA. EPA-600/3-78-009, U.S. ENVIRONMENTAL PROTECTION AGENCY, ENVIRONMENTAL RESEARCH LABORATORY, GULF BREEZE, FL. 19P.

THIS RESEARCH PROGRAM WAS INITIATED WITH THE OVERALL OBJECTIVE OF DETERMINING THE ROLE OF NADPH-DEPENDENT MICROSOMAL MONO-OXYGENASE IN THE METABOLISM OF THE WIDESPREAD ENVIRONMENTAL CARCINOGEN BENZO(A)PYRENE (BP) BY THE OYSTER CRASSOSTREA VIRGINICA. THIS ENZYME SYSTEM IS IMPORTANT IN DETOXYFYING VARIOUS XENOBIOTICS AND IN ACTIVATING POLYCYCLIC AROMATIC HYDROCARBON ONCOGENS AS BP. A SENSITIVE RADIOISOTOPIC SYSTEM WAS DEVELOPED TO PERMIT THE QUANTIFICATION OF ALKALI-SOLUBLE AND WATER-SOLUBLE BP METABOLITES PRODUCED BY OYSTER MONO-OXYGENASE. AN NADPH- AND OXYGEN-DEPENDENT ARYL HYDROCARBON HYDROXYLASE (AHH) WAS SHOWN TO BE LOCATED IN THE DIGESTIVE GLANDS OF THESE BIVALVES ASSOCIATED WITH THE MICROSOMAL SUBCELLULAR FRACTION. THE SPECIFIC ACTIVITY OF OYSTER AHH WAS CONSIDERABLY LOWER THAN THAT OF LABORATORY MICE, BUT WAS CONSISTENTLY DEMONSTRABLE. THE BP METABOLITES PRODUCED WERE PRIMARILY WATER-SOLUBLE DERIVATIVES. THERE WAS SOME INDICATION THAT OYSTER AHH WAS INDUCED BY CHRONIC EXPOSURE OF THE ANIMALS TO THE ENVIRONMENTAL CARCINOGENS BP AND 3-METHYL-CHOLANTHRENE. THERE WAS STRONG EVIDENCE THAT EXPOSURE TO POLYCHLORINATED BIPHENYLS (PCB) CAUSED AHH INDUCTION. HIGH-PRESSURE LIQUID CHROMATOGRAPHY WAS USED TO IDENTIFY BP METABOLITES PRODUCED BY OYSTER AHH. THE GENERATION OF VARIOUS DIHYDRODIOL, QUINONE, AND HYDROXY BP DERIVATIVES WAS SHOWN; THIS PRODUCTION WAS AUGMENTED IN PCB-EXPOSED OYSTERS. THIS REPORT COVERS THE PERIOD FROM JULY 1, 1976 TO JUNE 30, 1977, AND WORK WAS COMPLETED AS OF AUGUST 31, 1977.

ANDERSON, ROBERT S., JESSICA E. DOOS, AND FRANCIS L. ROSE. 1982. DIFFERENTIAL ABILITY OF AMBYSTOMA TIGRINUM HEPATIC MICROSOMES FROM POLYCYCLIC AROMATIC HYDROCARBONS AND AROMATIC AMINES. CANCER LETT. 16(1):33-42. (ERL,GB X460).

A NUMBER OF CARCINOGENIC AROMATIC AMINES, WHEN ACTIVATED BY LIVER MICROSOMES FROM A SALAMANDER, AMBYSTOMA TIGRINUM, ARE MUTAGENIC FOR SALMONELLA TESTER STRAINS SENSITIVE TO FRAMESHIFT MUTAGENS. HOWEVER, 2 POLYCYCLIC AROMATIC HYDROCARBONS (PAH) (BENZO(A)PYRENE (BAP) AND PERYLENE) THAT ARE RENDERED MUTAGENIC BY MAMMALIAN MICROSOMES ARE NOT ACTIVATED BY AMBYSTOMA MIXED-FUNCTION OXIDASES. BAP WAS CHOSEN FOR STUDY BECAUSE IT IS A WELL-KNOWN ENVIRONMENTAL CARCINOGEN; PERYLENE, AN ISOMER OF BAP, HAS BEEN IMPLICATED AS AN ETIOLOGICAL AGENT IN CUTANEOUS NEOPLASIA IN AMBYSTOMA. THESE RESULTS SUPPORT THE OBSERVATION THAT AMPHIBIANS ARE QUITE RESISTANT TO PAH CARCINOGENESIS AND SUGGEST THAT AROMATIC AMINES MAY BE MORE APPROPRIATE MODEL CARCINOGENS.

BIBA, DIANE MARY. 1983. EFFECTS OF AFLATOXIN ON THE BROWN BULLHEAD ICTALURUS NEBULOSIS. M.S. THESIS. AUBURN UNIVERSITY, AUBURN, AL. 53P. (ERL,GB X357).

BROWN BULLHEADS HAD RENAL LESIONS 25 DAYS AFTER A ONE-HOUR EXPOSURE TO 1.0 MG/LITER AFLATOXIN B-1 (AFB) DURING THE FIFTH DAY OF EMBRYONIC DEVELOPMENT, INDICATING A SIMILARITY TO THE EFFECTS OF AFB REPORTED FOR RAINBOW TROUT. RENAL LESIONS WERE NOT FOUND IN BROWN BULLHEADS AFTER EMBRYO EXPOSURE TO 0.5 MG/LITER AFB. LIVER HISTOLOGY AND ULTRASTRUCTURE OF CONTROL BROWN BULLHEADS WERE SIMILAR TO CHANNEL CATFISH, ICTALURUS PUNCTATUS. NO LESIONS WERE OBSERVED IN BROWN BULLHEAD LIVERS EXAMINED 25 DAYS TO EIGHT MONTHS AFTER EMBRYO EXPOSURE TO 0.5 MG/LITER OR 1.0 MG/LITER AFB. THE LACK OF LIVER TUMOR INDUCTION EIGHT MONTHS AFTER EMBRYO EXPOSURE TO 0.5 MG/LITER AFB OR 1.0 MG/LITER AFB SUGGESTS THAT LONGER INDUCTION TIMES OR HIGHER DOSAGES OF AFB ARE REQUIRED FOR TUMORIGENICITY IN BROWN BULLHEADS. A BENZO(A)PYRENE (BAP) ASSAY INDICATED NO INDUCTION OF THE MIXED-FUNCTION OXIDASE (MFO) SYSTEM IN BROWN BULLHEAD MICROSOMES EIGHT MONTHS AFTER EMBRYO EXPOSURE TO 0.5 MG/LITER AFB. LESIONS WERE NOT OBSERVED IN LIVERS OR TRUNK KIDNEYS OF BROWN BULLHEADS 25 DAYS AFTER A ONE-HOUR EXPOSURE DURING THE FIFTH DAY OF DEVELOPMENT TO AN ORGANIC CONCENTRATE OF EFFLUENT FROM THE SOUTH TUSKEGEE WATER POLLUTION CONTROL PLANT, MACON COUNTY, ALABAMA. AFTER THREE INTRAPERITONEAL INJECTIONS OF 1.7 MG/KG AFB AT 10-DAY INTERVALS, LIVERS OF BROWN BULLHEADS EXHIBITED LIMITED INDUCTION OF THE MFO SYSTEM AFTER A BAP METABOLISM ASSAY. THE MFO INDUCTION WAS PROBABLY RESTRICTED BY AFLATOXIN INHIBITION OF PROTEIN SYNTHESIS. INJECTION OF AFB CAUSED ACCUMULATION OF LIPOFUCHSIN AND HEMOSIDERIN WITHIN MACROPHAGE CENTERS IN THE LIVER, AND ULTRASTRUCTURALLY, MITOCHONDRIAL PYKNOSIS AND VESICULATION AND DEGRANULATION OF ROUGH ENDOPLASMIC RETICULUM OF HEPATOCYTES.

BUNTING, DIANE LEIGH. 1979. EVALUATION OF BENZO(A)PYRENE METABOLISM IN AN OYSTER (OSTREA EDULIS)-BACTERIA SYSTEM. M.S. THESIS. OREGON STATE UNIVERSITY, CORVALLIS, OR. 121P. (ERL,GB X285).

THE OVERALL OBJECTIVE OF THIS RESEARCH PROJECT WAS TO EVALUATE THE METABOLISM OF BENZO(A)PYRENE (BAP) BY THE EUROPEAN FLAT OYSTER (OSTREA EDULIS)-BACTERIA SYSTEM. INDIVIDUAL OYSTERS EXIST IN NATURE AS "SYSTEMS" WITH COMMENSAL MICROORGANISMS AND SHOULD BE RECOGNIZED AS SUCH WHEN THE METABOLISM OF A SPECIFIC ENVIRONMENTAL CONTAMINANT IS BEING STUDIED. SINCE BIVALVES ARE EXPOSED TO ENVIRONMENTAL POLLUTANTS THAT ENTER COASTAL WATERS, IT IS IMPORTANT TO DETERMINE IF THE "NATURAL" OYSTER SYSTEM CAN DETOXYFY THOSE CONTAMINANTS LIKELY TO CAUSE BIOLOGICAL DAMAGE.

COUCH, J.A., J.T. WINSTEAD, D.J. HANSEN, AND L.R. GOODMAN. 1979. VERTEBRAL DYSPLASIA IN YOUNG FISH EXPOSED TO THE HERBICIDE TRIFLURALIN. J. FISH DISEASES. 2(1):35-42. (ERL,GB 346).

SHEEPSHEAD MINNOWS, CYPRINODON VARIEGATUS LACEPEDE, EXPOSED TO 5.5 TO 31 MG/L OF THE HERBICIDE TRIFLURALIN, THROUGHOUT THEIR FIRST 28 DAYS OF LIFE, DEVELOPED A HERETOFORE UNDESCRIBED VERTEBRAL DYSPLASIA. THIS DYSPLASIA CONSISTED OF SYMMETRICAL HYPERTROPHY OF VERTEBRAE (THREE TO 20 TIMES NORMAL), CHARACTERIZED BY FOCI OF OSTEOBLAST AND FIBROBLASTS ACTIVELY LAYING DOWN BONE AND BONE PRECURSORS. EFFECTS OF THE ABNORMAL VERTEBRAL DEVELOPMENT WERE DORSAL VERTEBRAL GROWTH INTO THE NEURAL CANAL, VENTRAL COMPRESSION OF RENAL DUCTS, AND LONGITUDINAL FUSION OF VERTEBRAE. FISH, EXPOSED FOR 51 DAYS TO 16.6 MG/L TRIFLURALIN AND THEREAFTER DEPURATED FOR 41 DAYS, SHOWED NO INCREASE IN VERTEBRAL DYSPLASIA DURING DEPURATION; HOWEVER, RESIDUAL SPINAL COLUMN DAMAGE WAS EVIDENT. SERUM CALCIUM CONCENTRATIONS WERE ELEVATED IN ADULT FISH EXPOSED FOR 4 DAYS TO 16.6 MG/L TRIFLURALIN. FLUOROSIS OR MIMICRY OF HYPERVITAMINOSIS ARE CONSIDERED POSSIBLE MECHANISMS FOR THE OSSEOUS EFFECT, BUT ARE NOT CONSIDERED TO BE THE ONLY POSSIBLE CAUSES. THE HIGHLY PREDICTABLE NATURE OF THIS DISORDER IN EXPERIMENTAL EXPOSURES STRENGTHENS THE PROBABILITY THAT YOUNG FISH MAY SERVE AS EXPERIMENTAL MODELS FOR DETERMINING EFFECTS OF CHEMICALS ON EARLY VERTEBRATE ONTOGENY, PARTICULARLY IN REGARD TO SKELETAL DEVELOPMENT.

COUCH, JOHN A. IN PRESS. ENLARGEMENT OF AND HISTOPATHOLOGIC EFFECTS IN THE PITUITARY OF A TELEOST EXPOSED TO THE HERBICIDE TRIFLURALIN. J. FISH DISEASES. (ERL,GB 438).

PITUITARY GLANDS OF SHEEPSHEAD MINNOWS, CYPRINODON VARIEGATUS, EXPOSED FOR 19 MONTHS TO 1-5 UG/L TRIFLURALIN WERE SIGNIFICANTLY ENLARGED AND POSSESSED HISTOPATHOLOGIC CHARACTERISTICS (WHEN COMPARED TO GLANDS OF CONTROLS) SUCH AS PSEUDOCYSTS, CONGESTION OF BLOOD VESSELS AND EDEMA. MOST OF THE FISH WITH ENLARGED PITUITARIES ALSO HAD DIFFUSE VERTEBRAL HYPEROSTOSIS AND OTHER DYSPLASTIC VERTEBRAL CHANGES. SEVERAL SPECULATIVE MECHANISTIC PATHS ARE SUGGESTED FOR THE MODE OF EFFECT OF TRIFLURALIN ON THE VERTEBRAL AND PITUITARY TISSUES. STUDY OF THE FORM AND FUNCTION OF PITUITARY GLANDS OF TELEOSTS FROM NATURAL POPULATIONS MIGHT PROVIDE INDICATIONS OF CHRONIC PHYSIOLOGICAL STRESS, PARTICULARLY IN RELATION TO CHEMICAL POLLUTANT STRESS.

COUCH, JOHN A. 1979. SHRIMPS (ARTHROPODA: CRUSTACEA: PENAEIDAE). IN: POLLUTION ECOLOGY OF ESTUARINE INVERTEBRATES. C.W. HART, JR. AND L.H. SAMUEL, EDITORS, ACADEMIC PRESS, NEW YORK, NY. PP. 235-258. (ERL,GB X046).

THE MAJORITY OF REPORTS AVAILABLE ABOUT POLLUTION AND PENAEID SHRIMPS CONCERNS STUDIES INVOLVING THE COMMERCIALY VALUABLE PENAEID SHRIMPS OF THE U.S. ATLANTIC STATES AND GULF COAST. THEREFORE, MOST OF THE INFORMATION PRESENTED HERE WILL BE RELATED TO THE FOLLOWING THREE SPECIES: PENAEUS DUORARUM (PINK SHRIMP), PENAEUS AZTECUS (BROWN SHRIMP), AND PENAEUS SETIFERUS (WHITE SHRIMP), ALL ATLANTIC AND GULF OF MEXICO SPECIES. REFERENCE TO OTHER SPECIES OF PENAEID AND SOME NONPENAEID CRUSTACEA WILL BE MADE WHEN SPECIFIC STUDIES CONTRIBUTE SIGNIFICANTLY TO OUR UNDERSTANDING OF POLLUTION ECOLOGY OF SHRIMPS. THIS CHAPTER WILL COVER THE FOLLOWING POLLUTANT CATEGORIES AND SITUATIONS: ORGANIC CHEMICALS OTHER THAN PETROLEUM, PETROLEUM AND RELATED COMPOUNDS, HEAVY METALS, BIOLOGICAL AGENTS, AND INTERACTIONS OF POLLUTANTS AND OTHER FACTORS. UNDER EACH OF THESE DIVISIONS TOXICITY AND SPECIFIC TISSUE, ORGANISMIC, POPULATION, AND ECOLOGICAL EFFECTS WILL BE REVIEWED WHEN KNOWN. FURTHER, THE UPTAKE, TRANSPORT, AND FATE OF POLLUTANTS WILL BE DISCUSSED AS THEY MAY AFFECT THE ECOLOGY OF PENAEID SHRIMPS

COUCH, JOHN A. 1981. VIRAL DISEASES OF INVERTEBRATES OTHER THAN INSECTS. IN: PATHOGENESIS OF INVERTEBRATE MICROBIAL DISEASES. ELIZABETH W. DAVIDSON, EDITOR, ALLENHELD, OSMUN, TOTOWA, NJ. PP. 127-160. (ERL,GB 274).

THIRTEEN EXAMPLES OF VIRUS OR VIRUSLIKE RELATED PATHOSES IN NON-INSECT INVERTEBRATES ARE DESCRIBED. FROM CONSIDERATION OF THESE EXAMPLES, IT BECOMES OBVIOUS THAT DETAILED DESCRIPTIONS OF PATHOGENESIS OF VIRUS DISEASES IN NON-INSECT INVERTEBRATES HAS NOT KEPT PACE WITH THE FREQUENCY OF NEW REPORTS OF VIRUSES FROM THESE INVERTEBRATES. WHEN POSSIBLE, IT IS OF UPMOST IMPORTANCE FOR AUTHORS REPORTING VIRAL ENTITIES FROM INVERTEBRATES TO INCLUDE AS MUCH INFORMATION AS CAN BE COLLECTED ON THE DISEASE SYNDROME, CELLULAR PATHOGENESIS, PHYSIOLOGICAL AND BEHAVIORAL EFFECTS AND TISSUE DISTRIBUTION OF THE VIRUS. IN SOME CASES, INFORMATION HAS BEEN SO SCANT THAT READERS ARE NOT EVEN CERTAIN AS TO THE PREVALENCE OF THE VIRUS IN REPORTED HOSTS. BASIC INFORMATION ON THE NATURE OF NON-INSECT INVERTEBRATE VIRUS DISEASES IS NEEDED FOR SEVERAL REASONS. INSIGHTS INTO MECHANISMS OF PATHOGENESIS AND PATHOGENIC EFFECTS IN INVERTEBRATE VIRUSES MAY GIVE BETTER UNDERSTANDING OF VERTEBRATE VIRUS DISEASES. FURTHER, A MAJOR OPPORTUNITY EXISTS WITH INVERTEBRATE VIRUS DISEASE TO INVESTIGATE THE FUNDAMENTAL ASPECTS OF CELLULAR IMMUNITY.

COUCH, JOHN A. 1982. AQUATIC ANIMALS AS INDICATORS OF ENVIRONMENTAL EXPOSURES. J. ENVIRON. SCI. HEALTH PART A ENVIRON. SCI. ENG. 17(4):473-476. (ERL,GB 431).

AQUATIC ANIMALS ARE USEFUL AS INDICATORS OF MANY KINDS OF POLLUTANTS IN THE AQUATIC ENVIRONMENT. THE PRESENCE OF POLLUTANTS IN THE GENERAL ENVIRONMENTS OF AIR, LAND AND WATER IS REFLECTED IN THEIR ACCUMULATIONS IN AND EFFECTS ON AQUATIC ORGANISMS BECAUSE THE AQUATIC PORTION OF THE BIOSPHERE IS OFTEN THE "SINK" FOR HUMAN-GENERATED POLLUTANTS. AQUATIC ANIMALS LEND THEMSELVES PARTICULARLY WELL TO THE STUDY OF SPECIAL PHENOMENA, SUCH AS CARCINOGENESIS AND TERATOGENESIS. THE USE OF AQUATIC ANIMALS AND SYSTEMS ADDS AN IMPORTANT DIMENSION TO RESEARCH ON THOSE POLLUTANTS THAT MAY AFFECT WILDLIFE AND HUMAN HEALTH.

COUCH, JOHN A., LEE A. COURTNEY, AND STEVEN S. FOSS. 1981. LABORATORY EVALUATION OF MARINE FISHES AS CARCINOGEN ASSAY SUBJECTS. IN: PHYLETIC APPROACHES TO CANCER: PROCEEDINGS OF THE 11TH INTERNATIONAL SYMPOSIUM OF THE PRINCESS TAKAMATSU CANCER RESEARCH FUND, TOKYO, 1980. CLYDE J. DAWE, EDITOR, JAPAN SCIENTIFIC SCIENCES PRESS, TOKYO, JAPAN. PP. 125-139. (ERL,GB 171).

THE U.S. EPA AND THE NATIONAL CANCER INST. (NCI) HAVE MAJOR RESPONSIBILITIES FOR DETERMINING THE FATE AND RISKS OF CARCINOGENIC AGENTS IN THE NATURAL ENVIRONMENT. UNDER THE AUSPICES OF EPA/NCI, THE CARCINOGEN RESEARCH TEAM AT THE USEPA LAB., GULF BREEZE, HAS A MAJOR ROLE IN INVESTIGATING THE FATE, EFFECTS, AND RISKS OF CARCINOGENIC AGENTS IN THE AQUATIC PORTION OF THE BIOSPHERE. IN REGARD TO THIS ROLE, THERE IS A NEED FOR PRACTICAL, EXPERIMENTAL EXPOSURE SYSTEMS FOR THE SHORT TERM, AND LONG TERM EXPOSURE OF FISHES AND INVERTEBRATES IN ORDER TO EVALUATE THEIR RESPONSES TO ENVIRONMENTALLY SIGNIFICANT CARCINOGENS. WE HAVE DESIGNED AND TESTED AN ADAPTABLE, AQUATIC LABORATORY SYSTEM FOR FLOWING WATER OR STATIC WATER ASSAYS OF CARCINOGENIC OR SUSPECT CARCINOGENIC AGENTS AGAINST MARINE FISHES. WE REPORT HERE THE DESIGN, RESULTS OF LONG TERM TESTS, AND THE FUTURE USES OF THE SYSTEM FOR DETERMINING THE RISKS OF CARCINOGENIC AGENTS IN THE AQUATIC ENVIRONMENT, AND AS A SYSTEM COMPLEMENTARY TO MAMMALIAN ASSAY SYSTEMS, BUT WHICH PERMITS THE PHYLOGENETIC EXPANSION OF CARCINOGEN ASSAY METHODOLOGY. A PILOT TEST OF THE DESCRIBED SYSTEM HAS BEEN COMPLETED. THIS TEST UTILIZED FLOWING FILTERED, ESTUARINE WATER, CONTROLLED WATER TEMPERATURE, CONTROLLED PHOTO PERIOD, CONTROLLED NUTRITION OF TEST SPECIES, OXYGEN CONCENTRATION MONITORING, AND VARIOUS LIFE CYCLE STAGES OF THE TEST FISH, THE SHEEPSHEAD MINNOW, CYPRINODON VARIEGATUS, AND THE SUSPECT CARCINOGENIC HERBICIDE, TRIFLURALIN. CONTINUOUS EXPOSURES TO 1 TO 5 MG/L TRIFLURALIN WERE CONDUCTED WITH ZYGOTE THRU EMBRYOGENESIS TO ADULT STAGES OF THE FISH.

COUCH, JOHN A., LEE A. COURTNEY, JAMES T. WINSTEAD, AND STEVEN S. FOSS. 1979. AMERICAN OYSTER (CRASSOSTREA VIRGINICA) AS AN INDICATOR OF CARCINOGENS IN THE AQUATIC ENVIRONMENT. IN: ANIMALS AS MONITORS OF ENVIRONMENTAL POLLUTANTS. NATIONAL ACADEMY OF SCIENCES, WASHINGTON, DC. PP. 65-84. (ERL,GB 338).

THE AMERICAN OYSTER (C. VIRGINICA) WAS USED AS THE EXPERIMENTAL ANIMAL FOR CHRONIC EXPOSURE TO 3-METHYLCHOLANTHRENE (3-MC) AND BENZOCALPYRENE (BP) IN AN EXPOSURE SYSTEM IN WHICH THE CARCINOGENS CAN BE CONTINUOUSLY INJECTED INTO FREE FLOWING WATER AT FIXED RATES RANGING FROM 1 TO 5 MG/L. EXPERIMENTS DESIGNED TO DETERMINE UPTAKE AND DISTRIBUTION OF H3MC AND C14BP SHOWED THAT THESE ARE CONCENTRATED IN OYSTER TISSUES IN DIRECT PROPORTION TO THE DOSAGE OF CARCINOGEN INJECTED INTO THE SYSTEM. RESIDUAL CONCENTRATIONS AS HIGH AS 84.4 MG/KG OF MC AND 36.4 MG/KG OF BP WERE PRESENT IN OYSTERS AS LONG AS 6 MONTHS FOLLOWING EXPOSURE. AUTORADIOGRAPHY SHOWED INTENSE LOCALIZATION OF C14BP IN DISTAL PORTIONS OF THE TUBULES OF THE DIGESTIVE GLAND AND TO A LESSER EXTENT IN THE GONADAL TISSUES. ARYL HYDROCARBON HYDROXYLASE (AHH) ACTIVITY WAS PRESENT IN HOMOGENATES OF HEPATOPANCREAS AFTER 5.5 MONTHS OF EXPOSURE TO THE CARCINOGENS, IN CONTRAST TO CONTROL ANIMALS IN WHICH AHH ACTIVITY WAS QUITE LOW. IN EIGHT OYSTERS EXPOSED TO MC, AN INFILTRATION OF CELLS BELIEVED TO BE OF HEMATOPOIETIC ORIGIN WAS ENCOUNTERED IN THE MANTLE. SOME APPEAR TO BE IDENTICAL IN TYPE TO THOSE WHICH CONSTITUTE SARCOMA-LIKE LESIONS ENCOUNTERED IN FERAL OYSTER POPULATIONS. HOWEVER, IT WOULD BE PREMATURE AT THIS STAGE TO ASSIGN ANY ETIOLOGICAL SIGNIFICANCE TO THE EXPERIMENTAL FINDINGS.

COUCH, JOHN A., AND CLYDE DAWE. IN PRESS. MOUSE VS MINNOW: THE FUTURE OF FISH IN CARCINOGENICITY TESTING (A FRIENDLY DISCUSSION/DEBATE BY DR. JOHN COUCH AND DR. CLYDE DAWE) - DEBATE: THE FISHY SIDE. IN: PROCEEDINGS OF THE SYMPOSIUM ON THE USE OF SMALL FISH SPECIES IN CARCINOGENICITY TESTING, BETHESDA, MARYLAND, DECEMBER 8-10, 1981. U.S. NATIONAL CANCER INSTITUTE. (ERL,GB 472).

THE TEXT IS PART OF A DEBATE AND ADVOCATES THE USE OF SMALL FISH SPECIES AS LABORATORY TEST ORGANISMS IN DETECTING AND DETERMINING POTENCY AND ACTIVITY OF SUSPECTED CARCINOGENS. THE USEFULNESS OF FISH SPECIES IS COMPARED AND CONTRASTED WITH THE USEFULNESS OF THE MORE CONVENTIONAL ASSAY SPECIES, SUCH AS RODENTS.

COUCH, JOHN A., AND ELSAYED ELNENAAY. IN PREP. COMPLEX CHROMATOPHORE IN A MARINE TELEOST FISH, *FUNDULUS GRANDIS*: MORPHOLOGICAL AND BIOCHEMICAL CHARACTERISTICS. (ERL,GB 286).

THREE SPECIMENS OF *FUNDULUS GRANDIS*, THE GULF KILLIFISH, HAD PIGMENTED TUMORS COMPRISED OF A CELL TYPE THAT HAD CHARACTERISTICS OF DIFFERENT PIGMENT CELL PHENOTYPES. THE FISH WERE FROM A MARICULTURE ATTEMPT ON THE GULF COAST OF ALABAMA USA, AND WERE OLDER LARGER SPECIMENS OF OVER 6,000 F. *GRANDIS* EXAMINED. A DETAILED LIGHT MICROSCOPY, ELECTRON MICROSCOPY, CHROMATOGRAPHIC, AND CELL CULTURE WAS CONDUCTED ON THE TUMORS FROM THREE FISH. THE TUMOR CELL POSSESSED PTERINOSOMES AS THE DOMINANT CYTOPLASMIC ORGANELLE, BUT ALSO HAD PREMELANOSOMES, MELANOSOMES, AND POSSIBLE REFLECTING PLATELETS. THE MAJOR PIGMENTS ISOLATED AND IDENTIFIED WERE PTERIDINE PIGMENTS. NO CAROTENOID PIGMENTS OR CAROTENOID VESTICLES WERE IDENTIFIED OR DETECTED. THE TUMORS WERE INVASIVE, REPLACED AND ISOLATED NORMAL MUSCLE TISSUES, BUT WERE NOT METASTATIC. ONE FISH WITH THE TUMORS BECAME MORIBUND WHILE HELD IN AQUARIUM, AND PRESENTED EVIDENCE THAT THE NEOPLASMS GREW AND INCREASED IN NUMBERS. THE CAUSES OF THE NEOPLASM IN *FUNDULUS* ARE UNKNOWN, BUT BOTH ENVIRONMENTAL AND GENETIC FACTORS MAY PLAY ROLES IN ITS GENESIS.

COUCH, JOHN A., FRANK G. LOWMAN, AND FORD A. CROSS. 1980. BIOMONITORING OF COASTAL WATERS--AN OVERVIEW. IN: BIOLOGICAL MONITORING FOR ENVIRONMENTAL EFFECTS. DOUGLAS L. WOLF, EDITOR, D.C. HEATH AND COMPANY, LEXINGTON, MA. PP. 93-95. (ERL,GB X156).

ESTUARINE AND COASTAL WATERS OF THE UNITED STATES NOT ONLY SERVE AS PRIME HABITAT FOR A SIGNIFICANT FRACTION OF COMMERCIAL AND RECREATIONAL MARINE FISHERIES, BUT ALSO RECEIVE INDUSTRIAL AND MUNICIPAL WASTES FROM A RAPIDLY EXPANDING COASTAL ECONOMY. IN ORDER TO ENSURE THAT LEVELS OF CONTAMINANTS IN COASTAL ECOSYSTEMS DO NOT AFFECT EITHER PUBLIC HEALTH OR FISHERIES RESOURCES ADVERSELY, BOTH STATE AND FEDERAL AGENCIES ARE CONDUCTING A VARIETY OF BIOMONITORING PROGRAMS. IN ADDITION, GENERIC RESEARCH PROJECTS ARE UNDERWAY AT SEVERAL UNIVERSITY, STATE, AND FEDERAL LABORATORIES TO DETERMINE WHICH ENVIRONMENTAL AND PHYSIOLOGICAL FACTORS REGULATE THE BODY BURDEN OF CONTAMINANTS IN MARINE ORGANISMS. THIS INFORMATION CAN THEN BE USED TO HELP INTERPRET DATA OBTAINED IN BIOMONITORING PROGRAMS AND TO ALLOW MORE PRECISE PREDICTIONS OF CONTAMINANT LEVELS IN BIOTA PRIOR TO DISCHARGE.

COUCH, JOHN A., AND W. PETER SCHOOR. 1980. EFFECTS OF CARCINOGENS, MUTAGENS, AND TERATOGENS ON NON-HUMAN SPECIES (AQUATIC ANIMALS). IN: ANNUAL REPORT ON NATIONAL CANCER INSTITUTE AND ENVIRONMENTAL PROTECTION AGENCY PROJECTS. U.S. DEPT. OF HEALTH, EDUCATION, AND WELFARE, PUBLIC HEALTH SERVICE, NATIONAL INSTITUTE OF HEALTH, BETHESDA, MD. 38P. (ERL,GB X002).

A RESEARCH PROGRAM USING AQUATIC SYSTEMS AND ORGANISMS TO STUDY THE FATE AND EFFECTS OF CARCINOGENS HAS BEEN UNDERWAY DURING FY 79 AT THE GULF BREEZE EPA LABORATORY. THE TWO MAJOR INVESTIGATIVE, DISCIPLINARY AREAS HAVE BEEN IN PATHOBIOLOGY AND BIOCHEMISTRY. A FISH-CARCINOGEN ASSAY SYSTEM HAS BEEN DEVELOPED THAT INVOLVES LABORATORY, CONTROLLED LONG-TERM EXPOSURE OF FISH TO SUSPECT CARCINOGENS FOLLOWED BY HISTOPATHOLOGY OF EXPOSED FISH AND THE FINDING OF INDUCED GROWTHS. THIS SYSTEM APPEARS ADEQUATE FOR CARCINOGEN TESTS FOR FISH. A FIELD SURVEY IS UNDERWAY FOR TUMOR AND DISEASE PREVALENCE IN FISH AND SHELLFISH IN VARIOUSLY POLLUTED ESTUARIES ALONG THE NORTHERN GULF OF MEXICO. IT IS TOO EARLY TO PREDICT THE SIGNIFICANCE OF THE FINDINGS IN THIS STUDY. BIOCHEMICAL STUDIES HAVE REVEALED THAT FISH MAY RESPOND IN ENZYMATIC REACTIONS IN WAYS SIMILAR TO MAMMALS EXPOSED TO THE SAME CARCINOGENS, AND THAT FISH MAY PROVE TO BE ADEQUATE SUPPLEMENTAL, BIOLOGICAL MONITORS OF CARCINOGENS IN THE ENVIRONMENT. IT WAS SHOWN THAT ASIDE FROM INDUCTION OF OXYGENASE ACTIVITY, TRANSFERASES RESPONSIBLE FOR DETOXIFICATION REACTIONS ARE ALSO INDUCED, THE LATTER BY METABOLITES RATHER THAN PARENT COMPOUND. THE SIGNIFICANCE OF THIS IS THAT WHILE THE OXYGENASES ARE RESPONSIBLE FOR PRODUCING ULTIMATE CARCINOGENS FROM PROCARCINOGENS, THE TRANSFERASES ARE INVOLVED IN THE EXCRETION AND HENCE DETOXIFICATION OF THE OXIDIZED METABOLITES.

COUCH, JOHN A., AND W. PETER SCHOOR. 1981. EFFECTS OF CARCINOGENS, MUTAGENS AND TERATOGENS ON NON-HUMAN SPECIES-AQUATIC ANIMALS. IN: PROCEEDINGS OF THE FIRST NCI/EPA/NIOSH COLLABORATIVE WORKSHOP: PROGRESS ON JOINT ENVIRONMENTAL AND OCCUPATIONAL CANCER STUDIES. H.F. KRAYBILL, INGEBORG C. BLACKWOOD, AND NANCY B. FREAS, EDITORS, U.S. GOVERNMENT PRINTING OFFICE, WASHINGTON, DC. PP. 333-376. (ERL,GB X332).

A RESEARCH PROGRAM USING AQUATIC SYSTEM AND ORGANISMS TO STUDY THE FATE AND EFFECTS OF CARCINOGENS IN THE AQUATIC ENVIRONMENT HAS BEEN UNDERWAY DURING THE FY'S 78 AND 79 AT THE GULF BREEZE EPA LABORATORY. THE TWO MAJOR INVESTIGATIVE, DISCIPLINARY AREAS HAVE BEEN IN PATHOBIOLOGY AND BIOCHEMISTRY. A FISH-CARCINOGEN ASSAY SYSTEM HAS BEEN DEVELOPED THAT INVOLVES LABORATORY CONTROLLED LONG-TERM EXPOSURE OF FISH TO SUSPECT CARCINOGENS FOLLOWED BY HISTOPATHOLOGY AND PHYSIOLOGY OF EXPOSED FISH, INDUCED GROWTHS, AND RELATED DISORDERS. THIS SYSTEM APPEARS ADEQUATE FOR CARCINOGEN TESTS FOR FISH. A TWO YEAR FIELD STUDY IS UNDERWAY OF TUMOR, DISEASE PREVALENCE, AND CARCINOGEN RESIDUE OR METABOLITES IN FISH AND SHELLFISH IN VARIOUSLY POLLUTED ESTUARIES ALONG THE NORTHERN GULF OF MEXICO. IT IS TOO EARLY TO PREDICT THE SIGNIFICANCE OF THE FINDINGS IN THIS STUDY, BUT SEVERAL NEW TUMOR TYPES HAVE BEEN DISCOVERED IN FISH. BIOCHEMICAL STUDIES HAVE REVEALED THAT FISH MAY RESPOND IN ENZYMATIC REACTIONS IN WAYS SIMILAR TO MAMMALS EXPOSED TO THE SAME CARCINOGENS, AND THAT FISH MAY PROVE TO BE ADEQUATE SUPPLEMENTAL, BIOLOGICAL MONITORS OF CARCINOGENS IN THE ENVIRONMENT.

COUCH, JOHN A., AND W. PETER SCHOOR. 1982. EFFECTS OF CARCINOGENS, MUTAGENS, AND TERATOGENS ON NON-HUMAN SPECIES (AQUATIC ANIMALS). IN: PROCEEDINGS OF THE SECOND NCI/EPA/NIOSH COLLABORATIVE WORKSHOP: PROGRESS ON JOINT ENVIRONMENTAL AND OCCUPATIONAL CANCER STUDIES, SEPTEMBER 9-11, 1981, ROCKVILLE, MD. HERMAN F. KRAYBILL, INGEBORG C. BLACKWOOD, AND NANCY B. FREAS, EDITORS, U.S. GOVERNMENT PRINTING OFFICE, WASHINGTON, DC. PP. 688-726. (ERL,GB 433).

AQUATIC SYSTEMS AND ORGANISMS ARE UNDER EXAMINATION IN ORDER TO DEVELOP INDICATOR, SCREENING, AND MODELING CAPABILITIES FOR DETECTION OF CARCINOGENS, MUTAGENS AND TERATOGENS. IN THE THIRD YEAR OF THE PROGRAM, SEVERAL ADVANCES WERE MADE IN THE DEVELOPMENT OF ASSAYS, UTILIZING SHEEPSHEAD MINNOWS (LIVER LESIONS VIA BENZIDINE AND AFLATOXIN EXPOSURE), RAINBOW TROUT (LIVER TUMORS VIA BENZO(A)PYRENE EXPOSURES). RESULTS OF LONG-TERM EXPOSURES OF FISH TO THE HERBICIDE TRIFLURALIN SHOW THAT INDUCED BONEY GROWTHS ARE ACCOMPANIED BY HISTOPATHOLOGIC CHANGES OF THE PITUITARY. THESE AND OTHER STUDIES CONTINUE TO REVEAL THAT FISH HAVE METABOLIC PATHWAYS SIMILAR TO MAMMALS FOR DISPOSITION OF CERTAIN CARCINOGENS. A SIGNIFICANT NUMBER OF COOPERATIVE AGREEMENTS WITH PRINCIPAL INVESTIGATORS SUPPORT AN EXTRAMURAL COMPLEMENTAL AND SUPPLEMENTAL EFFORT IN THE IDENTIFICATION OF AQUATIC SPECIES AND SYSTEMS THAT MAY SERVE AS EARLY WARNING MECHANISMS.

COUCH, JOHN A., W. PETER SCHOOR, WILL DAVIS, AND LEE COURTNEY. 1983. EFFECTS OF CARCINOGENS, MUTAGENS, AND TERATOGENS ON NONHUMAN SPECIES (AQUATIC ANIMALS): FOURTH ANNUAL REPORT NCI/EPA COLLABORATIVE PROGRAM. EPA-600/9-83-005, U.S. ENVIRONMENTAL PROTECTION AGENCY, ENVIRONMENTAL RESEARCH LABORATORY, GULF BREEZE, FL. 46P.

AQUATIC SYSTEMS AND ORGANISMS ARE UNDER BOTH LABORATORY AND FIELD STUDY IN ORDER TO DEVELOP INDICATOR, SCREENING, AND MODELING CAPABILITIES FOR DETECTION AND EVALUATION OF RISKS OF CACINOGENS, MUTAGENS, AND TERATOGENS. STUDIES INCLUDE BOTH GULF BREEZE LABORATORY PROJECTS AND COMPLEMENTARY, EXTRAMURAL PROJECTS. IN THE FOURTH YEAR OF THE PROGRAM, SEVERAL ADVANCES WERE MADE IN THE DEVELOPMENT OF LABORATORY AND FIELD CARCINOGEN ASSAYS, UTILIZING FISHES SUCH AS THE SHEEPSHEAD MINNOW (LIVER LESIONS VIA AFLATOXIN EXPOSURES), AND FRESHWATER CAT FISH (PAPILLOMATOUS-LIKE LESIONS VIA CHLORINATED EFFLUENT EXPOSURES). EMPHASIS IS STILL PLACED ON THE DEVELOPMENT AND UTILIZATION OF CRITICAL LIFE STAGE EXPOSURES (E.G., EMBRYO AND NEWLY HATCHED FRY EXPOSURES) IN ORDER TO EXPEDITE CARCINOGEN TESTS AND MINIMIZE TIME REQUIRED FOR TUMOROGENIC RESPONSES. PRENEOPLASTIC HEPATIC LESION DEVELOPMENT IN MENIDIA AT 12 WEEKS SUGGESTS PROMISE FOR THIS SPECIES AND EXPOSURE METHOD. A NOVEL APPROACH HAS SHOWN THAT TIGER SALAMANDERS MAY BE GOOD BIOCHEMICAL AND HISTOLOGIC INDICATORS OF THE PRESENCE OF CERTAIN CARCINOGENS (POLYCYCLIC AROMATIC HYDROCARBONS - PAH'S). SKIN AND LIVER TISSUES OF THE SALAMANDERS REVEALED INDUCED ENZYME ACTIVITY (MFO SYSTEM) FOLLOWING EXPOSURE TO THE PAH, PERYLENE. CONSIDERABLE FIELD MONITORING WORK ON MOLLUSKS AND CARCINOGENIC PAH'S ALONG THE COAST OF OREGON HAS REVEALED A POSITIVE CORRELATION BETWEEN PREVALENCE OF CELLULAR PROLIFERATION DISORDERS IN SHELLFISH AND HIGHER CONCENTRATIONS OF CERTAIN PAH'S IN NATURAL WATER.

COUCH, JOHN A., AND W.P. SCHOOR. 1981. EFFECTS OF CARCINOGENS, MUTAGENS, AND TERATOGENS ON NON-HUMAN SPECIES (AQUATIC ANIMALS). IN: SECOND ANNUAL REPORT ON NATIONAL CANCER INSTITUTE AND ENVIRONMENTAL PROTECTION AGENCY PROJECTS. U.S. DEPT. OF HEALTH, EDUCATION, AND WELFARE, PUBLIC HEALTH SERVICE, NATIONAL INSTITUTE OF HEALTH, BETHESDA, MD. PP. 57-103. (ERL,GB X334).

THE SECOND ANNUAL REPORT OF THE GULF BREEZE LABORATORY AQUATIC CARCINOGEN PROGRAM, CONTAINS INFORMATION ON ADVANCES AND PROGRESS IN BOTH IN-HOUSE EFFORTS AND EXTRAMURAL COOPERATIVE AGREEMENT PROJECTS THAT ARE SUPPLEMENTAL TO THE GOALS OF THE PROGRAM FOR FY 80. FLEXIBLE FISH CARCINOGEN ASSAY SYSTEMS WITH OPTIONAL MODES OF EXPOSURE OF BOTH FRESHWATER AND MARINE FISHES AND INVERTEBRATES HAVE BEEN DEVELOPED AND TESTED FOR EFFICIENCY. THE SYSTEM AT GULF BREEZE IS VALID FOR EXPOSURE OF FISHES THROUGH ENTIRE LIFE CYCLES TO ENVIRONMENTALLY REALISTIC CONCENTRATIONS OF SUSPECT CARCINOGENS. RESULTS OF TRIFLURALIN (HERBICIDE, SUSPECT CARCINOGEN) VERSUS SHEEPSHEAD MINNOW (TEST FISH) INDICATE THAT THE SYSTEM IS VALID FOR CARCINOGEN TESTS. ANOTHER EXPERIMENTAL ASSAY SYSTEM FOR RAINBOW TROUT HAS BEEN DEVELOPED AND TESTED THROUGH THE COOPERATIVE AGREEMENT AT OREGON STATE UNIVERSITY, WHILE FURTHER WORK HAS BEEN COMPLETED ON THE FRESHWATER CATFISH SYSTEM AT THE UNIVERSITY OF SOUTHERN MISSISSIPPI. THE FIELD COLLECTION PHASE OF THE EPIZOOTIOLOGY OF TUMORS AND CELLULAR DISEASES IN FISH AND SHELLFISH IN RELATION TO HUMAN POLLUTANT ACTIVITY HAS BEEN COMPLETED. EARLY TRENDS INDICATE A POSITIVE RELATIONSHIP BETWEEN DISEASE FREQUENCY AND POLLUTANT ACTIVITY, BUT MUCH ANALYSIS OF DATA IS INCOMPLETE AT THIS POINT. ANALYTICAL ADVANCES IN THE RESOLUTION AND IDENTIFICATION OF POLYCYCLIC AROMATIC HYDROCARBONS AND THEIR METABOLITES IN AQUATIC ORGANISMS HAVE BEEN MADE AT GULF BREEZE. WORK IS PROGRESSING ON CHARACTERIZING THE RESPONSES OF LIVER ENZYME SYSTEMS IN SEVERAL FISHES FROM BOTH FRESHWATER AND MARINE WATERS. NEW COOPERATIVE AGREEMENTS ON STUDIES OF NATURAL POPULATIONS OF FISHES AND SALAMANDERS WITH RELATIVELY HIGH PREVALENCES OF TUMORS HAS BEGUN LATE IN FY 80.

COUCH, JOHN A., AND JAMES T. WINSTEAD. 1979. CONCURRENT NEOPLASTIC AND PROTISTAN DISORDERS IN THE AMERICAN OYSTER (*CRASSOSTREA VIRGINICA*). *HALIOTIS*. 8(2):249-253. (ERL,GB 353).

ONE OF 373 OYSTERS EXAMINED AS PART OF A HISTOLOGICAL SURVEY OF OYSTERS FROM APALACHICOLA BAY, FLORIDA, USA, HAD A CONCURRENT BLOOD CELL PROLIFERATIVE DISORDER AND A PROTISTAN INFECTION. THE NEOPLASTIC BLOOD CELLS (LEUKOCYTES) WERE FOUND THROUGHOUT THE VESICULAR CONNECTIVE TISSUES AND BLOOD SPACES IN SECTIONS OF THE OYSTER. THESE PROLIFERATING CELLS RESEMBLED THE NEOPLASTIC CELLS DESCRIBED BY COUCH (1969) AND FARLEY (1969) FROM OTHER SPECIMENS OF *CRASSOSTREA VIRGINICA* FROM CHESAPEAKE BAY, MARYLAND, USA. MITOTIC FIGURES WERE ABUNDANT IN FOCI OF THE NEOPLASTIC TISSUE. EPITHELIAL TISSUES OF THE GUT OF THIS OYSTER WERE INFECTED BY SPORE AND SCHIZOGONIC STAGES OF *DERMOCYSTIDIUM MARINUM*, A PRESUMED PATHOGENIC PROTIST OF OYSTERS. SPORES OF THIS PROTIST AND OTHER PROLIFERATIVE STAGES WERE OBSERVED IN CONNECTIVE TISSUES AND BLOOD SPACES. THERE WAS NO MORPHOLOGICAL EVIDENCE THAT THE NEOPLASTIC BLOOD CELLS WERE RELATED TO THE PROTIST LIFE CYCLE STAGES.

COURTNEY, LEE A., AND JOHN A. COUCH. IN PRESS. USEFULNESS OF CYPRINODON VARIEGATUS AND FUNDULUS GRANDIS IN CARCINOGENICITY TESTING: ADVANTAGES AND SPECIAL PROBLEMS. IN: PROCEEDINGS OF SYMPOSIUM ON THE USE OF SMALL FISH SPECIES IN CARCINOGENICITY TESTING, BETHESDA, MARYLAND, DECEMBER 8-10, 1981. U.S. NATIONAL CANCER INSTITUTE. (ERL,GB 442).

CYPRINODON VARIEGATUS AND FUNDULUS GRANDIS, TWO SPECIES OF CYPRINODONTID FISHES EXTENSIVELY STUDIED AND USED IN TOXICOLOGICAL AND BIOLOGICAL INVESTIGATIONS, ARE COMPARED AS LABORATORY TEST ANIMALS. THEIR ECOLOGY AND GENERAL BIOLOGY, AND SUITABILITY FOR VARIOUS TYPES OF EXPERIMENTATION ARE EXAMINED. A LABORATORY SYSTEM FOR EXPOSING CRITICAL LIFE STAGES (E.G., EMBRYOS, FRY, JUVENILES) OF THESE SPECIES TO SUSPECT CARCINOGENS IS DESCRIBED. A DISCUSSION OF THE USE, FINDINGS, AND POTENTIAL OF THESE SPECIES IN ONCOLOGICAL STUDIES AND CARCINOGEN ASSAYS IS PRESENTED, PARTICULARLY IN REGARD TO RESPONSES TO THREE KNOWN OR SUSPECT CARCINOGENIC CHEMICALS (E.G., TRIFLURALIN, BENZIDINE, AND AFLATOXIN). FINALLY, ADVANTAGES AND DISADVANTAGES OR SPECIAL PROBLEMS IN USING THE SPECIES AS CARCINOGEN TEST ANIMALS ARE REVIEWED.

ELNENAAY, ELSAYED A., AND W. PETER SCHOOR. 1981. SEPARATION OF THE ISOMERIC PHENOLS OF BENZO(A)PYRENE BY HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY. ANAL. BIOCHEM. 111(2):393-400. (ERL,GB 046\*).

A TECHNIQUE HAS BEEN DEVELOPED TO SEPARATE A MIXTURE OF THE TWELVE ISOMERIC PHENOLS OF BENZO(A)PYRENE BY USING HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY WITH FLUORESCENCE DETECTION AND VARIOUS SEQUENCES OF METHANOL/WATER GRADIENTS. DETECTION BY FLUORESCENCE HAS INCREASED THE SENSITIVITY OF THE METHOD WHEN COMPARED WITH UV DETECTION. THE EFFECTS OF FLOW RATE, TEMPERATURE, AND VARIOUS TYPES OF GRADIENTS ON THE SEPARATION OF THE ISOMERIC PHENOLS ARE DISCUSSED. IT HAS BEEN FOUND THAT UNDER THE CONDITIONS NORMALLY EMPLOYED TO SEPARATE THESE PHENOLS FROM OTHER METABOLITES OF BENZO(A)PYRENE, SEVERAL OF THE PHENOLS ARE NOT SEPARATED POSSIBLY LEADING TO INCORRECT IDENTIFICATION AS WELL AS QUANTITATION. DIOLS AND DIONES OF BENZO(A)PYRENE ARE ALSO SEPARATED BY THIS PROCEDURE.

ELNENAEE, ELSAYED, AND W.P. SCHOOR. 1981. SIMPLE HIGH PERFORMANCE LIQUID CHROMATOGRAPHY METHOD FOR SEPARATION OF BENZO(A)PYRENE METABOLITES (ABSTRACT). CLIN. CHEM. 27(6):1099. (ERL,GB X344).

TO CONTINUE OUR STUDY TO DEVELOP A RELIABLE METHOD FOR QUALITATIVE AND QUANTITATIVE SEPARATION OF BENZO(A)PYRENE (BAP) METABOLITES, WE REPORT A SIMPLE, RAPID HPLC USING PERKIN ELMER ODS SIL-X COLUMN AND A MIXTURE OF METHANOL AND WATER AS ISOCRATIC ELUANT. AS WE PREVIOUSLY REPORTED (J. ANAL. BIOCHEM., IN PRESS) BOTH THE FLOW RATE AND SOLVENT COMPOSITION HAVE DIFFERENT EFFECTS ON SEPARATION PATTERN. THE USE OF BOTH, FLUORESCENCE AND U.V. DETECTION SIMULTANEOUSLY WAS FOUND TO BE OF GREAT IMPORTANCE CONCERNING THE FACT THAT SOME METABOLITES E.G. DIONES MAY HAVE RELATIVELY GOOD ABSORPTION WHILE THE OTHER METABOLITES (PHENOLS AND DIOLS) HAVE EXCELLENT FLUORESCENCE ACTIVITY AND RELATIVELY POOR ABSORPTION. THE ABSORPTION WAS MONITORED AT 254 NM AND FLUORESCENCE (EX. 263 NM AND EM. 370 FILTER). THE USE OF AN ISOCRATIC SOLVENT (65% METHANOL IN WATER) ELIMINATES USE OF ANY DRIFT OF THE BASELINE SPECIALLY FOR THE UV SIDE IF COMPARED TO A GRADIENT SYSTEM. THE FLOW RATES RANGING FROM 0.3-0.6 ML/MIN. WERE TESTED AND THE 0.4 ML/MIN. RESULTED IN A GOOD SEPARATION. THE FOLLOWING BAP DERIVATIVES WERE SEPARATED IN ONE CHROMATOGRAM (T)9,10-, (T)7,8-DIHYDRODIOL, 1,6-, 6,12- AND 3,6-DIONE, 4,5-EPOXIDE, 5-OH, 6-OH, 9-OH, 10-OH, 7-OH, 1-OH, AND 3-OH BAP. WHEN AN IN VITRO REACTION OF BAP AND LIVER MICROSOMES OF A TREATED FISH, FUNGULUS GRANDIS, WAS SEPARATED BY THIS METHOD, ALL THE ABOVE DERIVATIVES, BUT 10-OH, ISOLATED AND IDENTIFIED AS METABOLITES. THE METHOD IS SIMPLE, EFFICIENT IN RESOLUTION OF THE METABOLITES WITH NO POSSIBILITY OF OVERLAPPING PEAKS THAT MAY LEAD TO INCORRECT IDENTIFICATION AND QUANTITATION.

GREGORY, PAULA E., PATRICIA N. HOWARD-PEEBLES, RUDOLPH D. ELLENDER, AND BILLY J. MARTIN. 1980. ANALYSIS OF A MARINE FISH CELL LINE FROM A MALE SHEEPSHEAD. J. HERED. 71(3):209-211. (ERL,GB X198).

CHROMOSOMES FROM CONSECUTIVE CULTURE PASSAGES OF A DEVELOPING CELL LINE FROM FIN FIBROBLASTS OF A MALE SHEEPSHEAD (ARCHOSARGUS PROBATOCEPHALUS) WERE ANALYZED. IT WAS DEMONSTRATED THAT THE MODAL CHROMOSOME NUMBER IS 48. THE CHROMOSOME TYPES FOUND IN THESE CELLS INCLUDED 8 SUBMETACENTRICS, 8-12 ACROCENTRICS, AND 28-32 TELOCENTRICS. EVIDENCE SUGGESTS THAT THE PRIMARY TYPE OF CHROMOSOMAL ALTERATION THAT OCCURRED IN CULTURED SHF-1 CELLS IS ANEUPLOIDY; A LARGE METACENTRIC CHROMOSOME OF UNDETERMINED ORIGIN WAS OBSERVED.

GREGORY, PAULA E., PATRICIA N. HOWARD-PEEBLES, RUDOLPH D. ELLENDER, AND BILLY J. MARTIN. 1980. C-BANDING OF CHROMOSOMES FROM THREE ESTABLISHED MARINE FISH CELL LINES. COPEIA. (3):545-547. (ERL,GB X199).

DIFFERENTIAL GIEMSA STAINING OF THE CONSTITUTIVE HETEROCHROMATIC IN HUMAN CHROMOSOMES HAS BECOME A USEFUL AND ACCEPTED TECHNIQUE (CARRIGHI AND HSU, 1971). SUCH A STAINING TECHNIQUE COULD BE OF GREAT VALUE WHEN APPLIED TO THE CHROMOSOMES OF OTHER ORGANISMS, ESPECIALLY THOSE WITH NUMEROUS MORPHOLOGICAL IDENTICAL CHROMOSOMES. MANY FISH KARYOTYPES POSSESS A LARGE GROUP OF MORPHOLOGICALLY SIMILAR CHROMOSOMES. A TECHNIQUE HAS BEEN DEVELOPED THROUGH MODIFICATION OF A C-BANDING PROCEDURE THAT PRODUCES DISTINCT BANDS AND THUS ALLOWS IDENTIFICATION OF THE HETEROCHROMATIC REGIONS OF INDIVIDUAL PAIRS OF FISH CHROMOSOMES. THIS TECHNIQUE HAS BEEN APPLIED TO THREE ESTABLISHED MARINE FISH CELL LINES. C-BANDING HAS BEEN REPORTED ON SEVERAL TROUT SPECIES (ABE AND MURAMOTO, 1974; ZENZES AND VOICULESCU, 1975; THORGAARD, 1976); HOWEVER, NONE OF THESE STUDIES EMPLOYED ESTABLISHED CELL LINES.

GRIZZLE, J.M., T.E. SCHWEDLER, AND A.L. SCOTT. 1981. PAPILOMAS OF BLACK BULLHEADS, ICTALURUS MELAS (RAFINESQUE), LIVING IN A CHLORINATED SEWAGE POND. J. FISH DISEASES. 4(4):345-351. (ERL,GB X250).

PAPILOMAS ON BROWN BULLHEADS, ICTALURUS NEBULOSUS (LE SUEUR), AND YELLOW BULLHEADS, ICTALURUS NATILIS (LE SUEUR), HAVE BEEN REPORTED FREQUENTLY IN CERTAIN AREAS OF EASTERN NORTH AMERICA (HARSHBARGER 1977). THE PAPILOMAS OF BLACK BULLHEADS, ICTALURUS MELAS (RAFINESQUE), DESCRIBED HEREIN ARE NOTEWORTHY BECAUSE OF THEIR FREQUENCY AND UNIFORMITY OF LOCATION.

GRIZZLE, JOHN M., AND PAUL MELIUS. 1982. CAUSES OF PAPILOMAS ON FISH EXPOSED TO CHLORINATED SEWAGE EFFLUENT. EPA-600/3-82-087, U.S. ENVIRONMENTAL PROTECTION AGENCY, ENVIRONMENTAL RESEARCH LABORATORY, GULF BREEZE, FL. 22P.

THIS RESEARCH WAS INITIATED TO DETERMINE THE CAUSE OF ORAL PAPILOMAS IN BLACK BULLHEADS (ICTALURUS MELAS) FROM THE FINAL OXIDATION POND OF THE TUSKEGEE, ALABAMA, SEWAGE TREATMENT PLANT. THE WATER IN THIS POND WAS CHLORINATED EFFLUENT FROM THE SEWAGE TREATMENT PLANT. THE PRESENCE OF A CARCINOGENIC AND MUTAGENIC CHEMICAL IN THE EFFLUENT OF A SEWAGE TREATMENT PLANT WAS INDICATED BY PAPILOMAS DEVELOPING ON CAGED BLACK BULLHEADS, GLUCURONOSYLTRANSFERASE INDUCTION IN CAGED CHANNEL CATFISH, AND AMES-TEST MUTAGENICITY OF WATER EXTRACT. UNLIKE PREVIOUSLY STUDIED FISH PAPILOMAS, VIRUS-LIKE PARTICLES WERE NOT PRESENT IN THE TUMOR CELLS. ALTHOUGH MUTAGENIC AND CARCINOGENIC CHEMICALS HAVE NOT BEEN IDENTIFIED IN THE WASTEWATER, CHLORINE IS IMPLICATED AS A FACTOR CONTRIBUTING TO THE INDUCTION OF THE PAPILOMAS BECAUSE THE PREVALENCE OF PAPILOMAS ON WILD BLACK BULLHEADS EXPOSED TO THE EFFLUENT DECREASED FROM 73% TO 23% AFTER THE CHLORINATION RATE WAS REDUCED. THIS REPORT WAS SUBMITTED IN FULFILLMENT OF GRANT NO LCR809336010 BY AUBURN UNIVERSITY UNDER THE SPONSORSHIP OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY. THIS REPORT COVERS THE PERIOD FROM 12 OCTOBER 1981 TO 11 OCTOBER 1983, AND WORK WAS COMPLETED AS OF 11 OCTOBER 1983.

HARSHBARGER, JOHN C., ELLIOT R. JACOBSON, CHARLIE E. SMITH, AND JOHN A. COUCH. 1980. HEMATOPOIETIC NEOPLASMS IN INVERTEBRATES AND COLD-BLOODED VERTEBRATES. IN: ADVANCES IN COMPARATIVE LEUKEMIA RESEARCH, 1979. DAVID S. YOHN, BORIS A. LAPIN, AND JAMES R. BLAKESLEE, EDITORS, ELSEVIER/NORTH-HOLLAND, NEW YORK, NY. PP. 223-225. (ERL,GB X158).

MANY EXCELLENT EXAMPLES OF HEMATOPOIETIC NEOPLASMS OCCUR IN INVERTEBRATE AND COLD-BLOODED VERTEBRATE ANIMALS. SINCE THESE GROUPS COMPRISE OVER 99% OF THE ANIMAL KINGDOM AND CONTAIN AN ENORMOUS DIVERSITY COMPARED TO WARM-BLOODED ANIMALS, THEY COULD UNDOUBTLY PROVIDE MODELS OPTIMALLY SUITED FOR TESTING SPECIFIC HYPOTHESES. I RECOMMEND CANCER RESEARCHERS CONSIDER THIS POTENTIAL IN PLANNING FUTURE EXPERIMENTS.

HENDRICKS, J. D., T. R. MEYERS, AND D. W. SHELTON. IN PRESS. HISTOLOGIC PROGRESSION OF HEPATIC NEOPLASMS IN RAINBOW TROUT (SALMO GAIRDNERI). IN: PROCEEDINGS OF SYMPOSIUM ON THE USE OF SMALL FISH SPECIES IN CARCINOGENICITY TESTING. U.S. NATIONAL CANCER INSTITUTE. (ERL,GB X353).

HENDRICKS, J.D., R.O. SINNHUBER, H.M. LOVELAND, N.E. PAWLOWSKI, AND J.E. NIXON. 1980. HEPATOCARCINOGENICITY OF GLANDLESS COTTONSEEDS AND REFINED COTTONSEED OIL TO RAINBOW TROUT (SALMO GAIRDNERI). SCIENCE. 208(4441):309-310. (ERL,GB X275).

GLANDLESS COTTONSEED KERNELS ARE AVAILABLE FOR PURCHASE AND CONSUMPTION BY THE GENERAL PUBLIC. THESE KERNELS CONTAIN NO GOSSYPOL BUT STILL HAVE A FULL COMPLEMENT OF NATURALLY OCCURRING CYCLOPROPENOID FATTY ACIDS, WHICH IN RAINBOW TROUT ARE ACTIVE AS SYNERGISTS WITH AFLATOXINS AND PRIMARY LIVER CARCINOGENS. DIETS CONTAINING GLANDLESS COTTONSEED KERNELS OR A LIGHTLY PROCESSED COTTONSEED OIL PRODUCED SIGNIFICANT NUMBERS OF HEPATOCELLULAR CARCINOMAS IN RAINBOW TROUT AFTER 1 YEAR. THE MUCH GREATER INCIDENCE OF CANCER INDUCED BY THE KERNEL THAN BY THE OIL INDICATES THAT SYNERGISTS OR OTHER CARCINOGENS MAY BE PRESENT IN THE KERNEL IN ADDITION TO THE CYCLOPROPENOID FATTY ACIDS.

HENDRICKS, J.D., J.H. WALES, R.O. SINNHUBER, J.E. NIXON, P.M. LOVELAND, AND R.A. SCANLAN. 1980. RAINBOW TROUT (SALMO GAIARDNERI) EMBRYOS: A SENSITIVE ANIMAL MODEL FOR EXPERIMENTAL CARCINOGENESIS. FED. PROC. 39(14):3222-3229. (ERL,GB X359).

DIETARY EXPOSURES HAVE DEMONSTRATED RAINBOW TROUT TO BE THE MOST SENSITIVE EXPERIMENTAL ANIMAL TO THE HEPATOCARCINOGENICITY OF AFLATOXIN B(1) (AFB). MORE RECENTLY THE DEVELOPMENT OF AN ALTERNATE EXPOSURE METHOD HAS SHOWN TROUT TO BE EVEN MORE SENSITIVE TO AFB(1). THIS METHOD INVOLVES THE SINGLE EXPOSURE OF FERTILE RAINBOW TROUT EGGS (EMBRYOS) TO A 0.5 PPM AQUEOUS SOLUTION OF AFB(1) FOR 30 MINUTES, RINSING THE EGGS IN WATER, AND ALLOWING HATCHING, SWIM-UP AND THE ONSET OF FEEDING TO PROCEED AS USUAL. RESULTING FISH ARE FED A CONTROL DIET FOR 1 YEAR AT WHICH TIME APPROXIMATELY TWO-THIRDS OF THE POPULATION WILL HAVE DEVELOPED HEPATOCELLULAR CARCINOMA OF THE LIVER. VARIABLES, SUCH AS EMBRYO AGE OF GREATEST SENSITIVITY, CARCINOGEN CONCENTRATION, AND LENGTH OF EXPOSURE, HAVE BEEN DEFINED FOR AFB(1) EXPOSURES. SENSITIVITY AFB(1) INCREASED WITH INCREASING AGE OF THE EMBRYO, THE MODEL SYSTEM SHOWED A DOSE-RESPONSE TO INCREASING CARCINOGEN CONCENTRATION, AND ONE-HALF HOUR EXPOSURES APPEARED TO BE OPTIMUM FOR AFB(1). EXPERIMENTS WITH OTHER CARCINOGENS HAVE SHOWN THE EMBRYO MODEL SYSTEM TO BE SENSITIVE TO THE HEPATOCARCINOGENICITY OF AFB(1) METABOLITES (AFLATOXICOL, AFLATOXIN M(1), AND AFLATOXIN G(1)), STERIGMATOCYSTIN, VERSICOLORIN A, DIMETHYLNITROSAMINE, AND N-METHYL-N'-NITRO-N-NITROSOGUANIDINE. THE LATTER COMPOUND ALSO INITIATED NEPHROBLASTOMAS OF THE KIDNEYS. THE RESULTS DEMONSTRATE THE POTENTIAL FOR THE TROUT EMBRYO TO BE DEVELOPED INTO A CONVENIENT, ECONOMICAL, AND SENSITIVE WHOLE ANIMAL MODEL SYSTEM FOR EXPERIMENTAL CARCINOGENESIS.

HENDRICKS, JERRY D. 1982. CHEMICAL CARCINOGENESIS IN FISH. IN: AQUATIC TOXICOLOGY, VOL. 1. LAVERN J. WEBER, EDITOR, RAVEN PRESS, NEW YORK. PP. 149-211. (ERL,GB X251).

MOST OF THE RESEARCH ON EXPERIMENTAL CARCINOGENESIS IN SALMONIDS HAS BEEN CONDUCTED BY TWO RESEARCH GROUPS. EARLY STUDIES INTO THE ETIOLOGY OF THE TROUT LIVER CANCER EPIZOOTIC WERE PERFORMED AT THE U.S. FISH AND WILDLIFE SERVICE'S WESTERN FISH NUTRITION LABORATORY AT COOK, WASHINGTON, UNDER THE DIRECTION OF DRS. JOHN E. HALVER AND LAWRENCE M. ASHLEY. A CONTINUING STUDY OF THE METABOLISM AND CARCINOGENICITY OF AFB AND ITS METABOLITES IN RAINBOW TROUT, AS WELL AS THE DEVELOPMENT OF THE RAINBOW TROUT AS A DOCUMENTED RESEARCH ANIMAL FOR CARCINOGENIC AND TOXICOLOGIC RESEARCH, HAS OCCURRED FOR THE PAST 16 YEARS AT THE FOOD TOXICOLOGY AND NUTRITION LABORATORY (FTNL) IN THE DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY AT OREGON STATE UNIVERSITY UNDER THE DIRECTION OF PROFESSOR RUSSELL O. SINNHUBER.

HENDRICKS, JERRY D., THEODORE R. MEYERS, JOHN L. CASTEEL, JOE E. NIXON, PATRICIA M. LOVELAND, AND GEORGE S. BAILEY. 1982. RAINBOW TROUT EMBRYOS: ADVANTAGES AND LIMITATIONS FOR CARCINOGENESIS RESEARCH (ABSTRACT). ANNU. MEET. AM. ASSOC. CANCER RES. PROC. 23:58. (ERL,GB X279).

HENDRICKS, JERRY D., THEODORE R. MEYERS, DENNIS W. SHELTON, AND RUSSELL O. SINNHUBER. 1982. LIVER NEOPLASIA AND INDUCTION OF HEPATIC MIXED FUNCTION OXIDASE ENZYMES THE RAINBOW TROUT FOLLOWING DIETARY EXPOSURE TO BENZO(A)PYRENE (ABSTRACT). ANNU. MEET. AM. ASSOC. CANCER RES. PROC. 23:58. (ERL,GB X258).

THE INFLUENCE OF BENZO(A)PYRENE (BP) ON THE INDUCTION OF CERTAIN ENZYMES WITHIN THE HEPATIC MIXED FUNCTION OXIDASE (MFO) SYSTEM AND ITS POTENTIAL CARCINOGENICITY WERE EXAMINED IN RAINBOW TROUT DURING A CONTINUOUS DIETARY EXPOSURE. NINE WEEK FEEDING TRIALS WERE PERFORMED USING 500 AND 1000 PPM OF BP TO DETERMINE THE MAXIMUM TOLERATED DOSE (MTD) WITHOUT PRODUCING FISH MORTALITIES OR GROWTH INHIBITION. LEVELS OF MFO ENZYMES INCLUDING ETHOXYRESORUFIN-O-DEETHYLASE (EROD), ETHOXYCOUMARIN-O-DEETHYLASE (ECOD), ARL HYDROCARBON HYDROXYLASE (AHH) AND CYTOCHROME P-450 WERE MEASURED DURING THIS TIME. A FEEDING TRIAL USING A MTD OF 1000 PPM WAS INITIATED IN DUPLICATE GROUPS OF 100 FINGERLING RAINBOW TROUT. TROUT WERE SAMPLED AT 6, 12 AND 18 MONTHS FOR NECROPSY AND SUBSEQUENT GROSS AND HISTOLOGICAL EXAMINATION OF INTERNAL ORGANS. MEAN MFO ENZYME LEVELS OF EROD, ECOD, AND AHH WERE SIGNIFICANTLY (P LESS THAN 0.05) ELEVATED SHOWING DOSE AND TIME RESPONSE RELATIONSHIPS WHEN COMPARED TO THOSE OF FISH FED A BP-FREE DIET. P-450 LEVELS IN BP-FED FISH INCREASED ONLY SLIGHTLY. AT 12 MONTHS 15% OF THE BP-FED FISH HAD HISTOLOGICALLY CONFIRMED NEOPLASTIC LESIONS OF THE LIVER. AFTER 18 MONTHS 20% GROSS LESIONS WERE OBSERVED, HISTOLOGICAL CONFIRMATION IS IN PROGRESS. NO EVIDENCE OF NEOPLASIA WAS OBSERVED IN CONTROL FISH. THESE RESULTS INDICATE THAT IN RAINBOW TROUT BP IS A POTENT INDUCER OF CERTAIN HEPATIC MFO ENZYMES AND IS A HEPATOCARCINOGEN WHEN FED CONTINUOUSLY IN THE DIET.

HILLEBERT, SUSAN A., B.J. MARTIN, AND R.D. ELLENDER. 1980. EXPOSURE OF A TELEOST CELL LINE TO SUSPECTED CARCINOGENS. J. MISS. ACAD. SCI. 25:71-75. (ERL,GB X197).

PRELIMINARY STUDIES HAVE EVALUATED THE USEFULNESS OF A CELL LINE FROM THE SHEEPSHEAD (ARCHOSARGUS PROBATOCEPHALUS) AS A CARCINOGEN ASSAY SYSTEM. ACUTE TOXICITY LEVELS HAVE BEEN ESTABLISHED FOR THREE KNOWN MAMMALIAN CARCINOGENS: BENZO(A)PYRENE, BENZIDINE, AND DIETHYLNITROSAMINE. LONG-TERM EXPOSURES HAVE PROVIDED EVIDENCE THAT BENZO(A)PYRENE AND BENZIDINE HAVE MUTAGENIC EFFECTS ON THIS CELL LINE.

HINTON, DAVID E., AND JOHN A. COUCH. IN PREP. PATHOBIOLOGICAL MEASURES OF MARINE POLLUTION EFFECTS. IN: PROCEEDINGS OF CONFERENCE ON MEANINGFUL MEASURES OF MARINE POLLUTION EFFECTS, APRIL 26-29, 1982, PENSACOLA BEACH, FL. U.S. NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION. (ERL,GB 475).

THE INTENT OF THIS REVIEW IS TO DISCUSS THE MAJOR CATEGORIES OF PATHOBIOLOGICAL RESEARCH AND TO PRESENT STRENGTHS AND WEAKNESSES OF EACH. WHERE APPROPRIATE, EXAMPLES FROM THE AQUATIC TOXICOLOGY LITERATURE ARE CITED. FINALLY, THE APPLICATION OF THE PATHOBIOLOGIC APPROACH TO FIELD STUDIES AND THE IMPORTANCE OF FINDINGS IN AQUATIC SPECIES TO OTHER SPECIES INCLUDING MAN IS DISCUSSED.

KOENIG, CHRISTOPHER C., DANIEL C. ABEL, COURTNEY W. KLINGENSMITH, AND MICHAEL B. MADDOCK. 1982. USEFULNESS OF THE SELF-FERTILIZING CYPRINODONTID FISH, RIVULUS MARMORATUS AS AN EXPERIMENTAL ANIMAL IN STUDIES INVOLVING CARCINOGENESIS, TERATOGENESIS AND MUTAGENESIS. EPA-600/3-82-075, U.S. ENVIRONMENTAL PROTECTION AGENCY, ENVIRONMENTAL RESEARCH LABORATORY, GULF BREEZE, FL. 129P.

RIVULUS MARMORATUS IS A NATURALLY SELF-FERTILIZING CYPRINODONTID FISH INHABITING MANGROVE MARSHES THROUGHOUT THE CARIBBEAN. AS A RESULT OF INTERNAL SELF-FERTILIZATION THIS OVIPAROUS SPECIES IS COMPOSED OF A NUMBER OF ISOGENIC, HOMOZYGOUS LINES (CLONES), SEVERAL OF WHICH HAVE BEEN IDENTIFIED BY HISTOCOMPATIBILITY EXPERIMENTS AND MAINTAINED IN LABORATORY CULTURE FOR OVER 30 YEARS. SIMPLIFIED CULTURE AND HANDLING METHODS ARE GIVEN AND DATA ARE PRESENTED ON THE REPRODUCTION, GROWTH AND DEVELOPMENT OF RIVULUS UNDER LABORATORY CULTURE AS A PRELUDE TO THE EVALUATION OF ITS POTENTIAL AS A BIOASSAY ANIMAL. SEVERAL TYPES OF BIOASSAYS WERE RUN AND EVALUATED USING RIVULUS: BEHAVIORAL, CARCINOGENICITY, TERATOGENICITY, TOXICITY, AND MUTAGENICITY. ADVANTAGES AND DISADVANTAGES OF USING RIVULUS FOR SUCH BIOASSAYS ARE DISCUSSED. BEHAVIORALLY, RIVULUS IS CAPABLE OF DETECTING AND AVOIDING WATER CONTAMINATED WITH H<sub>2</sub>S. THEY RESPOND (EC<sub>50</sub> = 123.6 PPB H<sub>2</sub>S) BY LEAPING FROM THE WATER AND REMAINING EMERGENT FOR VARIOUS PERIODS OF TIME WHILE RESPIRING CUTANEOUSLY. HEPATOCELLULAR CARCINOMA AMONG OTHER PATHOLOGIC CHANGES WERE OBSERVED IN LIVERS OF RIVULUS A YEAR AFTER EXPOSURE OF ADULTS AND LARVAE TO DIETHYLNITROSAMINE (45, 30, AND 15 PPM IN WATER) FOR 5 WEEKS AND 12 WEEKS, RESPECTIVELY. NO PATHOLOGIC CHANGES WERE FOUND IN EMBRYOS EXPOSED SIMILARLY. HIGH RATES OF VARIOUS SKELETAL MALFORMATIONS RESULTED IN OFFSPRING OF ADULTS EXPOSED TO DIBUTYL PHTHALATE (DBP) AND 2,3,4,6-TETRACHLOROPHENOL (TECP) AT CONCENTRATIONS OF 20, 10 AND 5% (DBP - 0.740, 0.370, 0.185 MG/L; TECP - 0.220, 0.110, 0.055 MG/L) OF THE LARVAL 96-HOUR LC<sub>50</sub>. NO DOSE-RESPONSE RELATIONSHIPS OF SKELETAL MALFORMATIONS WERE FOUND FOR SIMILAR EXPOSURES TO PENTACHLOROPHENOL, 2,3,5-TRICHLOROPHENOL OR BROMOFORM, HOWEVER, CHRONIC EXPOSURE OF DEVELOPING HATCHLINGS TO TECP RESULTED IN FIN AND GILL EROSION AND CHRONIC EXPOSURE TO BROMOFORM PRODUCED DORSAL FIN ABNORMALITIES. AS PART OF A MUTAGENESIS BIOASSAY 14 ENZYME SYSTEMS REPRESENTING 28 LOCI WERE SCREENED FOR THE THREE LABORATORY CLONES AND ONE WILD-CAUGHT CLONE BUT NO ELECTROPHORETIC DIFFERENCES WERE FOUND. ATTEMPTS TO CULTURE RIVULUS CELLS FAILED. ALSO, THE KARYOTYPE OF RIVULUS IS NOT SUITABLE FOR SHORT-TERM CYTOGENETIC ASSAYS SUCH AS THE SISTER CHROMATID EXCHANGE (SCE) ASSAY. ALTERNATIVELY, HOWEVER, THE TOADFISH (OPSANUS TAU) POSSESSES A SUITABLE KARYOTYPE FOR SCE ANALYSIS AND WE HAVE BEEN SUCCESSFUL IN CULTURING TOADFISH CELLS TO FOURTH PASSAGE. INCREASED RATES OF SCE WERE OBTAINED WHEN TOADFISH CELLS WERE EXPOSED IN VITRO TO THE MUTAGEN ETHYL METHANESULFONATE BUT NOT BROMOFORM. ANOTHER SET OF EXPERIMENTS IS PRESENTED WHICH INVOLVES CHARACTERIZATION OF THE NATURE OF THE TOADFISH CYTOCHROME P450 SYSTEM.

LATOUCHE, Y. DAVID, CASEY W. BENNETT, AND MICHAEL C. MIX. 1981. DETERMINATION OF VANADIUM IN A MARINE MOLLUSC USING A CHELATING ION EXCHANGE RESIN NEUTRON ACTIVATION. BULL. ENVIRON. CONTAM. TOXICOL. 26(2):224-227. (ERL,GB X351).

STUDIES DESIGNED TO MEASURE CONTAMINANTS IN THE MARINE AND ESTUARINE ENVIRONMENT HAVE GENERALLY NEGLECTED VANADIUM. ENVIRONMENTAL VANADIUM HAS BEEN CONSIDERED AS A TRACE CONSTITUENT OF PETROLEUM WHICH HAS LEVELS RANGING, FOR EXAMPLE, FROM 0.6 TO 1400 PPM IN DIFFERENT VENEZUELAN CRUDE OILS (NAS 1974). VARIABLE VANADIUM CONCENTRATIONS CHARACTERIZE DIFFERENT PETROLEUMS; SUCH "FINGERPRINTS" IN OIL SPILL SAMPLES HAVE BEEN USEFUL IN ESTABLISHING RESPONSIBILITY FOR POLLUTION INCIDENTS (GUINN ET AL. 1971).

LATOUCHE, Y. DAVID, AND MICHAEL C. MIX. 1981. SEASONAL VARIATION IN SOFT TISSUE WEIGHTS AND TRACE METAL BURDENS IN THE BAY MUSSEL, MYTILUS EDULIS. BULL. ENVIRON. CONTAM. TOXICOL. 27(6):821-828. (ERL,GB X310).

THE PURPOSE OF THE PRESENT STUDY WERE TO MEASURE THE LEVELS OF 6 TRACE METALS IN M. EDULIS SOFT TISSUES DURING A 9-MONTH PERIOD, ESTABLISH PATTERNS OF SEASONAL VARIATION AND DETERMINE THE NORMAL RANGES OF METAL BURDENS IN MUSSELS. THE METALS WERE VANADIUM (V), MANGANESE (MN), NICKEL (NI), COPPER (CU), ZINC (ZN), AND CADMIUM (CD); NI, CU, ZN, AND CD ARE EPA PRIORITY POLLUTANTS.

LATOUCHE, Y. DAVID, AND MICHAEL C. MIX. 1982. EFFECTS OF DEPURATION, SIZE AND SEX ON TRACE METAL LEVELS IN BAY MUSSELS. MAR. POLLUT. BULL. 13(1):27-29. (ERL,GB X412).

THE EFFECTS OF DEPURATION, SIZE AND SEX ON THE CONCENTRATIONS OF MN, NI, CU, ZN AND CD WERE DETERMINED FOR GONADAL AND SOMATIC TISSUES OF MYTILUS EDULIS FROM YAQUINA BAY, OREGON. AFTER DEPURATION, MN LEVELS DECREASED SIGNIFICANTLY IN BOTH TISSUES WHILE CU AND NI CONCENTRATIONS INCREASED IN SOMATIC TISSUES. THE LATTER FINDING MAY HAVE BEEN ASSOCIATED WITH A STRESS RESPONSE MANIFESTED BY THE APPEARANCE OF NEW BYSSAL THREADS AND ATTACHMENT TO THE VESSEL. LARGER, AND PRESUMABLY OLDER, MUSSELS CONTAINED HIGHER CONCENTRATIONS OF NI, CU AND CD IN THEIR SOMATIC TISSUES WHILE SMALLER ANIMALS HAD GREATER SOMATIC LEVELS OF MN. THERE WERE NO SIGNIFICANT DIFFERENCES IN GONAD CONCENTRATIONS BETWEEN THE TWO SIZE GROUPS. MANGANESE AND ZN LEVELS WERE GREATER IN THE GONADS OF FEMALE MUSSELS AND CD WAS MORE CONCENTRATED IN THE SOMATIC TISSUES OF FEMALES.

LATOUCHE, Y. DAVID, AND MICHAEL C. MIX. 1982. SEASONAL VARIATIONS OF ARSENIC AND OTHER TRACE ELEMENTS IN BAY MUSSELS (MYTILUS EDULIS). BULL. ENVIRON. CONTAM. TOXICOL. 29(6):665-670. (ERL,GB X418).

THE PURPOSES OF THIS STUDY WERE TO INVESTIGATE SEASONAL VARIATIONS OF ARSENIC IN A POPULATION OF BAY MUSSELS (MYTILUS EDULIS) AND TO COMPARE RESULTS WITH VARIATIONS OF SEVERAL OTHER TRACE ELEMENTS MORE COMMONLY MEASURED IN ENVIRONMENTAL STUDIES. SEASONAL VARIATIONS OF MANGANESE, NICKEL, COPPER, ZINC, AND CADMIUM WERE INVESTIGATED PREVIOUSLY (LATOUCHE & MIX 1981), BUT ARSENIC AND ITS RELATIONSHIP WITH THOSE METALS IS NOW REPORTED FOR THE FIRST TIME.

LATOUCHE, YVES D. 1981. TRACE METAL LEVELS IN A POPULATION OF MYTILUS EDULIS FROM YAQUINA BAY, OREGON. PH.D. THESIS. OREGON STATE UNIVERSITY, CORVALLIS, OR. 135P. (ERL,GB X408).

THE PRESENT STUDY IS CONCERNED WITH THE M. EDULIS REPRODUCTIVE CYCLE AND ITS EFFECT ON SOFT TISSUE CONTENT OF SIX TRANSITION METALS THAT ARE IMPORTANT IN BIOLOGICAL FUNCTION AND/OR AS POLLUTANTS IN ESTUARINE ENVIRONMENTS. A NATURAL POPULATION WITH A SUITABLY LARGE NUMBER OF INDIVIDUALS FROM A LOCATION RELATIVELY FREE FROM METAL POLLUTANTS OF ANTHROPOGENIC ORIGIN, WAS CHOSEN FOR THE INVESTIGATION. THE SEXUAL STATE OF THE MUSSELS WAS DETERMINED BY MEASURING THE WEIGHT OF GONADAL MATERIAL RELATIVE TO SOMATIC TISSUE WEIGHT. METAL BURDENS IN GONADAL AND SOMATIC TISSUES WERE DETERMINED AT REGULAR INTERVALS FOR ANIMALS WITHIN A SINGLE-SIZE RANGE. THIS PROCEDURE HAD THE SIGNIFICANT ADVANTAGE OF EXCLUDING ANY EXTRINSIC FACTORS THAT MIGHT HAVE IMPINGED ON A POPULATION OF ANIMALS MAINTAINED IN A LABORATORY FOR A RELATIVELY LONG PERIOD (8 MONTHS). IT WAS ALSO ESSENTIAL THAT NO UNNATURAL STIMULI THAT MIGHT HAVE INDUCED SPAWNING BE PRESENT, AND THAT NO ORDINARY ENVIRONMENTAL CUES BE EXCLUDED. SEVERAL ENVIRONMENTAL MONITORING PROGRAMS WILL BE DISCUSSED WITH RESPECT TO THE METHODS THAT THEY EMPLOY, AND THE TYPE AND QUALITY OF THE DATA THAT THEY PROVIDE. RESULTS OF THIS STUDY WILL INDICATE HOW SUCH DATA MAY BE IMPROVED, AND ERRORS REDUCED BY MODIFICATION OF EXISTING PROCEDURES. THIS WILL LEAD TO DEFINING PROCEDURES THAT SHOULD BE USED IN MONITORING PROGRAMS. THE METALS OF CHOICE WERE VANADIUM, MANGANESE, NICKEL, COPPER, ZINC, AND CADMIUM. NICKEL, COPPER, ZINC, AND CADMIUM ARE EPA PRIORITY POLLUTANTS.

LONG, R.L., AND B.J. MARTIN. 1980. MORPHOLOGY OF PERIPHERAL BLOOD CELLS OF CYPRINODON VARIEGATUS (ABSTRACT). J. MISS. ACAD. SCI. 26(SUPPL.):123. (ERL,GB X195).

PERIPHERAL BLOOD FROM THE SHEEPSHEAD MINNOW, CYPRINODON VARIEGATUS, HAS BEEN STUDIED TO DETERMINE CELL TYPES. FRESH PREPARATIONS, ROMANOWSKY'S STAINED SMEARS, AND THICK EPOXY SECTIONS WERE STUDIED USING LIGHT MICROSCOPY. CORRELATIVE OBSERVATIONS WERE ACCOMPLISHED USING TRANSMISSION ELECTRON MICROSCOPY. CELLS IDENTIFIED WERE ERYTHROCYTES, EOSINOPHILIC GRANULOCYTES, LYMPHOCYTES, AND THROMBOCYTES. THE DIFFERENTIATION BETWEEN EARLY LYMPHOCYTES AND THROMBOCYTES ON A MORPHOLOGICAL BASIS REMAINS PROBLEMATIC.

MARTIN, B. J., AND W. W. GREENWICH. 1981. BENZIDINE TOXICITY (ABSTRACT). J. MISS. ACAD. SCI. 26(SUPPL.):127. (ERL,GB X356).

AS A PREREQUISITE TO LONG-TERM EXPOSURES OF THE CHANNEL CATFISH, ICTALURUS PUNCTATUS, TO THE MAMMAL CARCINOGEN, BENZIDINE, TOXICITY STUDIES WERE ACCOMPLISHED. CATFISH, 2-4 INCHES STANDARD LENGTH, WERE MAINTAINED IN 10 GALLON AQUARIA FOR THE STATIC BIOASSAYS. THE FISH WERE FASTED 4 DAYS PRIOR TO THE ASSAYS AND WATER QUALITY WAS MONITORED. THE 96 HOUR LC-50 WAS APPROXIMATELY 60 PPM.

MARTIN, B.J. 1980. EFFECTS OF PETROLEUM COMPOUNDS ON ESTUARINE FISHES. EPA-600/3-80-019, U.S. ENVIRONMENTAL PROTECTION AGENCY, ENVIRONMENTAL RESEARCH LABORATORY, GULF BREEZE, FL. 31P.

EFFECTS OF THE CARCINOGENIC POLYCYCLIC AROMATIC HYDROCARBONS (PAH), BENZO(A)PYRENE (BAP), AND METHYLCHOLANTHRENE (MCA) WERE INVESTIGATED WITH SHEEPSHEAD MINNOWS (CYPRINODON VARIEGATUS) AND CHANNEL CATFISH (ICTALURUS PUNCTATUS). A CLOSED-CIRCULATING SYSTEM WAS DESIGNED TO MAINTAIN UP TO 100 SHEEPSHEAD MINNOWS IN ARTIFICIAL SEAWATER FOR LONG-TERM EXPOSURES. FISH WERE MAINTAINED IN THIS SYSTEM FOR UP TO 31 WEEKS WITH WEEKLY CONTAMINATIONS OF PAH. DUE TO THEIR CHEMICAL PROPERTIES SIGNIFICANT LEVELS OF BAP AND MCA REMAINED IN THE WATER COLUMN FOR ONLY CA. 24 HOURS EACH WEEK AND NO TUMORS WERE OBSERVED IN THE EXPOSED FISH DURING THE PERIOD OF THE STUDY. THE INCIDENCE AND TYPES OF LESIONS IN CONTROL AND EXPOSED FISH WERE BASICALLY SIMILAR EXCEPT IN CATFISH THAT WERE FED PAH CONTAMINATED FOOD. HIGH LEVELS OF CONTAMINATION (1MG/GM FOOD) APPEARED TO BE TOXIC AND LOWER LEVELS OF CONTAMINATION (0.1 MG/GM FOOD) PRODUCED SUFFICIENT STRESS TO MAKE THE CATFISH SUSCEPTIBLE TO FATAL PARASITE INFESTATIONS. BOTH SPECIES ACCUMULATED RADIOACTIVELY LABELLED PAH AT CONCENTRATIONS MUCH HIGHER THAN THEIR NORMAL CONCENTRATIONS IN THE WATER. THESE RESULTS DEMONSTRATE THAT SHEEPSHEAD MINNOWS FUNCTION WELL AS EXPERIMENTAL ORGANISMS IN ARTIFICIAL SEAWATER IN A CLOSED SYSTEM MAINTAINED AT A NONCOASTAL FACILITY. THUS, THEY PROVIDE AN EXCELLENT MODEL SYSTEM FOR THE STUDY OF LONG-TERM EFFECTS OF CHRONIC EXPOSURE TO POLLUTING AGENTS.

MARTIN, B.J. 1982. DEVELOPMENT OF A CARCINOGEN ASSAY SYSTEM UTILIZING ESTUARINE FISHES. EPA-600/3-82-091, U.S. ENVIRONMENTAL PROTECTION AGENCY, ENVIRONMENTAL RESEARCH LABORATORY, GULF BREEZE, FL. 50P.

THE OBJECTIVE OF THIS PROJECT WAS THE DEVELOPMENT OF SYSTEMS TO ASSAY THE EFFECTS OF CHEMICAL CARCINOGENS ON MARINE TELEOSTS. IT WAS DETERMINED THAT LC-50 FOR BENZINDINE WITH RESPECT TO CYPRINODON VARIEGATUS WAS CA. 64 PPM. WEEKLY CONTAMINATIONS OF 1 PPM BENZIDINE CAUSED SOME INDIVIDUALS TO DEVELOP PROLIFERATIVE LIVER LESIONS. EXPOSURE OF C. VARIEGATUS EARLY EMBRYOS PRODUCED THE FOLLOWING ANOMALIES AT CONCENTRATIONS OF 50 PPM AND ABOVE: TUBED HEART SYNDROME WITH DISTENDED PERICARDIA, POOR CIRCULATION, SPARSE DISTRIBUTION OF MELANOPHORES, INABILITY TO HATCH, ABNORMAL HEAD MORPHOLOGY, SCOLIOSIS, AND FAINT RBC PIGMENTATION. CHRONIC EXPOSURE OF A CELL LINE FROM ARCHOSARGUS PROBATOCEPHALUS TO BENZIDINE AND BENZO(A)PYRENE PRODUCED MUTAGENIC EFFECTS. TWO NOVEL TECHNIQUES WERE DEVELOPED TO STUDY THE EFFECTS OF CARCINOGENS ON C. VARIEGATUS AT THE CELLULAR LEVEL -- AN ASEPTIC EMBRYO TECHNIQUE AND AN EMBRYO-PRIMARY CELL CULTURE TECHNIQUE. STANDARD IMMUNOLOGICAL TECHNIQUES WERE MINIATURIZED TO STUDY THE IMMUNE SYSTEM OF C. VARIEGATUS. SERUM ELECTROPHORESIS DISCLOSED THAT THE SERUM PROTEINS OF BENZIDINE-EXPOSED FISH DIFFERED FROM UNEXPOSED CONTROLS.

MARTIN, B.J., R.D. ELLENDER, S.A. HILLEBERT, AND M.M. GUESS. IN PRESS. PRIMARY CELL CULTURES FROM THE TELEOST, CYPRINODON VARIEGATUS: CULTURE ESTABLISHMENT AND APPLICATION IN CARCINOGEN EXPOSURE STUDIES. IN: PROCEEDINGS OF THE SYMPOSIUM ON THE USE OF SMALL FISH SPECIES IN CARCINOGENICITY TESTING, BETHESDA, MARYLAND, DECEMBER 8-10, 1981. U.S. NATIONAL CANCER INSTITUTE. (ERL,GB X260).

METHODS WERE DEVELOPED TO MAINTAIN C. VARIEGATUS FRY ASEPTICALLY FOR EXTENDED PERIODS. PRELIMINARY STUDIES INDICATED THAT UNDER OPTIMUM CONDITIONS STERILE EMBRYOS DEVELOP NORMALLY FOR A SUFFICIENT TIME TO FUNCTION AS CARCINOGEN/TERATOGEN ASSAY SYSTEMS. AN EMBRYO-PRIMARY CELL CULTURE TECHNIQUE WAS DEVELOPED THAT INCORPORATES, IN A SINGLE SYSTEM, CERTAIN CHARACTERISTICS OF BOTH INTACT EMBRYOS AND PRIMARY CELL CULTURES, ALLOWING SIMULTANEOUS OBSERVATION OF THE EFFECTS OF CARCINOGENS ON THE WHOLE ORGANISM AND PRIMARY CELL MONOLAYERS. THE EFFECTIVE USE OF THESE SYSTEMS PROVIDES THE OPPORTUNITY TO STUDY THE EFFECTS OF CARCINOGENS ON TELEOSTS AT THE CELLULAR AND ORGANISMIC LEVEL.

MARTIN, B.J., AND W.W. GREENWICH. 1980. EXPOSURE OF TWO TELEOST SPECIES TO POLYCYCLIC AROMATIC HYDROCARBONS (ABSTRACT). J. MISS. ACAD. SCI. XXV(SUPPL.):120. (ERL,GB X194).

SHEEPSHEAD MINNOWS, CYPRINODON VARIEGATUS, AND CHANNEL CATFISH, ICTALURUS PUNCTATUS, WERE MAINTAINED IN WATER CONTAMINATED WEEKLY WITH POLYCYCLIC AROMATIC HYDROCARBONS (PAH). IN OTHER EXPERIMENTS, FISH WERE MAINTAINED ON PAH CONTAMINATED FOOD REGIMES. BECAUSE OF THE SOLUBILITY PROPERTIES OF PAH, SIGNIFICANT LEVELS DID NOT REMAIN IN THE WATER COLUMN. HIGH LEVELS OF FOOD CONTAMINATION APPEARED TO STRESS CATFISH SUFFICIENTLY TO INCREASE THEIR SUSCEPTIBILITY TO PARASITIC INFESTATION. EXPERIMENTS IN WHICH RADIOACTIVELY LABELLED PAH WAS PLACED IN THE WATER COLUMN INDICATED A RATHER VARIABLE BIOACCUMULATION. HIGHEST LEVELS OF LABEL WERE OBSERVED IN GILL AND LIVER TISSUE, AN INTERMEDIATE LEVEL IN GI TRACT, AND A LOWER LEVEL IN SKELETAL MUSCLE. THE VARIABILITY OF THESE DATA WAS REDUCED WHEN FISH WERE FED LABELLED PAH. THE RESULTS SUGGEST THAT SIGNIFICANT EXPOSURE OF FISH TO PAH IS MORE LIKELY TO OCCUR AS A RESULT OF THEIR INGESTING CONTAMINATED MATERIAL, THAN FROM DIRECT BODY EXPOSURE TO PAH IN THE WATER COLUMN.

EADOR, C.B., B.L. MIDDLEBROOKS, AND B.J. MARTIN. IN PRESS. SEROLOGIC  
LTERATIONS IN CARCINOGEN-EXPOSED TELEOSTS: PROCEDURES FOR PREPARATION AND  
NALYSIS OF SAMPLES FROM SMALL FISH. IN: PROCEEDINGS OF THE SYMPOSIUM ON  
HE USE OF SMALL FISH SPECIES IN CARCINOGENICITY TESTING, BETHESDA, MARYLAND,  
ECEMBER 8-10, 1981. U.S. NATIONAL CANCER INSTITUTE. (ERL,GB X261).

IN ORDER TO STUDY THE EFFECTS OF ENVIRONMENTAL CARCINOGENS ON THE  
IMMUNE SYSTEM OF CYPRINODON VARIEGATUS, IT WAS NECESSARY TO  
MINIATURIZE OR MODIFY STANDARD IMMUNOLOGICAL PROCEDURES, DUE TO THE  
SMALL SIZE OF THE FISH. MODIFICATIONS IN STANDARD BLEEDING PROCEDURES  
ALLOWED COLLECTION OF SUFFICIENT SERUM TO PERFORM MOST SEROLOGICAL  
PROCEDURES. SERUM ELECTROPHORESIS SHOWED CONSIDERABLE VARIATION BETWEEN  
EXPOSED AND UNEXPOSED FISH AS DID QUALITATIVE IMMUNOELECTROPHORESIS  
TECHNIQUES. A BACTERIOPHAGE NEUTRALIZATION PROCEDURE WAS SUCCESSFULLY  
ADAPTED FOR USE WITH THE C. VARIEGATUS SYSTEM TO MEASURE ANTIVIRAL  
ANTIBODIES. THE PRESENCE OF ANTIBODY-FORMING CELLS IN SPLEEN  
SUSPENSIONS FROM FISH IMMUNIZED WITH HUMAN TYPE O ERYTHROCYTES WAS  
DEMONSTRATED BY A MODIFIED IMMUNE ROSETTE PROCEDURE. A CAPILLARY TUBE  
PROCEDURE WAS DEVELOPED FOR SEPARATION OF LEUCOCYTES FROM ERYTHROCYTES  
IN BLOOD DEVELOPED FOR SEPARATION OF LEUCOCYTES FROM ERYTHROCYTES IN  
BLOOD FROM C. VARIEGATUS.

ELIUS, P., D. ELAN, M. KILGORE, AND W.P. SCHOOR. 1979. INDUCTION OF  
OLYAROMATIC HYDROCARBON OXIDASE IN MARINE ORGANISMS (ABSTRACT). IN:  
BSTRACTS: XITH INTERNATIONAL CONGRESS OF BIOCHEMISTRY, JULY 8-13, 1979,  
ORONTO, CANADA. NATIONAL RESEARCH COUNCIL OF CANADA, TORONTO. PP. 691.  
ERL,GB X277).

CERTAIN KINDS OF DRUGS, SUCH AS PHENOBARBITAL, AND ENVIRONMENTAL  
POLLUTANTS, SUCH AS POLYHALOGENATED BIPHENYLS, ARE WELL-KNOWN TO  
INDUCE CYTOCHROME P450 ENZYMES IN RAT LIVER. THE CYTOCHROME P450  
ENZYME SYSTEMS ARE RESPONSIBLE FOR SUCH CONVERSIONS AS BENZO(A)PYRENE  
(BP) TO A MUTAGENIC AND CARCINOGENIC BENZO(A)PYRENE EPOXIDE. OUR  
REPORT IS CONCERNED WITH THE TREATMENT OF MULLET (MUGIL CEPHALUS) AND  
KILLIFISH (FUNDALUS GRANDIS) WITH AROCLOR 1254 AT LEVELS FROM 25 TO  
200 MG/K. THE INCREASE IN MIXED FUNCTION OXIDASES HAS BEEN MEASURED BY  
USING THE AMES TEST ON MICROSOMAL FRACTIONS PREPARED FROM THE FISH  
LIVERS WITH BENZO(A)PYRENE, 3-METHYLCHOLANTHRENE AND CRYSENE AS THE  
SUBSTRATES. WE HAVE ALSO MEASURED THE BP OXIDASE, THE HEPATIC  
MICROSOMAL REDUCTASES AND CYTOCHROME P450 ACTIVITIES IN THE LIVER  
MICROSOMAL PREPARATIONS. THE AROCLOR INDUCED LIVERS WERE FOUND TO BE  
CAPABLE OF ACTIVATING CERTAIN COMPOUNDS TO MUTAGENS.

MELIUS, PAUL. IN PRESS. COMPARATIVE BENZO(A)PYRENE METABOLITE PATTERNS IN FISH AND RODENTS. IN: PROCEEDINGS OF THE SYMPOSIUM ON THE USE OF SMALL FISH SPECIES IN CARCINOGENICITY TESTING, BETHESDA, MARYLAND, DECEMBER 8-10, 1981. U.S. NATIONAL CANCER INSTITUTE. (ERL,GB X365).

BENZO(A)PYRENE IS CONVERTED TO 3-HYDROXYBENZO(A)-PYRENE, 9-HYDROXYBENZO(A)PYRENE, 4,5-BENZO(A)PYRENE-DIHYDRODIOL, 7,8-BENZO(A)PYRENEDIHYDRODIOL, 9,10-BENZO(A)-PYRENEDIHYDRODIOL AND BENZO(A)PYRENE QUINONES BY POST MITOCHONDRIAL SUPERNATANT OR MICROSOMES IN SUCH FISH AS THE RAINBOW TROUT FLOUNDER, SALMON, MULLET, LITTLE SKATE, FUNDULUS GRANDIS AND SEA CATFISH. IT IS ALSO NOW WELL-ESTABLISHED THAT MANY FISH CONVERT BENZO(A)PYRENE TO POTENT MUTAGENIC METABOLITES AS HAS BEEN DEMONSTRATED USING THE AMES TEST, ESPECIALLY WHEN THE FISH ARE INDUCED WITH AROCLOR OR 3-METHYLCHOLANTHRENE, THE METABOLITE PATTERNS OBTAINED AT DIFFERENT SUBSTRATE CONCENTRATION LEVELS INDICATE THAT THE METABOLISM IS MORE COMPLEX AT LOW CONCENTRATIONS WHERE RECYCLING OF METABOLITES IS PRODUCED IN THE IN VITRO SYSTEM.

MELIUS, PAUL, DAVID ELAM, MELVIN KILGORE, BARRIE TAN, AND W.P. SCHOOR. 1979. MIXED FUNCTION OXIDASE INDUCIBILITY AND POLYAROMATIC HYDROCARBON METABOLISM IN THE MULLET, SEA CATFISH, AND GULF KILLIFISH. IN: POLYNUCLEAR AROMATIC HYDROCARBONS: CHEMISTRY AND BIOLOGICAL EFFECTS. A. BJORSETH AND A.J. DENNIS, EDITORS, BATELLE PRESS, COLUMBUS, OH. PP. 1059-1075. (ERL,GB X268).

OUR STUDIES HAVE SHOWN THAT THE MULLET (MUGIL CEPHALUS), THE SEA CATFISH (ARIUS FELIS) AND THE GULF KILLIFISH (FUNDULUS GRANDIS) POSSESS MFO SYSTEMS WHICH ARE INDUCIBLE BY AROCLOR 1254 (MULLET) AND BY 3-MC (SEA CATFISH AND GULF KILLIFISH). BAP TREATED GULF KILLIFISH DID NOT APPEAR TO METABOLIZE BAP AS EFFICIENTLY AND SEEMED TO PRODUCE LOWER LEVELS OF BAP METABOLITES THAN DID 3-MC-TREATED GULF KILLIFISH. THIS MAY HAVE RESULTED BECAUSE (1) BAP IS A LESS EFFECTIVE INDUCER THAN 3-MC OR (2) IN VIVO BAP METABOLITE MAY HAVE INDUCED THE CONJUGATION SYSTEMS, WHICH WOULD RESULT IN ETHYL ACETATE INSOLUBLE AND NONMUTAGENIC IN VITRO BAP METABOLITES. THESE STUDIES SHOW THAT CERTAIN SIMILARITIES EXIST IN THE MECHANICS OF FISH AND MAMMALIAN MFO SYSTEMS EVEN THOUGH DIFFERENCES EXIST IN THE ACTIVITIES OF THESE SYSTEMS. CHAMBERS AND YARBROUGH SPECULATE THAT THE LESS ACTIVE MFO SYSTEMS OF FISH REFLECT THEIR EVOLUTIONARY ADAPTATION TO AN ENVIRONMENT IN WHICH XENOBIOTICS ARE NATURALLY DILUTED.

MEYERS, T.R., AND J.D. HENDRICKS. 1983. HISTOPATHOLOGY OF FOUR SPONTANEOUS NEOPLASMS IN THREE SPECIES OF SALMONID FISHES. J. FISH DIS. 6(5):481-499. (ERL,GB X358).

GROSS AND HISTOLOGICAL DESCRIPTIONS OF FOUR DIFFERENT SPONTANEOUS NEOPLASMS IN THREE SPECIES OF SALMONID FISHES ARE PROVIDED: THYMIC LYMPHOMA AND DERMAL FIBROSARCOMA, RESPECTIVELY, IN TWO ARTIFICIALLY REARED SOCKEYE SALMON, ONCORHYNCHUS NERKA (WALBAUM), RENAL PAPILLIFEROUS CYSTADENOMA IN A WILD CAUGHT CHINOOK SALMON, O. TSHAWYTSCHA (WALBAUM); CAPILLARY HAEMANGIOMA OF THE DERMIS IN AN ARTIFICIALLY REARED RAINBOW TROUT, SALMO GAIARDNERI RICHARDSON. THE FREQUENCY OF OCCURRENCE OF THESE AND RELATED TUMOUR TYPES, AS REPORTED IN THE LITERATURE, ARE COMPARED IN SALMONID AND NON-SALMONID FISH.

MEYERS, THEODORE R., AND JERRY D. HENDRICKS. 1982. SUMMARY OF TISSUE LESIONS IN AQUATIC ANIMALS INDUCED BY CONTROLLED EXPOSURES TO ENVIRONMENTAL CONTAMINANTS, CHEMOTHERAPEUTIC AGENTS, AND POTENTIAL CARCINOGENS. MAR. FISHERIES REV. 44(12):1-17. (ERL,GB X368).

THIS ARTICLE WAS WRITTEN TO PROVIDE A USEFUL REFERENCE FOR AQUATIC TOXICOLOGISTS/PATHOLOGISTS BY CONSOLIDATING THIS DESCRIPTIVE MATERIAL WITH KEY REFERENCES THROUGH 1981. THIS INFORMATION IS PRESENTED IN FIVE TABLES. TABLE 1 IDENTIFIES AT LEAST 90 ENVIRONMENTAL CONTAMINANTS USED AS PESTICIDES, HERBICIDES, OR AS INDUSTRIAL CHEMICALS WHICH ARE CATEGORIZED IN THE FOLLOWING MANNER: ORGANOCHLORINES, PETROLEUM COMPOUNDS, ORGANOPHOSPHATES, CARBAMATES, HEAVY METAL SALTS, NITROGENOUS COMPOUNDS, MISCELLANEOUS COMPOUNDS, AND CHEMOTHERAPEUTIC AGENTS. TABLE 4 LISTS AT LEAST 50 COMPOUNDS GROUPED AS MYCOTOXINS, PLANT DERIVATIVES, AND OTHER CHEMICALS ALL OF WHICH HAVE BEEN TESTED FOR CARCINOGENIC ACTIVITY. TABLES 2, 3 AND 5 DESCRIBE AND REFERENCE HISTOLOGIC AND/OR ULTRASTRUCTURAL LESIONS OR ABNORMALITIES CAUSED BY THESE COMPOUNDS, THEIR ROUTES OF EXPOSURE, AND AQUATIC SPECIES TESTED.

MIX, M.C. 1983. HAEMIC NEOPLASMS OF BAY MUSSELS, MYTILUS EDULIS, FROM OREGON: OCCURRENCE, PREVALENCE, SEASONALITY, AND HISTOPATHOLOGICAL PROGRESSION. J. FISH DIS. 6(3):239-248. (ERL,GB X379).

THE OCCURRENCE, PREVALENCE, SEASONALITY AND HISTOPATHOLOGICAL PROGRESSION OF A CELLULAR DISORDER, THOUGHT TO BE A HAEMIC NEOPLASM, WERE STUDIED IN SUBPOPULATIONS OF MYTILUS EDULIS INHABITING DIFFERENT SITES IN YAQUINA BAY, OREGON, FROM 1976-1981. THERE WERE SIGNIFICANT DIFFERENCES IN THE OCCURRENCE OF THE DISORDER THAT WERE RELATED TO GEOGRAPHICAL LOCATION. IN THE SUBPOPULATION WITH THE HIGHEST LEVELS OF THE DISEASE, THE PREVALENCE RATES RANGED FROM 0 TO 20% WITH A 5-YEAR MEAN OF 9.8%. THERE WAS A STATISTICALLY SIGNIFICANT RELATIONSHIP BETWEEN PREVALENCE AND SEASON. DURING THE 5-YEAR STUDY PERIOD, THERE WAS A CONSISTENT PATTERN CHARACTERIZED BY HIGHEST PREVALENCES DURING JANUARY TO MARCH FOLLOWED BY A PERIOD OF DECLINE TO LOWER LEVELS DURING THE SUMMER AND EARLY AUTUMN, AFTER WHICH THERE WAS AN INCREASE. DATA ANALYSES REVEALED THAT THERE WAS NO SEASONAL HISTOPATHOLOGICAL PROGRESSION OF THE DISORDER. NUMBERS OF STAGE 1 (EARLY), 2, 3 AND 4 (ADVANCED) CASES WERE NOT RELATED TO SEASON BUT OCCURRED IN A RANDOM MANNER THROUGHOUT THE ENTIRE YEAR.

MIX, MICHAEL C. 1983. STUDIES ON POLYNUCLEAR AROMATIC HYDROCARBONS AND METALS IN MOLLUSCS (ABSTRACT). IN: WORKSHOP ON SUBLETHAL EFFECTS OF STRESS ON MARINE ORGANISMS, MARCH 30-31, 1982, ASILOMAR, PACIFIC GROVE, CALIFORNIA. MICHAEL MARTIN AND FLORENCE HARRISON, EDITORS, NTIS, SPRINGFIELD, VA. PP. 55. (ERL,GB X283).

DURING THE PAST 5 YEARS, OUR RESEARCH HAS FOCUSED ON MEASURING LEVELS OF 15 UNSUBSTITUTED POLYNUCLEAR AROMATIC HYDROCARBONS (PNAH) AND CERTAIN METALS IN BIVALVE MOLLUSCS FROM INDIGENOUS POPULATIONS THAT INHABIT OREGON ESTUARIES. THE PRIMARY OBJECTIVES OF SOME OF THE MAJOR STUDIES WERE TO: (1) MEASURE CONCENTRATIONS OF PNAH AND METALS IN SHELL FISH FROM DIFFERENT LOCATIONS FOR AN EXTENDED PERIOD OF TIME IN ORDER TO ESTABLISH A DEPENDABLE BASELINE, (2) DETERMINE WHETHER OR NOT PNAH CONCENTRATIONS IN MOLLUSCS REFLECT THE DEGREE OF ENVIRONMENTAL CONTAMINATION, (3) EVALUATE SEASONAL VARIATIONS IN PNAH AND METAL CONCENTRATIONS IN MOLLUSCS, (4) DETERMINE WHETHER OR NOT THERE WERE STATISTICAL CORRELATIONS BETWEEN THE PRESENCE OF CELLULAR PROLIFERATIVE DISORDERS IN SUBPOPULATIONS OF MUSSELS (*MYTILUS EDULIS*) AND PNAH CONCENTRATIONS IN THEIR TISSUES, AND (5) DETERMINE WHETHER OR NOT CERTAIN STATISTICAL RELATIONSHIPS COULD BE USED FOR PREDICTIVE PURPOSES IN DETERMINING AND EVALUATING PNAH CONCENTRATIONS IN INDIGENOUS SHELLFISH. OUR DATA SUGGEST THAT A TWO OR THREE YEAR PERIOD IS REQUIRED TO ESTABLISH BASELINE LEVELS OF PNAH IN SHELLFISH. THERE WERE SIGNIFICANT CORRELATIONS BETWEEN PNAH CONCENTRATIONS IN MUSSELS, THE OCCURRENCE OF CELLULAR DISORDERS AND THE QUALITY OF THE ENVIRONMENT THEY INHABIT. THERE WERE SIGNIFICANT SEASONAL VARIATIONS IN BOTH PNAH AND METAL CONCENTRATIONS IN *M. EDULIS*. FINALLY, THE DATA FROM OUR STUDIES INDICATE THAT IT MAY BE POSSIBLE TO IDENTIFY SITE-SPECIFIC VARIABLES (INDIVIDUAL PNAH OR METALS) THAT CAN BE USED FOR ASSESSING PNAH CONCENTRATION IN THE ENVIRONMENT.

MIX, MICHAEL C. 1979. CHEMICAL CARCINOGENS IN BIVALVE MOLLUSKS FROM OREGON ESTUARIES. EPA-600/3-79-034, U.S. ENVIRONMENTAL PROTECTION AGENCY, ENVIRONMENTAL RESEARCH LABORATORY, GULF BREEZE, FL. 33P.

THE RESEARCH UNDERTAKEN INVOLVED THE USE OF INDIGENOUS POPULATIONS OF BIVALVE MOLLUSKS AS MONITORS FOR DETECTING AND QUANTIFYING ENVIRONMENTAL BENZO(A)PYRENE (BAP) IN OREGON ESTUARIES. SHORT-TERM AND LONG-TERM STUDIES WERE CONDUCTED IN ORDER TO ESTABLISH BASELINE LEVELS OF BAP AND TO IDENTIFY SEASONAL VARIATIONS IN BAP CONCENTRATIONS IN SHELLFISH. A PRESUMPTIVE CELLULAR PROLIFERATIVE DISORDER, THOUGHT POSSIBLY TO BE NEOPLASTIC, WAS ALSO STUDIED IN MUSSELS, *MYTILUS EDULIS*, FROM YAQUINA BAY. HISTOLOGICAL STUDIES REVEALED THAT MUSSELS INHABITING POLLUTED ENVIRONMENTS, AND WITH HIGH BAP BODY BURDENS, HAD AN AVERAGE 6-8% PREVALENCE OF THE CELLULAR PROLIFERATIVE DISORDER WHILE THOSE FROM CLEAN ENVIRONMENTS AND WITH LOW OR UNDETECTABLE LEVELS, DID NOT HAVE THE DISORDER. THE CELLULAR CONDITION SHOWED A DEFINITE SEASONAL PATTERN, THERE WAS A LOW PREVALENCE DURING THE SUMMER AND FALL FOLLOWED BY AN INCREASE DURING THE EARLY WINTER AND A PEAK PREVALENCE OCCURRED IN JANUARY-FEBRUARY. THE ATYPICAL, LARGE CELLS THAT CHARACTERIZE THE DISORDER IN *M. EDULIS* POSSESS MANY ULTRASTRUCTURAL PROPERTIES IN COMMON WITH MALIGNANT VERTEBRATE CELLS. FURTHER STUDIES ARE REQUIRED TO EVALUATE THE PUBLIC HEALTH SIGNIFICANCE OF THESE RESULTS.

MIX, MICHAEL C. 1982. POLYNUCLEAR AROMATIC HYDROCARBONS AND CELLULAR PROLIFERATIVE DISORDERS IN BIVALVE MOLLUSCS FROM OREGON ESTUARIES. EPA-600/4-82-026, U.S. ENVIRONMENTAL PROTECTION AGENCY, ENVIRONMENTAL RESEARCH LABORATORY, GULF BREEZE, FL. 49P.

THE RESEARCH PROJECT INVOLVED UTILIZING INDIGENOUS POPULATIONS OF ECONOMICALLY-IMPORTANT BIVALVE MOLLUSCS AS MONITORS FOR DETECTING AND QUANTIFYING ENVIRONMENTAL PNAH, INCLUDING 11 COMPOUNDS CLASSIFIED AS CARCINOGENS, 11 EPA PRIORITY POLLUTANTS AND 11 TOXIC POLLUTANTS. BASELINE LEVELS OF PNAH WERE DETERMINED DURING A TWO-YEAR PERIOD FOR MUSSELS (*M. EDULIS*), CLAMS (*M. ARENARIA* AND *T. CAPAX*) AND OYSTERS (*C. GIGAS*) FROM DIFFERENT SITES, RANGING FROM RELATIVELY PRISTINE TO MODERATELY POLLUTED, IN YAQUINA, COOS AND TILLAMOOK BAYS, OREGON. TOTAL CONCENTRATIONS OF 15 UNSUBSTITUTED PNAH WERE 30-60 UG/KG IN SHELLFISH FROM UNCONTAMINATED WATERS TO GREATER THAN 1000 UG/KG IN THOSE FROM SITES CLASSIFIED AS CONTAMINATED. A MAJOR EFFORT WAS MADE TO DETERMINE AND EVALUATE CERTAIN RELATIONSHIPS BETWEEN PNAH AND THEIR CONCENTRATIONS IN SHELLFISH. STUDIES WERE CONDUCTED TO: DETERMINE THE EFFECTS OF DEPURATION ON PNAH CONCENTRATIONS; IDENTIFY SEASONAL DIFFERENCES IN PNAH CONCENTRATIONS; AND MEASURE BAP UPTAKE AND ELIMINATION. PRELIMINARY STUDIES INDICATED THAT MUSSELS MAY POSSESS A LIMITED ABILITY TO METABOLIZE BAP. MULTIPLE REGRESSION AND MULTIPLE CORRELATION TECHNIQUES WERE USED TO IDENTIFY AND EVALUATE INTERRELATIONSHIPS BETWEEN PNAH. CERTAIN RELATIONSHIPS MAY BE USEFUL FOR PREDICTIVE PURPOSES IN EVALUATING ENVIRONMENTAL PNAH. THE DATA FROM THESE STUDIES INDICATE THAT IT MAY BE POSSIBLE TO IDENTIFY SITE-SPECIFIC, SIGNIFICANT VARIABLES (INDIVIDUAL PNAH) AFTER A SUITABLE PERIOD OF SAMPLING AND TO SUBSEQUENTLY MEASURE ONLY THOSE KEY VARIABLES FOR AN ADEQUATE ASSESSMENT OF TOTAL PNAH. COMBINED WITH OTHER APPROACHES, THIS MAY RESULT IN CONSIDERABLE COST REDUCTIONS FOR LONG-TERM BIOLOGICAL MONITORING PROGRAMS. CELLULAR PROLIFERATIVE DISORDERS, RESEMBLING NEOPLASTIC CONDITIONS IN VERTEBRATES, WERE FOUND IN MUSSELS WITH THE GREATEST PNAH CONCENTRATIONS. FURTHER STUDIES WILL BE NECESSARY TO DETERMINE THE SIGNIFICANCE OF THIS CORRELATION. THIS REPORT WAS SUBMITTED IN FULFILLMENT OF CONTRACT NO. R806224020 BY OREGON STATE UNIVERSITY, CORVALLIS, OREGON, UNDER THE SPONSORSHIP OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY. THIS REPORT COVERS THE PERIOD OCTOBER 1, 1978 TO NOVEMBER 30, 1980.

MIX, MICHAEL C., AND WILBUR P. BREESE. 1980. CELLULAR PROLIFERATIVE DISORDER IN OYSTERS (*OSTREA CHILENSIS*) FROM CHILOE, CHILE, SOUTH AMERICA. J. INVERTEBR. PATHOL. 36(1):123-124. (ERL,GB X252).

BEGINNING IN THE LATE 1960S AND THROUGH-OUT THE PAST DECADE, UNUSUAL, PERHAPS NEOPLASTIC, LARGE CELLS WITH RATHER CONSISTENT CHARACTERISTICS WERE DESCRIBED IN MUSSELS, CLAM, AND OYSTERS FROM SEVERAL BAYS IN THE UNITED STATES AND THE UNITED KINGDOM (M.C. MIX, J.W. HAWKES, AND A.K. SPARKS, J. INVERTEBR. PATHOL. 34, 41-56, 1979) THE LARGE, CHARACTERISTIC CELLS ARE THOUGHT BY MANY WORKERS TO BE ABNORMAL LEUKOCYTES OR LEUKOCYTE PRECURSORS (E.G., C.A. FARLEY AND A.K. SPARKS, BIBL. HAEMATOL. 36, 610-617, 1970). THIS NOTE DESCRIBES AN APPARENTLY IDENTICAL CONDITION IN *OSTREA CHILENSIS* FROM CHILE.

MIX, MICHAEL C., DIANE L. BUNTING, AND D.T. ABBOTT. 1979. PRELIMINARY STUDIES TO EVALUATE THE POTENTIAL OF USING EMBRYO AND LARVAL STAGES OF THE GOOSE BARNACLE, *POLLICIPES POLYMERUS* FOR MARINE BIOASSAYS. IN: PROCEEDINGS OF THE SECOND BIENNIAL CRUSTACEAN HEALTH WORKSHOP, TAMU-SG-79-114. D.H. LEWIS AND J.K. LEONG, EDITORS, TEXAS A & M UNIVERSITY, COLLEGE STATION, TX. PP. 361-381. (ERL,GB X166).

THE GENERAL PURPOSE OF THESE STUDIES WAS TO DETERMINE IF THE DEVELOPMENTAL AND LARVAL STAGES OF THE GOOSE BARNACLE, *POLLICIPES POLYMERUS* WOULD BE USEFUL ORGANISMS TO USE AS A MARINE BIOASSAY SYSTEM. DIFFERENT CULTURE SYSTEMS AND CULTURING CONDITIONS WERE DEVELOPED AND EVALUATED. WE DESIGNED A SIMPLE, INEXPENSIVE SYSTEM THAT CAN BE USED TO CULTURE FERTILE EGGS UNDER NORMAL LABORATORY CONDITIONS (ROOM TEMPERATURE AND AMBIENT LIGHT-DARK CYCLE). THE CULTURE MEDIUM CONSISTS OF INSTANT OCEAN SEA SALTS MIXED IN TAP WATER TO A SALINITY OF 28-30 PARTS PER THOUSAND. ANTIBIOTIC CONCENTRATIONS OF 10 MG/L SEAWATER OF STREPTOMYCIN SULFATE AND 10 MG/L SEAWATER OF PENICILLIN G ARE THEN ADDED TO THE ARTIFICIAL SEAWATER. AS A RESULT OF THESE AND OTHER STUDIES, IT SEEMS LIKELY THAT *P. POLYMERUS* MAY BE A VALUABLE BIOASSAY ORGANISM. MORE COMPLETE STUDIES, NECESSARY TO GATHER LARGE AMOUNTS OF DATA FOR DEVELOPING AND STATISTICALLY EVALUATING DIFFERENT CRITERIA TO DETERMINE DELETERIOUS EFFECTS, ARE REQUIRED BEFORE A FINAL JUDGEMENT CAN BE MADE ABOUT THE FUTURE USE OF *P. POLYMERUS* FOR BIOASSAYS.

MIX, MICHAEL C., JOYCE W. HAWKES, AND ALBERT K. SPARKS. 1979. OBSERVATIONS ON THE ULTRASTRUCTURE OF LARGE CELLS ASSOCIATED WITH PUTATIVE NEOPLASTIC DISORDERS OF MUSSELS, *MYTILUS EDULIS*, FROM YAQUINA BAY, OREGON. J. INVERTEBR. PATHOL. 34(1):41-56. (ERL,GB X152).

LARGE CELLS, GENERALLY THOUGHT TO BE ASSOCIATED WITH NEOPLASTIC DISORDERS IN BIVALVE MOLLUSKS, WERE STUDIED WITH THE ELECTRON MICROSCOPE. THE ATYPICAL CELLS HAD AN AVERAGE DIAMETER OF 15  $\mu$ M AND A NUCLEAR TO CYTOPLASMIC RATIO OF ABOUT 1-1.5. NUCLEI WERE EXTENSIVELY PLEOMORPHIC AND BIZARRE SHAPES WERE COMMON. NUCLEOLI WERE PROMINENT AND OFTEN MULTIPLE. IN THE CYTOPLASM OF THE LARGE CELLS, THERE WAS A WIDE RANGE OF VARIABILITY IN ANOMALOUS ORGANELLES. TWO CELL TYPES WERE ORIGINALLY THOUGHT TO EXIST; HOWEVER, IT IS NOW THOUGHT THAT THE TWO CELL TYPES REPRESENT THE TWO EXTREME MORPHOLOGICAL EXPRESSIONS OF A SINGLE CELL LINE. THEIR VARYING APPEARANCE IS CORRELATED WITH THE DENSITY OF RIBOSOMES AND ABUNDANCE OF CELLULAR ORGANELLES. THE LARGE *MYTILUS EDULIS* CELLS POSSESS MANY ULTRASTRUCTURAL PROPERTIES THAT ARE CHARACTERISTIC OF CERTAIN MALIGNANT VERTEBRATE CELLS. HOWEVER, ALTERNATIVE EXPLANATIONS FOR THEIR STRUCTURE AND FUNCTION ARE ALSO POSSIBLE.

MIX, MICHAEL C., SUSAN J. HEMINGWAY, AND RANDY L. SCHAFFER. 1982. BENZO(A)PYRENE CONCENTRATIONS IN SOMATIC AND GONAD TISSUES OF BAY MUSSELS, MYTILUS EDULIS. BULL. ENVIRON. CONTAM. TOXICOL. 28(1):46-51. (ERL,GB X425).

RECENT STUDIES HAVE DEMONSTRATED CLEARLY THAT POLYNUCLEAR AROMATIC HYDROCARBONS (PNAH) ARE UBIQUITOUS ENVIRONMENTAL CONTAMINANTS (NEFF 1979). BIVALVE MOLLUSCS, ESPECIALLY M. EDULIS, HAVE BEEN USED AS BIOLOGICAL MONITORS FOR EVALUATING LEVELS OF PNAH IN MARINE ECOSYSTEMS. MOST REPORTS HAVE BEEN LIMITED TO CONCENTRATIONS OF BENZO(A)PYRENE (BAP) IN MUSSELS (DUNN & SCHAFFER 1979).

BENZO(A)PYRENE, A KNOWN CARCINOGEN, HAS BEEN CONSIDERED TO BE A GENERAL INDICATOR COMPOUND FOR PNAH (DUNN 1980, BROWN ET AL. 1980). RESULTS FROM VARIOUS SHELL FISH MONITORING PROGRAMS TEND TO SUPPORT THE BELIEF THAT SHELLFISH CAN BE USEFUL BIOMONITORS OF THE MARINE ENVIRONMENT. HOWEVER, CERTAIN QUESTIONS ABOUT SEASONABILITY AND TISSUE STORAGE SITES REMAIN TO BE RESOLVED. WHILE SOME ATTEMPTS HAVE BEEN MADE TO DETERMINE TISSUE STORAGE SITES OF BAP IN SHELLFISH (LEE ET AL. 1978, COUCH ET AL. 1979), THE DATA ARE LIMITED. THE PURPOSES OF THE PRESENT STUDY WERE TO MEASURE BAP CONCENTRATIONS IN THE SOMATIC AND GONADAL TISSUES OF M. EDULIS AND DETERMINE WHETHER OR NOT VARIATIONS IN THOSE TWO TISSUE COMPARTMENTS COULD BE RELATED TO SEASONAL FLUCTUATIONS DESCRIBED PREVIOUSLY (MIX & SCHAFFER 1979).

MIX, MICHAEL C., RONALD T. RILEY, KEITH I. KING, STEVEN R. TRENHOLM, AND RANDY L. SCHAFFER. 1977. CHEMICAL CARCINOGENS IN THE MARINE ENVIRONMENT. BENZO(A)PYRENE IN ECONOMICALLY-IMPORTANT BIVALVE MOLLUSKS FROM OREGON ESTUARIES. IN: FATE AND EFFECTS OF PETROLEUM HYDROCARBONS IN MARINE ORGANISMS AND ECOSYSTEMS. DOUGLAS A. WOLFE, EDITOR, PERGAMON PRESS, NEW YORK, NY. PP. 421-431. (ERL,GB X147).

WE HAVE RECENTLY BEGUN TO STUDY LEVELS OF CARCINOGENIC POLYCYCLIC AROMATIC HYDROCARBONS THAT ARE PRESENT IN BIVALVE MOLLUSKS FROM OREGON'S ESTUARIES. BECAUSE OF MANY UNIQUE FEATURES IN THEIR LIFE HISTORY AND BIOLOGY, INDIGENOUS SHELLFISH ARE USEFUL FOR MONITORING THE MARINE ENVIRONMENT. IN THIS PAPER, WE DESCRIBE BENZO(X)PYRENE (BAP) LEVELS IN ECONOMICALLY-IMPORTANT SHELLFISH POPULATIONS FROM SEVERAL SITES IN FIVE OREGON BAYS. WE HAVE ASSAYED BAP LEVELS IN CLAMS (TRESUS CAPAX, SAXIDOMUS GIGANTEUS, MYA ARENARIA), MUSSELS (MYTILUS EDULIS) AND OYSTERS (CRASSOSTREA GIGAS) FROM TILLAMOOK, NETARTS, YAQUINA, ALSEA AND COOS BAYS. DETECTABLE LEVELS OF BAP WERE PRESENT IN BIVALVES FROM 38 OF THE 44 SAMPLING SITES. HIGH LEVELS (LESS THAN 15 NG/G) WERE PRESENT IN MUSSELS COLLECTED FROM THE NEWPORT BAYFRONT IN YAQUINA BAY AND FROM A MARINA IN TILLAMOOK BAY. SIGNIFICANT LEVELS (LESS THAN 5 NG/G) WERE PRESENT IN M. ARENARIA COLLECTED FROM AN AREA ADJACENT TO THE SHIPPING DOCKS IN COOS BAY.

MIX, MICHAEL C., AND RANDY L. SCHAFFER. 1979. BENZO(A)PYRENE CONCENTRATIONS IN MUSSELS (MYTILUS EDULIS) FROM YAQUINA BAY, OREGON DURING JUNE 1976 - MAY 1978. BULL. ENVIRON. CONTAM. TOXICOL. 23(4/5):677-684. (ERL,GB X148).

THE PURPOSES OF THIS STUDY WERE TO MEASURE BAP CONCENTRATIONS IN INDIGENOUS POPULATIONS OF MUSSELS FOR A TWO-YEAR PERIOD, DETERMINE SEASONAL FLUCTUATIONS IN BAP BODY BURDENS, AND ANALYZE FACTORS THAT MAY INFLUENCE TEMPORAL CONCENTRATION PATTERNS.

MIX, MICHAEL C., AND RANDY L. SCHAFFER. 1983. CONCENTRATIONS OF UNSUBSTITUTED POLYCYCLIC AROMATIC HYDROCARBONS IN SOFTSHELL CLAMS FROM COOS BAY, OREGON, USA. MAR. POLLUT. BULL. 14(3):94-97. (ERL,GB X388).

CONCENTRATIONS OF BENZO(A)PYRENE (BAP) WERE MEASURED IN SUBPOPULATIONS OF SOFTSHELL CLAMS, MYA ARENARIA, FROM FOUR INTERTIDAL SITES IN COOS BAY FROM JUNE 1976 TO JUNE 1978. SUBSEQUENTLY, CONCENTRATIONS OF 15 UNSUBSTITUTED POLYNUCLEAR AROMATIC HYDROCARBONS (PNAH) WERE DETERMINED IN TWO SUBPOPULATIONS FROM SEPTEMBER 1978 TO AUGUST 1979. THERE WERE SIGNIFICANT DIFFERENCES BETWEEN BAP CONCENTRATIONS IN CLAMS FROM THE FOUR SITES. FOR THE TWO-YEAR PERIOD, THEY WERE HIGHEST IN CLAMS INHABITING AREAS ADJACENT TO THE INDUSTRIALIZED BAYFRONT AND LOWEST IN CLAMS INHABITING MORE REMOTE AREAS. THERE WERE NO SIGNIFICANT SEASONAL VARIATIONS IN BAP CONCENTRATIONS DURING THIS PERIOD. DURING THE 1978-79 STUDY, THE AVERAGE TOTAL PNAH CONCENTRATION IN CLAMS FROM THE BAYFRONT AREA WAS 555.1 UG KG(-1) COMPARED TO 76.3 UG KG(-1) FOR CLAMS FROM A MORE REMOTE ENVIRONMENT. IN GENERAL, PNAH CONCENTRATIONS WERE LOWEST IN THE FALL-WINTER AND HIGHEST DURING THE SPRING-SUMMER.

MIX, MICHAEL C., AND RANDY L. SCHAFFER. 1983. CONCENTRATIONS OF UNSUBSTITUTED POLYNUCLEAR AROMATIC HYDROCARBONS IN BAY MUSSELS (MYTILUS EDULIS) FROM OREGON, USA. MAR. ENVIRON. RES. 9(4):193-209. (ERL,GB X397).

CONCENTRATION OF FIFTEEN UNSUBSTITUTED POLYNUCLEAR AROMATIC HYDROCARBONS (PNAH) WERE MEASURED IN MYTILUS EDULIS FROM TWO SITES IN YAQUINA BAY, OREGON, USA, DURING 1979-1980. THERE WERE SIGNIFICANT DIFFERENCES IN PNAH LEVELS BETWEEN THE TWO POPULATIONS. THE AVERAGE TOTAL CONCENTRATION IN MUSSELS INHABITING THE MORE INDUSTRIALIZED BAYFRONT WAS 986 X 2 UG/KG COMPARED WITH 273 X 9 UG/KG IN MUSSELS FROM A MORE REMOTE SITE ACROSS THE BAY. SUBSTANTIAL DIFFERENCES WERE FOUND IN THE CONCENTRATIONS OF DIFFERENT PNAH IN M. EDULIS EXAMINED DURING THIS STUDY. THE SMALLER, MORE WATER SOLUBLE, COMPOUNDS WERE CONCENTRATED TO ONE OR TWO ORDERS OF MAGNITUDE ABOVE THE LARGER, LESS SOLUBLE PNAH.

MIX, MICHAEL C., RANDY L. SCHAFFER, AND SUSAN J. HEMINGWAY. 1981. POLYNUCLEAR AROMATIC HYDROCARBONS IN BIVALVE MOLLUSKS IN BAY MUSSELS (MYTILUS EDULIS) FROM OREGON. IN: PHYLETIC APPROACHES TO CANCER: PROCEEDINGS OF THE 11TH INTERNATIONAL SYMPOSIUM OF THE PRINCESS TAKAMATSU CANCER RESEARCH FUND, TOKYO, 1980. CLYDE J. DAWE, EDITOR, JAPAN SCI. SOC. PRESS, TOKYO. PP. 167-177. (ERL,GB X355).

TOTAL CONCENTRATIONS OF 15 UNSUBSTITUTED POLYNUCLEAR AROMATIC HYDROCARBONS (PNAH), INCLUDING PHENANTHRENE, FLUORANTHENE, PYRENE, BENZO(C)PHENANTHRENE, TRIPHENYLENE, BENZ(A)ANTHRACENE, BENZO(A)PYRENE (BP), DIBEN(A,H)ANTHRACENE, BENZO(G,H,I)PERYLENE, INDENO(1,2,3-C,D)PYRENE, AND CORONENE, WERE MEASURED MONTHLY IN MYTILUS EDULIS POPULATIONS FROM 2 SITES ON YAQUINA BAY, OREGON. PNAH CONCENTRATIONS FROM SITE Y1M RANGED FROM 141-401 UG/KG WHILE THOSE FROM SITE Y2M WERE HIGHER, 673-1,324 UG/KG. SEASONAL VARIATIONS WERE EVIDENT IN MUSSELS FROM Y2M BUT NOT Y1M; HIGHEST PNAH CONCENTRATIONS WERE PRESENT DURING JANUARY-MARCH.

MIX, MICHAEL C., RANDY L. SCHAFER, AND DAVID Y. LATOUCHE. 1980. ENVIRONMENTAL CONTAMINANTS AND THE OCCURRENCE OF CERTAIN PATHOLOGICAL CONDITIONS (ABSTRACT). IN: PROCEEDINGS OF THE ANNUAL MEETING OF THE SOCIETY OF INVERTEBRATE PATHOLOGY. (ERL,GB X259).

DURING THE PAST DECADE, THERE WERE SEVERAL REPORTS OF HISTOPATHOLOGICAL DISORDERS IN BIVALVE MOLLUSKS THAT WERE TENTATIVELY LINKED WITH INCREASED LEVELS OF ENVIRONMENTAL POLLUTANTS, WERE ANALYZED USING REVERSE SOLUTION. MORE RECENTLY, "MUSSEL WATCH" PROGRAMS HAVE UTILIZED SHELLFISH AS BIOMONITORS FOR MEASURING LEVELS OF SPECIFIC ENVIRONMENTAL CONTAMINANTS. OUR RESEARCH HAS BEEN CONCERNED WITH A POSSIBLE CORRELATION BETWEEN BODY BURDENS OF CARCINOGENIC POLYNUCLEAR AROMATIC HYDROCARBONS (PNAH) AND PROLIFERATIVE DISORDERS IN M. EDULIS AND OTHER BIVALVE SHELLFISH. WE HAVE RECENTLY EXTENDED OUR STUDIES TO INCLUDE METALS AND HAVE ALSO INITIATED STUDIES DESIGNED TO TEST THE VALIDITY OF CERTAIN ASSUMPTIONS AND PRINCIPLES GENERATED FROM EARLIER MONITORING STUDIES. EXTRACTS OF MUSSELS, CLAMS AND SEDIMENTS FROM OREGON ESTUARIES WERE ANALYZED FOR PNAH BY METHODS DEVELOPED IN OUR LABORATORY (A MODIFICATION OF DUNN'S TECHNIQUES). SAMPLES WERE PREPARED BY BASIC DIGESTION, LIQUID-LIQUID EXTRACTION, COLUMN CHROMATOGRAPHY ON FLORISIL, DMSO EXTRACTION AND COLUMN CHROMATOGRAPHY ON SEPHADEX LH-20 PRIOR TO ASSAY. EIGHTEEN PNAH, INCLUDING 12 EPA PRIORITY POLLUTANTS, WERE ANALYZED USING REVERSE PHASE LIQUID CHROMATOGRAPHY (HPLC) WITH UV AND FLUORESCENT DETECTION. LEVELS OF MN, NI, CU, ZN, CD, U AND AL WERE DETERMINED WITH FLAME ATOMIC ABSORPTION AND/OR NEUTRON ACTIVATION ANALYSIS. WE HAVE IDENTIFIED POTENTIAL RELATIONSHIPS BETWEEN PATHOLOGICAL CONDITIONS AND CONCENTRATIONS OF POLLUTANTS IN BIVALVE MOLLUSKS. WE HAVE ALSO FOUND THAT FLAWS IN CERTAIN ASSUMPTIONS USED IN OTHER STUDIES WILL NECESSITATE A CRITICAL EXAMINATION OF MONITORING PROCEDURES.

MIX, MICHAEL C., STEVE R. TRENHOLM, AND KEITH I. KING. 1979. BENZO(A)PYRENE BODY BURDENS AND THE PREVALENCE OF PROLIFERATIVE DISORDERS IN MUSSELS (MYTILUS EDULIS) IN OREGON. IN: ANIMALS AS MONITORS OF ENVIRONMENTAL POLLUTANTS. NATIONAL ACADEMY OF SCIENCES, WASHINGTON, DC. PP. 52-62. (ERL,GB X145).

LEVELS OF BENZO(A)PYRENE (BP) IN ECONOMICALLY IMPORTANT SHELLFISH FROM OREGON ESTUARIES WERE STUDIED. SHELLFISH FROM THE MORE POLLUTED AREAS OF YAQUINA BAY, OREG. (SITES Y2M, Y4M, FIGURE 1), CONTAINED SIGNIFICANT LEVELS OF BP (LESS THAN 15 UG/KG), WHILE THOSE FROM CLEANER AREAS (SITES Y1M, Y12M, FIGURE 1) CONTAINED VERY LOW OR UNDETECTABLE LEVELS OF BP. HISTOLOGICAL STUDIES HAVE SHOWN THAT NEARLY 10% OF THE MUSSELS WITH SIGNIFICANT BP BODY BURDENS HAVE APPARENT PROLIFERATIVE DISORDERS COMPARED TO NONE FOR THOSE SAMPLED FROM CLEAN SITES.

MORENO, MARK, AND B.J. MARTIN. 1979. EMBRYOLOGIC DEVELOPMENT OF THE SHEEPSHEAD MINNOW (CYPRINODON VARIEGATUS) (ABSTRACT). J. MISS. ACAD. SCI. XXIV:(SUPPLEMENT116. (ERL,GB X176).

SEXUALLY MATURE SPECIMENS COLLECTED FROM THE MISSISSIPPI GULF COAST WERE MAINTAINED IN AQUARIA AT 15-20% SALINITY AND 30 DEGREES CELSIUS. THE PHOTOPERIOD WAS MAINTAINED AT 14 HOURS LIGHT AND 10 HOURS DARK THROUGHOUT THE EXPERIMENT. EGGS WERE OBTAINED BY TEMPERATURE INDUCED, OR HUMAN CHORIONIC GONADOTROPIN INDUCED SPAWNING. DATA INCLUDE MECHANISMS OF: FERTILIZATION, BLASTULATION, GASTRULATION, EPIBOLY, AND ORGANOGENESIS. THIS STUDY SUGGESTS A POSSIBLE SIGNIFICANCE OF CERTAIN "WEDGE-LIKE" CELLULAR STRUCTURES SEEN IN EARLY CLEAVAGE.

PATTON, JOHN S., AND JOHN A. COUCH. IN PRESS. CAN TISSUE ANOMALIES THAT OCCUR IN MARINE FISH IMPLICATE SPECIFIC POLLUTANT CHEMICALS?. IN: PROCEEDINGS OF CONFERENCE ON MEANINGFUL MEASURES OF MARINE POLLUTION EFFECTS, APRIL 26-29, 1982, PENSACOLA BEACH, FL. U.S. NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION. (ERL,GB 474).

THE ADVANTAGE OF USING TISSUE ABNORMALITIES IN WILD FISH AS A MEASURE OF FISH HEALTH IS THAT THE ABNORMALITY, UNLIKE SENSITIVE BIOCHEMICAL ANOMALIES, CANNOT BE SAID TO HAVE OCCURRED DURING CAPTURE OR TRANSPORT TO THE LAB. IT USUALLY TAKES HOURS, DAYS, WEEKS, AND SOMETIMES EVEN MONTHS FOR ABNORMAL TISSUE PATHOLOGIES TO DEVELOP. THE RESEARCHER CAN BE CONFIDENT THAT SOME FACTOR IN THE FIELD CAUSED THE ABNORMALITY. WHEN AN ABNORMAL FISH IS CAPTURED, LOGICAL QUESTIONS APPEAR AT FOUR DIFFERENT LEVELS: 1) WHAT IS THE STRUCTURE OF MORPHOLOGY OF THE ABNORMALITY? MANY SCHOLARLY ARTICLES BY HISTOPATHOLOGISTS DESCRIBE IN DETAIL TISSUE ANOMALIES OBSERVED IN FIELD SPECIMENS. AT THIS LEVEL THE FOCUS IS ON THE PATHOLOGY ITSELF. 2) WHAT IS THE INCIDENCE OF THE PATHOLOGY IN THE POPULATION? HOW MANY ARE AFFLICTED, OLD OR YOUNG, MALE OR FEMALE? HERE THE FOCUS IS ON THE SPECIES POPULATION. 3) CAN THE INCIDENCE OF A FISH DISEASE BE LINKED TO ENVIRONMENTAL POLLUTION? HERE THE FOCUS IS ON CORRELATING PATHOLOGY WITH POLLUTION. 4) WHAT FACTOR OR FACTORS (CHEMICAL, PHYSICAL, AND/OR BIOLOGICAL) CAUSED THE PATHOLOGY IN THE POLLUTED WATERS? THIS IS PROBABLY THE MOST DIFFICULT QUESTION TO ANSWER AND THE SUBJECT OF THIS PAPER. ANSWERS TO THE FIRST THREE QUESTIONS MUST BE FOUND BEFORE ATTEMPTS CAN BE MADE AT ANSWERING THE FOURTH. IF A SPECIFIC FISH DISEASE CAN BE LINKED TO A SPECIFIC XENOBIOTIC, THEN A ANOTHER TIER OF QUESTIONS ARISES. 5) WHAT IS THE SIGNIFICANCE OF THIS TO HUMAN HEALTH AND WELL BEING? IS A FOOD SOURCE DIMINISHED, ARE HUMANS INGESTING FISH CONTAINING TOXIC CHEMICALS? WHAT IS THE AESTHETIC/ECONOMIC COST VERSUS THE INDUSTRIAL/ECONOMIC GAIN OF HAVING CONTINUED POLLUTION? ANSWERS TO THESE QUESTIONS ARE BEYOND THE SCOPE OF THIS PAPER. THIS PAPER WILL FOCUS ON THE QUESTION - ARE THERE POLLUTANT SPECIFIC PATHOLOGIES IN MARINE FISH?

PORTER, RONALD C., AND B.J. MARTIN. 1980. HISTOLOGY OF THE POST-PHARYNGEAL DIGESTIVE TRACT OF THE SHEEPSHEAD MINNOW, CYPRINODON VARIEGATUS (ABSTRACT). J. MISS. ACAD. SCI. 25(SUPPL):122. (ERL,GB X196).

CYPRINODON VARIEGATUS IS A COMMON CYPRINODONTIFORM MINNOW OF THE EAST COAST AND GULF OF MEXICO. THE DIGESTIVE TRACT WAS STUDIED BOTH GROSSLY AND MICROSCOPICALLY. IT IS DIVIDED INTO ESOPHAGUS, INTESTINAL SWELLING, INTESTINE PROPER, AND RECTUM, EACH REGION HAVING A MUCOSA, SUBMUCOSA, MUSCULARIS, AND SEROSA. TISSUES FOR MICROSCOPY WERE ROUTINELY STAINED WITH HEMATOXYLIN AND EOSIN, MALLORY'S TRIPLE STAIN, OR PAS AND EXAMINED USING BRIGHT FIELD AND PHASE CONTRAST MICROSCOPY. CELLULAR AND NUCLEAR DIMENSIONS OF COLUMNAR EPITHELIAL CELLS, GRANULAR CELLS, AND MUCUS-SECRETING CELLS WERE DETERMINED USING AN OCULAR MICROMETER.

RILEY, R.T. 1979. STIMULATORY EFFECT OF NAPHTHALENE ON GLUCOSE TRANSPORT IN THE OYSTER (ABSTRACT). PHARMACOL. 21:251. (ERL,GB X257).

IT HAS BEEN DEMONSTRATED THAT THE CARBON FLUX IN BIVALVES IS STIMULATED BY LOW LEVELS OF NAPHTHALENE. THE EFFECT OF NAPHTHALENE ON THE GLUCOSE TRANSPORT SYSTEM WAS STUDIED UTILIZING C14-ALPHA-METHYLGLUCOSIDE (MGP) AND H3-INSULIN. MGP TRANSPORT FOLLOWS MICHAELIS-MENTON KINETICS AND IS COMPETITELY INHIBITED BY ALPHA-D-GLUCOSE. DINITROPHENOL, PENTACHLOROPHENOL, CARBONYL-CYANIDE AND DICYCLOHEXYLCARBODIIMIDE ALL INHIBIT TRANSPORT. QUABAIN AND IODOACETATE HAVE NO EFFECT. NAPHTHALENE STIMULATES TRANSPORT. INHIBITORS STIMULATE DIFFUSIONAL LEAKAGE OF MGP. TRANSPORT SYSTEMS IN THE GILL MAY FUNCTION TO MAINTAIN INTRACELLULAR OSMOTIC BALANCE. THE MECHANISM BY WHICH NAPHTHALENE STIMULATES GLUCOSE TRANSPORT IS NOT KNOWN. HOWEVER, IT IS HYPOTHEZIZED THAT THE STIMULATORY EFFECT IS A RESULT OF ALTERATIONS IN LIPID-PROTEIN INTERACTIONS WITHIN THE LIPID BILAYER. A COROLLARY TO THIS IS THAT AT HIGHER TEMPERATURE THE MEMBRANE WILL BECOME LEAKY DUE TO INCREASED DISORDER OF LIPID PACKING. WHEN LEAKAGE BECOMES GREAT THE PART OF MGP ACCUMULATION WILL DROP. NAPHTHALENE LOADING SHOULD REDUCE THE TEMPERATURE AT WHICH LEAKAGE BEGINS. THE EFFECT OF TEMPERATURE ON MGP LEAKAGE IN NAPHTHALENE LOADED GILLS IS CURRENTLY BEING INVESTIGATED.

RILEY, R.T., AND M.C. MIX. 1981. EFFECTS OF NAPHTHALENE ON GLUCOSE METABOLISM IN THE EUROPEAN FLAT OYSTER, OSTREA EDULIS. COMP. BIOCHEM. PHYSIOL. C COMP. PHARMACOL. 70C(1):13-20. (ERL,GB X256).

(1). THE POOL SIZES AND REDISTRIBUTION OF C-14 LABEL FROM DEU-C-14-GLUCOSE INTO ETHANOL INSOLUBLE POLYSACCHARIDES, TOTAL PROTEIN, TOTAL POLAR LIPIDS, TOTAL NEUTRAL LIPIDS, FREE ALANINE, ASPARTATE, GLUTAMATE AND TOTAL ORGANIC ACIDS WERE DETERMINED FOR CONTROL AND NAPHTHALENE-TREATED OYSTERS OSTREA EDULIS. (2). THE FOLLOWING EFFECTS WERE ATTRIBUTED TO NAPHTHALENE TREATMENT: A DECREASE IN THE PERCENTAGE OF PROTEIN AND POLAR LIPID; AN INCREASE IN THE TOTAL AMINO ACIDS (SUM OF ALANINE, ASPARTATE AND GLUTAMATE); AN INCREASE IN ORGANIC ACIDS; AND INCREASE IN THE MEAN SPECIFIC ACTIVITY (GEOMETRIC) FOR ALL MEASURED POOLS. (3). THESE RESULTS SUGGESTED THAT NAPHTHALENE STIMULATED PROTEIN AND POLAR LIPID CATABOLISM, WHILE SIMULTANEOUSLY STIMULATING THE FLOW OF GLUCOSE-CARBON INTO ALL MEASURED POOLS.

RILEY, R.T., M.C. MIX, R.L. SCHAFFER, AND D.L. BUNTING. 1981. UPTAKE AND ACCUMULATION OF NAPHTHALENE BY THE OYSTER OSTREA EDULIS, IN A FLOW THROUGH SYSTEM. MAR. BIOL. 61(4):267-276. (ERL,GB X255).

A FLOW-THROUGH SYSTEM WAS USED TO FOLLOW NAPHTHALENE AND NAPHTHALENE METABOLITE ACCUMULATION IN THE SEAWATER AND IN THE TISSUE OF THE OYSTER OSTREA EDULIS. AFTER 72 H, 82.5% OF THE NAPHTHALENE CARBON WAS RECOVERED FROM THE SYSTEM. GLUCOSE WAS ADDED TO SEAWATER TO STIMULATE THE PATHWAYS OF GLUCOSE METABOLISM IN THE OYSTERS. STREPTOMYCIN (100 PPM) REDUCED MICROBIAL OXIDATION OF NAPHTHALENE AND GLUCOSE, AND REDUCED BACTERIAL GROWTH. HOWEVER, EVEN IN THE PRESENCE OF STREPTOMYCIN, MICROBIAL OXIDATION OF NAPHTHALENE WAS CONSIDERABLE. THE MAIN OXIDATION PRODUCT RECOVERED FROM SEAWATER WAS  $^{14}\text{CO}_2$ . RADIOACTIVITY WAS ALSO ASSOCIATED WITH COMPOUNDS WHICH SEPARATED BY TLC WITH 2- AND 1- NAPHTHOL. THE PATTERN OF NAPHTHALENE UPTAKE AND ACCUMULATION IN OYSTER TISSUES WAS RELATIVELY CONSTANT AFTER ONLY A FEW HOURS OF EXPOSURE TO NAPHTHALENE. THE POTENTIAL OF TISSUES TO ACCUMULATE NAPHTHALENE WAS SHOWN TO BE A FUNCTION OF MULTIPLE VARIABLES SUCH AS NUTRITIONAL STATE, LIPID CONCENTRATION, LENGTH OF EXPOSURE TO NAPHTHALENE, AND THE EXTERNAL NAPHTHALENE CONCENTRATION. CARBON-14-LABELED METABOLITES DERIVED FROM  $^{14}\text{C}$ -NAPHTHALENE WERE CONSISTENTLY RECOVERED FROM DIGESTS OF THE OYSTER TISSUES. NON- $\text{CO}_2$  ALKALINE-SOLUBLE SUBSTANCES WERE THE PRIMARY METABOLITES. HEXANE-EXTRACTABLE SUBSTANCES, WHICH SEPARATED BY TLC WITH KNOWN STANDARDS OF 2- AND 1- NAPHTHOL, WERE CONSISTENTLY RECOVERED FROM SEAWATER AND TISSUE DIGESTS. IT WAS NOT POSSIBLE TO CONCLUDE THAT THESE METABOLITES WERE A RESULT OF NAPHTHALENE METABOLISM BY OYSTER ENZYME SYSTEMS.

RILEY, RONALD T., AND MICHAEL C. MIX. 1980. THIN-LAYER SEPARATION OF CITRIC ACID CYCLE INTERMEDIATES, LACTIC ACID, AND THE AMINO ACID TAURINE. J. CHROMATOGR. 189(2):286-288. (ERL,GB X146).

THE IN VIVO REDISTRIBUTION OF THE C-LABEL FROM D-CU- $^{14}\text{C}$  GLUCOSE HAS BEEN STUDIED IN THE GILL TISSUE OF MARINE MOLLUSCS IN THIS LABORATORY. ONE PHASE OF THE STUDY REQUIRED THE SEPARATION OF ORGANIC ACIDS ISOLATED BY AN ION-EXCHANGE TECHNIQUE. THE METHOD OF SEPARATION NEEDED TO SEPARATE CLEANLY THE CITRIC ACID CYCLE INTERMEDIATES, LACTIC ACID AND THE AMINO ACID TAURINE. THE SEPARATION TECHNIQUE NEEDED TO BE INEXPENSIVE, CAPABLE OF HANDLING A FAIRLY LARGE SAMPLE VOLUME (10-20  $\mu\text{L}$ ), RELATIVELY RAPID, AND NEEDED TO ALLOW FOR THE EASY AND QUANTITATIVE RECOVERY OF SEPARATED  $^{14}\text{C}$ -LABELED COMPOUNDS. SEVERAL THIN-LAYER METHODS FOR SEPARATING ORGANIC ACIDS HAVE BEEN DESCRIBED PREVIOUSLY(1-5). ONE-DIMENSIONAL METHODS SUFFER FROM LACK OF RESOLUTION (1-3). TWO-DIMENSIONAL METHODS WHICH UTILIZED CRYSTALLINE CELLULOSE LAYERS (4) WERE DIFFICULT TO HANDLE AND EXHIBITED CONSIDERABLE TAILING. SEPARATION OF UNDERIVATIZED ACIDS ON SILICA GEL LAYERS RESULTED IN CROWDING OF ACIDS NEAR THE ORIGIN (5). ALSO, SAMPLE REMOVAL FROM SILICA GEL LAYERS CAN BE EXCEEDINGLY TEDIOUS. THIN-LAYER SEPARATION METHODS HAVE ALSO BEEN DESCRIBED WHICH MADE USE OF SILICA GEL-CELLULOSE MIXED LAYERS (2,3,6). THIS PAPER DESCRIBES A TWO-DIMENSIONAL MIXED-LAYER METHOD FOR SEPARATING CITRIC ACID CYCLE INTERMEDIATES, LACTIC ACID AND THE AMINO ACID TAURINE. THE METHOD CLEANLY SEPARATES ALL CITRIC ACID CYCLE INTERMEDIATES TESTED, EXCEPTING CITRIC ACID AND ISOCITRIC ACID. THE SOLVENTS ARE INEXPENSIVE AND THE METHOD ALLOWS FOR THE RAPID AND QUANTITATIVE REMOVAL OF ISOLATED  $^{14}\text{C}$ -LABELED ACIDS BY UTILIZING A SIMPLE CELLULOSE ACETATE STRIPPING MIXTURE(7).

RILEY, RONALD T., AND MICHAEL C. MIX. 1981. ION-EXCHANGE TECHNIQUE FOR CONCENTRATING AMMONIA FROM SMALL VOLUMES OF SEAWATER. MAR. CHEM. 10(2):159-160. (ERL,GB X205).

AN ION-EXCHANGE TECHNIQUE WAS USED TO CONCENTRATE AMMONIA FROM SEAWATER. PRECIPITATION OF BIVALENT CATIONS, PRIOR TO CONCENTRATION, REDUCED THE VARIABILITY OF AMMONIA RECOVERY FROM THE ION-EXCHANGE COLUMN AND LENGTHENED COLUMN LIFE. ANALYSIS OF THE ELUATE WAS BY THE PHENOLHYPOCHLORITE REACTION. THE METHOD WAS DESIGNED FOR USE WITH SMALL SEAWATER SAMPLES (LESS THAN 10 ML) AND HAS THE ADVANTAGE THAT IT CAN BE ADAPTED FOR USE WITH SMALL VOLUMES OF SEAWATER WITH NO LOSS IN SENSITIVITY. IN A 10 ML SEAWATER EXAMPLE  $\text{NH}_3$ -N CONCENTRATIONS OF 10-150  $\mu\text{g L}^{-1}$  WERE ACCURATELY DETERMINED.

RILEY, RONALD THOMAS. 1978. EFFECTS OF CHEMICAL PERTURBATION BY NAPHTHALENE ON GLUCOSE METABOLISM IN THE EUROPEAN FLAT OYSTER (*OSTREA EDULIS*): AN IN VIVO KINETIC. PH.D. DISSERTATION. OREGON STATE UNIVERSITY, CORVALLIS, OR. 173P. (ERL,GB X053).

THE PURPOSE OF THIS STUDY WAS TO EVALUATE THE POTENTIAL OF UTILIZING AN IN VIVO KINETIC ANALYSIS OF GLUCOSE METABOLISM AS AN APPROACH FOR ASSESSING THE EFFECTS OF CHEMICAL POLLUTANTS ON BIVALVE MOLLUSKS. THE RESULTS OF THE PRESENT STUDY SUGGEST THAT THIS APPROACH COULD BE A VALUABLE TOOL FOR EVALUATING THE LOW LEVEL EFFECTS OF CHEMICAL PERTURBANTS ON MARINE ORGANISMS. THERE WERE THREE TYPES OF EFFECTS EVIDENT: EFFECTS ATTRIBUTABLE TO STARVATION, EFFECTS ATTRIBUTABLE TO EITHER REDUCED OXYGEN CONCENTRATIONS IN THE FLOW-THROUGH SYSTEM OR DIFFERENCE IN THE GLUCOSE CONCENTRATIONS IN THE FLOW-THROUGH SYSTEM AND GLUCOSE INCUBATION VESSELS, AND EFFECTS DUE TO THE NAPHTHALENE TREATMENT.

SCHNEIDER, S.R., J.D. HENDRICKS, G.H. CONSTANTINE, AND R.E. LARSON. 1980. TOBRAMYCIN NEPHROTOXICITY AND LETHALITY IN COHO SALMON. TOXICOL. APPL. PHARMACOL. 54(3):399-404. (ERL,GB X350).

TREATMENT OF *YERSINIA RUCKERI*-INFECTED JUVENILE COHO SALMON WITH TOBRAMYCIN (TBM) REVEALED SIGNIFICANT TOXICITY OF THE DRUG TO THESE FISH. IN A GROUP OF FISH RECEIVING ONLY 5 MG/KG/DAY A CUMULATIVE MORTALITY OF 100% WAS OBSERVED IN 21 DAYS. TO VERIFY THE SITE OF TOXICITY, A SECOND STUDY WAS CONDUCTED IN ORDER TO HISTOLOGICALLY EVALUATE SPECIFIC TISSUES AND TO DETERMINE DOSE-RESPONSE CHARACTERISTICS. TBM PRODUCED NEPHROTOXICITY IN JUVENILE COHO SALMON AT DOSAGES ONLY HALF AS GREAT AS THOSE REQUIRED FOR AN EQUIVALENT EFFECT IN MAMMALS AND DID SO OVER A MUCH SHORTER TREATMENT COURSE. HISTOLOGICAL EXAMINATION REVEALED MODERATE TO COMPLETE PROXIMAL TUBULE NECROSIS AT 7.5 MG/KG EVERY OTHER DAY FOR 5 DAYS. LETHALITY OCCURRED AT DOSAGES AS LOW AS 2 MG/KG/DAY FOR 12 DAYS. THE DATA APPEAR TO INDICATE THAT SALMON MAY BE A POTENTIAL MODEL FOR STUDYING THE NEPHROTOXIC POTENTIAL OF CHEMICALS.

SCHOOR, W. PETER. IN PRESS. EXPOSURE OF FISHES TO BENZO(A)PYRENE AND SOME ASPECTS OF ANALYSIS OF METABOLITES. IN: PROCEEDINGS OF THE SYMPOSIUM ON THE USE OF SMALL FISH SPECIES IN CARCINOGENICITY TESTING, BETHESDA, MARYLAND, DECEMBER 8-10, 1981. U.S. NATIONAL CANCER INSTITUTE. (ERL,GB 454).

THE DISPOSITION OF BENZO(A)PYRENE [B(A)P] IN MOST ANIMAL SPECIES DEPENDS LARGELY ON THE EFFECT THAT THE MIXED FUNCTION OXYGENASE (MFO) AND TRANSFERASE SYSTEMS EXERT ON IT. SINCE THESE ENZYMES ARE INDUCIBLE BY COMPOUNDS SUCH AS PHENOBARBITAL (PB) AND 3-METHYLCHOLANTHRENE (3-MC), MUCH EFFORT WAS SPENT TO DETERMINE THEIR EFFECTS ON THE ENZYME SYSTEMS PRESENT IN SOME AQUATIC SPECIES. IN THE SPECIES TESTED SO FAR (MULLET, SEA CATFISH, AND KILLIFISH), INDUCTION WAS FOUND WHEN THE INDUCER WAS ADMINISTERED INTRAPERITONEALLY. FLOW-THROUGH EXPOSURE TO PB ALSO INDUCED MFO ACTIVITY IN MULLET AND KILLIFISH. MFO ACTIVITY WAS DETERMINED USING B(A)P AS SUBSTRATE AND THE RESULTING METABOLITES HAVE BEEN SEPARATED. THE PROBLEMS ASSOCIATED WITH THESE DETERMINATIONS ARE DISCUSSED IN LIGHT OF USING DATA ON AN INTER-LABORATORY BASIS.

SCHOOR, W. PETER, AND JOHN A. COUCH. 1979. CORRELATION OF MIXED-FUNCTION OXIDASE ACTIVITY WITH ULTRASTRUCTURAL CHANGES IN THE LIVER OF A MARINE FISH. CANCER BIOCHEM. BIOPHYS. 4(2):95-103. (ERL,GB 382).

SPECIMENS OF MULLET (MUGIL CEPHALUS), A MARINE FISH, WERE GIVEN SINGLE DOSES OF 3-METHYLCHOLANTHRENE INTRAPERITONEALLY AND THE ACTIVITY OF THE MICROSOMAL MIXED-FUNCTION OXYGENASE SYSTEM IN THE LIVER WAS MEASURED BY THE METABOLISM OF BENZO(A)PYRENE. THE ENZYME SYSTEM WAS FOUND TO BE INDUCIBLE WITH CONCOMITANT ULTRASTRUCTURAL CHANGES IN THE HEPATOCYTES. THE SPECIFIC ACTIVITY AND THE METABOLIC PROFILE APPROXIMATE THOSE OF THE RAT.

SCHOOR, W. PETER, AND ELSAYED ELNENAAY. 1980. METABOLITES OF BENZO(A)PYRENE FROM MULLET (MUGIL CEPHALUS): PROPERTIES AND DETECTION (ABSTRACT). PRESENTED AT THE FLORIDA SECTION OF THE AMERICAN CHEMICAL SOCIETY, TAMPA, FL, MAY 9, 1980. (ERL,GB 408).

INDIVIDUAL METABOLITES OF BENZO(A)PYRENE WERE SEPARATED BY HIGH PRESSURE LIQUID CHROMATOGRAPHY WITH METHANOL/WATER GRADIENTS. EXCITATION AND EMISSION SPECTRA WERE OBTAINED FOR EACH PEAK AFTER STOPPING THE HPLC FLOW AND COMPARED TO THOSE OF PURE STANDARDS. ALL TWELVE PHENOLS OF BENZO(A)PYRENE SHOWED DISTINCTLY DIFFERENT EXCITATION SPECTRA WHILE SHIFTS IN THE EMISSION SPECTRA WERE NOT UNIQUELY DIFFERENT. THE PHENOXIDES DID NOT YIELD DISTINCT SPECTRA. THE QUINONES AS WELL AS THE DIOLS SHOWED DIFFERING SENSITIVITIES TOWARDS LIGHT. CERTAIN REVERSE PHASE COLUMNS APPEAR TO HAVE THE TENDENCY TO REACT WITH PHENOLS CAUSING EITHER BINDING OR OTHER CATALYZED REACTIONS.

SCHOOOR, W. PETER, AND MEERA SRIVASTAVA. 1983. EFFECTS OF TRICHLOROPROPENE OXIDE ON THE METABOLISM OF BENZO(A)PYRENE BY 3-METHYLCHOLANTHRENE- AND PHENOBARBITAL-TREATED MULLET (MUGIL CEPHALUS), A MARINE FISH (ABSTRACT). IN: PROGRAM AND ABSTRACTS OF FIRST INTERNATIONAL SYMPOSIUM ON FOREIGN COMPOUND METABOLISM, OCT. 30 THRU NOVEMBER 4, 1983, WEST PALM BEACH, FLORIDA. (ERL,GB 490).

MARINE FISH, MULLET (MUGIL CEPHALUS), WERE TREATED WITH 3-METHYLCHOLANTHRENE (3-MC) AND PHENOBARBITAL (PB) BY INTRAPERITONEAL INJECTION, AND THE EFFECTS OF TRICHLOROPROPENE OXIDE (TCPO), AN INHIBITOR OF EPOXIDE HYDRATASE ACTIVITY, ON THE METABOLISM OF BENZO(A)PYRENE (BAP) BY ISOLATED LIVER MICROSOMES WERE EVALUATED. THE MOST SIGNIFICANT EFFECT FOUND WAS AN INCREASE IN THE OXIDATION OF BAP AT THE BAY REGION (POSITION 9 AND 10) IN FISH WHICH WERE PRETREATED WITH 3-MC AND PB. NO SIGNIFICANT DIFFERENCES WERE FOUND IN THE METABOLIC PATTERNS OF 3-MC- AND PB-TREATED FISH. WHEN METABOLITE PATTERNS OF THE DIHYDRODIOLS IN THE PRESENCE AND ABSENCE OF TCPO WERE COMPARED, THE PREDICTED SHIFTS WERE OBSERVED IN CONTROL AS WELL AS 3-MC- AND PB-TREATED ANIMALS. COMPARISON OF METABOLITE PATTERNS IN THE PRESENCE OF TCPO SHOWED DISTINCT DIFFERENCES BETWEEN CONTROL AND 3-MC- AND PB-TREATED ANIMALS. NO SIGNIFICANT DIFFERENCE IN METABOLITE PATTERNS WERE FOUND BETWEEN 3-MC- AND PB-TREATED ANIMALS IN EITHER PRESENCE OR ABSENCE OF TCPO. COMPARISON TO MAMMALIAN DATA SHOWED THE INDUCTION-RELATED METABOLITE PATTERN IN FISH TO BE VERY SIMILAR TO THAT FOUND IN RATS.

SCHOOOR, W. PETER, AND MEERA SRIVASTAVA. 1983. INDUCTION OF MFO IN MULLET LIVER MICROSOMES: EFFECT OF NADPH ON BENZO(A)PYRENE METABOLITE DISTRIBUTION AT 25 DEGREES AND 37 DEGREES (ABSTRACT). PRESENTED AT THE SECOND INTERNATIONAL SYMPOSIUM ON POLLUTANT RESPONSE IN MARINE ORGANISMS, APRIL 27-29, 1983, WOODS HOLE, MA. (ERL,GB 166).

MIXED-FUNCTION OXYGENASE ACTIVITIES IN MULLET (MUGIL CEPHALUS) WERE INDUCED WITH 3-METHYLCHOLANTHRENE AND PHENOBARBITAL (PB) ADMINISTERED INTRAPERITONEALLY TWICE OVER A THIRTY-DAY PERIOD. CONTROL AND INDUCED MFO ACTIVITIES WERE STUDIED AT 25 DEGREES AND 37 DEGREES CELSIUS USING 0.1 - 4.0 MM NADPH. INCREASES IN NADPH CONCENTRATIONS IN ACTIVITY DETERMINATIONS OF CONTROL MULLET MFO AT BOTH TEMPERATURES SHOWED CORRESPONDING ACTIVITY INCREASES AND RATHER BROAD ACTIVITY OPTIMA. NO SIGNIFICANT CHANGES IN THE METABOLITE COMPOSITION WERE OBSERVED. MFO ACTIVITIES INDUCED BY 3-MC AND CONDUCTED AT 37 DEGREES CELSIUS SHOWED INCREASES OF ALL METABOLITES EXCEPT THE 4,5-EPOXIDE AND 5-PHENOL WITH INCREASING NADPH CONCENTRATIONS. NO SUCH INCREASES WERE FOUND AT 25 DEGREES CELSIUS. INCREASES IN THE INDIVIDUAL METABOLITES WERE DISPROPORTIONATELY HIGHER AT 37 DEGREES CELSIUS AND HIGH NADPH CONCENTRATIONS WHEN COMPARED AT 25 DEGREES CELSIUS. SIMILAR TRENDS WERE FOUND WITH THE PB INDUCED MFO ACTIVITIES. THE DATA INDICATE THAT WITH REGARD TO COMPARATIVE INDUCTION, PHYSIOLOGICAL TEMPERATURE RANGES MAY MAKE COMPARISON OF ACTIVITIES DIFFICULT BETWEEN WARM- AND COLD-BLOODED SPECIES. PRELIMINARY DATA AT LOWER TEMPERATURES INDICATE THAT THE ANOMALIES OF MFO ACTIVITY IN THE MULLET OCCUR AT 37 DEGREES C RATHER THAN AT THE LOWER TEMPERATURES.

SCHOOR, W.P. 1979. FLUORIMETRIC CONFIRMATION OF METABOLITES OF BENZO(A)PYRENE FROM A MARINE FISH (ABSTRACT). IN: FOURTH INTERNATIONAL SYMPOSIUM ON POLYNUCLEAR AROMATIC HYDROCARBONS, COLUMBUS, OHIO, OCT. 2-4, 1979, BATELLE INSTITUTE. PP. 36. (ERL,GB X206).

SPECIMEN OF MULLET (MUGIL CEPHALUS), A MARINE FISH, WERE INDUCED WITH A SINGLE DOSE OF 3-METHYLOCHOLANTHRENE (30 MG/KG) INJECTED INTRAPERITONEALLY AND SACRIFICED AT DIFFERENT TIMES. THE ISOLATED LIVER MICROSOMAL FRACTION WAS ALLOWED TO METABOLIZE BENZO(A)PYRENE; THE RESULTING PRODUCTS WERE ISOLATED BY EXTRACTION, AND QUANTITATED BY HPLC COUPLED WITH ULTRAVIOLET AND FLUORESCENCE DETECTORS. EXCITATION AND EMISSION SPECTRA OF A NUMBER OF BAP METABOLITE STANDARDS WERE OBTAINED WHICH WERE USED IN IDENTIFYING PEAKS OBTAINED FROM THE METABOLISM EXPERIMENTS.

SMITH, A.C., AND M.C. MIX. 1978. EFFECTS OF SODIUM CHLORIDE CONCENTRATION ON ELECTROPHORETIC PATTERNS OF ADDUCTOR MUSCLE PROTEINS FROM BIVALVE MOLLUSCS. COMP. BIOCHEM. PHYSIOL. B COMP. BIOCHEM. 61B(1):169-171. (ERL,GB X153).

(1) AN EXTRACTION MEDIUM WAS SOUGHT THAT WOULD PRODUCE THE HIGHEST QUALITY ELECTROPHORETIC PATTERNS OF PROTEINS FROM BIVALVE MOLLUSCAN ADDUCTOR MUSCLES. (2) CELLULOSE ACETATE ELECTROPHORESIS WAS CONDUCTED ON ADDUCTOR MUSCLE PROTEINS EXTRACTED WITH DISTILLED WATER OR VARIOUS CONCENTRATIONS OF SALINE, WITH AND WITHOUT DIALYSIS, FROM THREE BIVALVE MOLLUSCAN SPECIES: PACIFIC OYSTERS, CRASSOSTREA GIGAS; JAPANESE LITTLENECK CLAMS, PROTOHECA SEMIDECUSSATA; AND HAWAIIAN MUSSLES (MAHAWELE), ISOGNOMON CONSTELLATEUM. (3) THE PROTEIN PATTERNS OBTAINED BY ELECTROPHORESIS REVEALED THAT MUSCLE EXTRACTED AND DIALYZED IN 0.030 G% NaCl SOLUTION PRODUCED SUPERIOR PATTERNS.

STRENGTH, D.R., H.H. DARON, J.L. AULL, J.F. WILSON, AND W.P. SCHOOR. 1980. INDUCTION OF GLUCURONIDE AND SULFATE TRANSFERASES BY PHENOBARBITAL AND POLYCYCLIC AROMATIC HYDROCARBONS (ABSTRACT). FED. PROC. 39:1694. (ERL,GB X404).

UDP-GLUCURONOSYL TRANSFERASE AND SULFATE TRANSFERASE WERE SIGNIFICANTLY INCREASED IN LIVERS OF RATES GIVEN PHENOBARBITAL (PB), 3-METHYLOCHOLANTHRENE (3MC) OR PHENANTHRENE (PA) ORALLY FOR 10 TO 14 DAYS. GLUCURONOSYL AND SULFATE TRANSFERASE ACTIVITIES, VARYING WITH COMPOUND OR ENZYME, WERE 40 TO 500% GREATER IN LIVERS OF TREATED ANIMALS THAN IN THEIR RESPECTIVE CONTROLS. BENZO(A)PYRENE WAS LESS EFFECTIVE AS AN INDUCER OF TRANSFERASES THEN WERE PA, PB, OR 3MC. UDPG-DEHYDROGENASE AND BETA-GLUCURONIDASE AND ARYLSULFATASE, ENZYMES THAT HYDROLYZE THE RESPECTIVE CONJUGATES OF HYDROXYARYL COMPOUNDS, WERE NOT CONSISTENTLY AFFECTED BY THE INDUCING AGENTS. VARIATIONS IN EXPOSURE TO INDUCERS (SINGLE INJECTIONS, DAILY INJECTIONS FOR SEVERAL DAYS OR CONTINUOUS FEEDING) INDICATED THAT LONG-TERM EXPOSURE TO RELATIVELY LARGE QUANTITIES OF THE COMPOUNDS (0.02 TO 0.1% OF DIET) WERE REQUIRED TO GIVE SIGNIFICANT RESPONSES. THE RESULTS SUGGEST THAT METABOLITES OF THE COMPOUNDS ADMINISTERED CONTRIBUTED TO THE INDUCTION PROCESS. ADDITIONAL STUDIES OF PB AND 3MC IN THE MARINE ANIMALS, OYSTER, CLAM AND MULLET, INVOLVING LIMITATIONS TO DOSAGE AND TIME OF EXPOSURE, DID NOT RESULT IN UNEQUIVOCAL INDUCTION.

STRENGTH, D.R., D.V. SARADAMBAL, SHOO-LIH WANG, AND H.H. DARON. 1982. GLUCURONOSYL- AND SULFO- TRANSFERASES IN FISH EXPOSED TO ENVIRONMENTAL CARCINOGEN. FED. PROC. 41:1147. (ERL,GB X262).

A HIGH INCIDENCE OF ORAL LESION WAS OBSERVED IN FERAL FISH TAKEN FROM HOLDING PONDS AT THE TUSKEGEE, AL SEWAGE TREATMENT PLANT, (J.M. GRIZZLE, ET AL., J. FISH DISEASE 4, 345, 1981). UDP-GLUCURONOSYL TRANSFERASE AND SULFOTRANSFERASE WERE FOUND TO BE ELEVATED IN LIVERS OF CHANNEL CATFISH AND BLACK BULLHEADS EXPOSED TO EFFLUENT IN SEVERAL POND LOCATIONS. THE INDUCTION OF THE TRANSFERASES IN EXPOSED FISH, COMPARED TO CONTROL, WAS REMARKABLY SIMILAR TO INDUCTION OF THE TWO ENZYMES IN RATS AND FISH GIVEN ORAL OR INTRAPERITONEAL DOSAGES OF KNOWN CARCINOGENS, 3-METHYLCHOLANTHRENE, BENZO(A)PYRENE (BP) OR THE COMPOUNDS PHENANTHRENE AND PHENOBARBITAL. FISH MICROSOMES FROM INDUCED ANIMALS OXIDIZED BP IN A MIXED FUNCTION OXIDASE SYSTEM. THE PRODUCTS WERE EXTRACTED FROM THE REACTION MIXTURE INTO ETHYLACETATE FOR ANALYSIS BY HPLC WITH BOTH UV AND FLUORESCENCE DETECTORS. A NUMBER OF PHENOLS WERE IDENTIFIED. CONJUGATION OF THE OXIDATION PRODUCTS OF BP WITH BOTH SULFATE AND GLUCURONIC ACID WAS OBSERVED. ADDITION OF EITHER UDPGA OR PAPS WITH SULFOTRANSFERASE CONJUGATED THE OXIDATION PRODUCTS WITH GLUCURONIC ACID OR SULFATE, RENDERING THEM MORE POLAR AND CAUSING THEIR DISAPPEARANCE FROM ETHYLACETATE EXTRACTS. CONJUGATION WAS ESSENTIALLY COMPLETE IN EITHER SYSTEM, INDICATING THAT THE TWO SYSTEMS ARE COMPLEMENTARY.

SULLIVAN, TIMOTHY J., AND MICHAEL C. MIX. 1983. PYROLYTIC DEPOSITION OF POLYNUCLEAR AROMATIC HYDROCARBONS DUE TO SLASH BURNING ON CLEAR-CUT SITES. BULL. ENVIRON. CONTAM. TOXICOL. 31(2):208-215. (ERL,GB X445).

THE OBJECTIVES OF THIS RESEARCH WERE TO IDENTIFY QUALITATIVELY AND QUANTITATIVELY THE DEPOSITION, PERSISTENCE AND FATE OF SELECTED UNSUBSTITUTED PNAH COMPOUNDS ON BURNED CLEAR-CUT SITES IN OREGON. THE PRESENT PAPER PRESENTS DATA ON THE INITIAL DEPOSITION OF PNAH AFTER SLASH BURNING. A SUBSEQUENT PAPER WILL CONSIDER THE FATE AND PERSISTENCE OF THE PNAH PRODUCED.

SULLIVAN, TIMOTHY J., AND MICHAEL C. MIX. 1983. SIMPLE AND INEXPENSIVE METHOD FOR MEASURING INTEGRATED LIGHT ENERGY. ENVIRON. SCI. TECHNOL. 17(2):127-128. (ERL,GB X461).

THE OZALID TECHNIQUE IS A SIMPLE AND INEXPENSIVE METHOD FOR MEASURING INTEGRATED SUNLIGHT ENERGY IN THE FIELD FOR PERIODS UP TO A MAXIMUM OF 1 DAY. THIS PAPER DESCRIBES A MODIFICATION OF THE OZALID TECHNIQUE THAT MAKES IT SUITABLE FOR LONG-TERM LIGHT MEASUREMENTS. DATA FROM THE MODIFIED OZALID METER WERE CALIBRATED AGAINST AN EPLEY PRECISION SPECTRO PYRANOMETER, YIELDING A STRONG POSITIVE CORRELATION ( $R^2 = 0.97$ ).

TAN, BARRIE, MELVIN V. KILGORE, DAVID L. ELAM, PAUL MELIUS, AND W.P. SCHOOR. 1981. METABOLITES OF BENZO(A)PYRENE IN AROCLOR 1254 TREATED MULLET. IN: AQUATIC TOXICOLOGY AND HAZARD ASSESSMENT, ASTM STP 737. D.R. BRANSON AND K.L. DICKSON, EDITORS, AMERICAN SOCIETY FOR TESTING AND MATERIALS, PHILADELPHIA, PA. PP. 239-246. (ERL,GB X267).

THIS PAPER PRESENTS A SYSTEMATIC APPROACH TO THE SEPERATION AND CHARACTERIZATION OF B(A)P METABOLITES USING THE EFFICIENT ANALYTICAL TECHNIQUE OF HIGH PRESSURE LIQUID CHROMATOGRAPHY (HPLC). HEPATIC S-9 PREPARATIONS FROM AROCLOR 1254 TREATED MULLET (MUGIL CEPHALUS) WERE USED TO STUDY THE INVITRO METABOLISM OF B(A)P. THE LIPID-SOLUBLE HYDROXYLATED PRODUCTS WERE EXTRACTED IN ETHYL ACETATE PRIOR TO HPLC ANALYSIS. THREE DIOLS (9,10; 7,8; AND 4,5) AND TWO PHENOLS (9 AND 3) OF B(A)P WERE ISOLATED AND IDENTIFIED. FROM THEIR UNRESOLVABLE QUINONES. THE RESULTS OBTAINED IN THE MULLET WERE COMPARED TO THOSE OBTAINED IN THE RAT (RATTUS NORVEGICUS).

TAN, BARRIE, AND PAUL MELIUS. 1981. INDIRECT ATOMIC ABSORPTION SPECTROMETRIC ASSAY FOR EPOXIDE HYDROLASE. ANAL. LETT. 14(B5):311-322. (ERL,GB X282).

AN INDIRECT ATOMIC ABSORPTION SPECTROMETRIC ASSAY FOR EPOXIDE HYDROLASE WAS REPORTED. THE ENZYMATIC PRODUCT 1,2-DIOL WAS OXIDIZED BY AN EXCESS OF POTASSIUM PERIODATE, AND THE UNCONSUMED PERIODATE WAS PREFERENTIALLY PRECIPITATED BY LEAD PERIODATE. THE PRECIPITATE WAS ACID DIGESTED FOLLOWED BY ATOMIC ABSORPTION DETERMINATION OF LEAD IN THE RESULTING SOLUTION. TRANS-STILBENE OXIDE (TSO) INDUCED RABBIT AND TILAPIA EPOXIDE HYDROLASE ACTIVITIES BY 350% AND 210% AT THE 490 MG TSO/KG TREATMENT WHILE AROCLOR 1254 (AR) ONLY SLIGHTLY INCREASED THEIR ACTIVITIES AT THE 200 MG AR/KG TREATMENT. THE 1,2-EPOXY-3,3-TRICHLOROPROPANE (TCPO) AT 0.1 MM COMPLETELY INHIBITED TILAPIA (CONTROL) AND RABBIT (490 MG TSO/KG) EPOXIDE HYDROLASE ACTIVITIES.

TAN, BARRIE, AND PAUL MELIUS. 1981. RESPONSES OF THE HEPATIC ENZYMES OF A TELEOST FISH TO TRANS-STILBENE OXIDE TREATMENT. BULL. ENVIRON. CONTAM. TOXICOL. 26(6):801-806. (ERL,GB X325).

THE MICROSOMAL MIXED FUNCTION OXIDASE (MFO) SYSTEM AND EPOXIDE HYDROLASE ARE IMPORTANT ENZYMES IN THE METABOLISM OF CARCINOGENIC POLYNUCLEAR AROMATIC HYDROCARBONS (JERINA DALY 1974, WIEBEL ET AL. 1974, HEIDELBERGER 1975, NEBERT ET AL. 1975). THE EPOXIDE HYDROLASE MAY ACT IN A DETOXIFYING SYSTEM, AS IN THE BENZO(A)PYRENE 4,5-OXIDE, OR IN AN ACTIVATING SYSTEM, AS IN THE METABOLISM OF BENZO(A)PYRENE 7,8-OXIDE TO BENZO(A)PYRENE 7,8-DIHYDRODIOL, THE PRECURSOR FOR THE ULTIMATE CARCINOGEN, BENZO(A)PYRENE 7,8-DIHYDRODIOL-9,10-EPOXIDE (SIMS ET AL. 1974, THAKKER ET AL. 1976). RECENTLY, TRANS-STILBENE OXIDE (TSO) WAS FOUND TO BE A SELECTIVE INDUCER OF EPOXIDE HYDROLASE ACTIVITY IN THE RAT LIVER WITH NO EFFECT ON FIVE INVESTIGATED MONOOXYGENASE PARAMETERS (SCHMASSMANN ET AL. 1978, SCHMASSMANN & OESCH 1978). TSO IS INVOLVED IN AN IMPORTANT DETOXIFICATION-ACTIVATION ROLE OF THE EPOXIDE HYDROLASE BUT NOT DIRECTLY IN THE MFO SYSTEM. IN THIS STUDY, THE EFFECT OF TSO ON THE HEPATIC ELECTRON TRANSPORT COMPONENTS OF THE MFO SYSTEM IN A TELEOST FISH, TILAPIA AUREA WAS INVESTIGATED.

TAN, BARRIE, AND PAUL MELIUS. 1982. BENZOCALPYRENE METABOLISM IN HEPATIC S-9 FRACTIONS OF AROCLOR 1254-TREATED MULLET (MUGIL CEPHALUS). IN: POLYNUCLEAR AROMATIC HYDROCARBONS: PHYSICAL AND BIOLOGICAL CHEMISTRY. M. COOKE ET AL., EDITOR, BATTELLE PRESS, COLUMBUS, OH. PP. 801-811. (ERL,GB X354).

BIOTRANSFORMATION OF XENOBIOTIC CHEMICALS IN AQUATIC SPECIES IS LESS WELL KNOWN THAN THAT IN MAMMALIAN SPECIES. SOME EXAMPLE OF BENZOCALPYRENE (BAP) METABOLITES WHICH HAVE BEEN DETECTED USING TISSUE PREPARATIONS FROM MARINE FISH INCLUDE 3-HYDROXYBENZOCALPYRENE (3-OH-BAP) (1,2), BAP-3,6-QUINONE (2), AND 7,8-DIHYDROXY-DIHYDROBENZOCALPYRENE (BAP-7,8-DIOL) (3). RECENTLY, BAP-4,5-DIOL, BAP-7,8-DIOL, BAP-9,10-DIOL, 3-OH-BAP, 9-OH-BAP, AND QUINONES WERE IDENTIFIED IN TROUT (4,5), SCUP (6), AND SKATE (7) WHEN LIVER MICROSOMES WERE INCUBATED WITH BAP. VARANASI ET AL. (8) HAVE IDENTIFIED THE BAP METABOLITES IN FLOUNDER, SOLE AND SALMON WHILE WE HAVE SEPARATED THESE METABOLITES IN MULLET, SEA CATFISH AND GULF KILLIFISH (9,10). IN ORDER TO ASCERTAIN THE BIOTRANSFORMATION PATHWAYS OF XENOBIOTICS, IT IS NECESSARY TO OBTAIN PROFILES OF METABOLITES AND THE FACTORS THAT INFLUENCE THEIR FORMATION. THIS PAPER PRESENTS THE PRODUCT PATTERNS OF PHENOLS, DIOLS, AND QUINONES PRODUCED BY THE AROCLOR-TREATED MULLET (MUGIL CEPHALUS). EFFECTS OF INCUBATION TIME, TEMPERATURE, PROTEIN CONCENTRATION AND ENZYME INDUCTION ON THE BAP METABOLISM WERE INVESTIGATED.

TAN, BARRIE, PAUL MELIUS, AND JOHN GRIZZLE. 1981. HEPATIC ENZYMES AND TUMOR HISTOPATHOLOGY OF BLACK BULLHEADS WITH PAPILOMAS. IN: CHEMICAL ANALYSIS AND BIOLOGICAL FATE: POLYNUCLEAR AROMATIC HYDROCARBONS. MARCUS COOKE AND ANTHONY J. DENNIS, EDITORS, BATTELLE PRESS, COLUMBUS, OH. PP. 377-386. (ERL,GB X276).

IN THIS STUDY, AN UNUSUALLY HIGH INCIDENCE OF PAPILOMAS (70+-5%) IN BLACK BULLHEADS (ICTALURUS MELAS) FOUND IN A TWO-ACRE FINAL OXIDATION SEWAGE POND. THE UNIQUE FEATURE WAS THAT THE AERATION (MAINTAINED BY 4 LARGE AERATORS) AND CHLORINATION (3MG CHLORINE/LITER) PROCESSES WERE ACHIEVED IN THIS FINAL OXIDATION POND. THIS REPORT DESCRIBES A BIOCHEMICAL (HEPATIC ENZYMES) COMPARISON OF THE BULLHEADS IN TWO PONDS (POLLUTED SEWAGE TREATMENT POND AND POLLUTION-FREE NEARBY POND), "LABORATORY" EXPERIMENTS THAT EMPLOYED SOME SILVER CARP (HYPOPHthalmichthys MOLITRIX) INTRODUCED INTO THE SEWAGE POND, A BRIEF SUMMARY OF THE TUMOR HISTOPATHOLOGY, AND A DISCUSSION OF THE POSSIBLE ROUTE/AGENT(S) RESPONSIBLE FOR THE HIGH TUMOR INCIDENCE.

TAN, BARRIE, PAUL MELIUS, AND MELVIN V. KILGORE. 1980. DETERMINATION OF 1,2-DIOLS BY INDIRECT ATOMIC ABSORPTION WITH DIGESTED LEAD PERIODATE. ANAL. CHEM. 52(3):602-604. (ERL,GB X144).

TECHNIQUES ARE DESCRIBED FOR THE DETERMINATION OF 1,2,-DIOLS BY INDIRECT ATOMIC ABSORPTION WITH DIGESTED LEAD PERIODATE. PRELIMINARY EXPERIMENTS INDICATE THAT STYRENE GLYCOL CAN BE DETERMINED IN THE PRESENCE OF STYRENE EPOXIDE. THIS IS OF PARTICULAR INTEREST BECAUSE EPOXIDE HYDRASE CATALYZES THE HYDROLYSIS OF AN EPOXIDE TO A 1,2-DIOL. THE PROCEDURE MAY LEND ITSELF TO THE DETERMINATION OF THE ENZYME ACTIVITY OF EPOXIDE HYDRASE, KNOWN FOR ITS PIVOTAL ROLE IN THE METABOLISM OF MANY CARCINOGENS AND TOXIC COMPOUNDS.

TAN, BARRIE, PAUL MELIUS, AND PAUL ZIEGLER. 1982. SIMPLE GAS CHROMATOGRAPHIC METHOD FOR THE STUDY OF ORGANIC SOLVENTS: MOISTURE ANALYSIS, HYGROSCOPICITY, AND EVAPORATION. J. CHROMATOGR. SCI. 20(5):213-217. (ERL,GB X278).

THIS PAPER PRESENTS THE BASELINE SEPARATION OF EIGHT COMMON LABORATORY ORGANIC SOLVENTS BY GC WITH TCD AND SIMPLE ISOTHERMAL CONDITIONS. THE INFLUENCE OF COLUMN TEMPERATURE ON THE CHROMATOGRAPHIC PARAMETERS, CAPACITY FACTOR (K), AND RESOLUTION (R), WAS STUDIED. RAPID ANALYSIS OF MOISTURE IN ORGANIC SOLVENTS WAS DEMONSTRATED. A LINEAR DETECTION RESPONSE OF 100 PPM TO 30% (V/V) WAS SHOWN FOR WATER IN ETHANOL. SOLVENT SAMPLES PLACED IN OPEN BEAKERS ABSORBED WATER AT VARYING RATES. THE RELATIVE RATE OF HYGROSCOPICITY WAS ETHANOL, 2-PROPANOL, ACETONITRILE ETHYL ACETATE, ACETONE GREATER THAN METHANOL GREATER THAN CHLOROFORM. SOLVENT SAMPLES, STORED IN STOPPERED VOLUMETRIC FLASKS OR SEPTUM-CAPPED VIALS AND PERIODICALLY SAMPLED, GAVE NO SIGNIFICANT MOISTURE ABSORPTION. A MIXTURE OF ORGANIC SOLVENTS IN A SLOWLY STIRRED OPEN BEAKER INDICATED DIFFERENCES IN ATMOSPHERIC EVAPORATION. THE RELATIVE RATE OF EVAPORATION WAS ETHER >> ACETONE, CHLOROFORM, ACETONITRILE GREATER THAN METHANOL, ETHYL ACETATE GREATER THAN ETHANOL, 1-PROPANOL >>WATER.

TRENHOLM, STEVE R., AND MICHAEL C. MIX. 1978. REGENERATION OF RADIATION-DAMAGED DIGESTIVE TISSUES IN JUVENILE PACIFIC OYSTERS (CRASSOSTREA GIGAS). J. INVERTEBR. PATHOL. 32(3):249-257. (ERL,GB X154).

JUVENILE PACIFIC OYSTERS, CRASSOSTREA GIGAS, WERE IRRADIATED WITH 16 AND 40 KRAD AND THEIR TISSUES EXAMINED HISTOLOGICALLY. DEGENERATIVE SYNDROMES AND TISSUE REGENERATION PROCESSES WERE DETERMINED FOR THE STOMACH, GUT, COLLECTING DUCTS, AND DIGESTIVE TUBULES. FOLLOWING DEGENERATION, TISSUE REGENERATION WAS OBSERVED IN THE DIGESTIVE TISSUES OF MOST OYSTERS EXPOSED TO 16 KRAD AND IN A LIMITED NUMBER EXPOSED TO 40 KRAD. REGENERATION WAS FIRST OBSERVED IN THE DIGESTIVE TUBULES AND SUBSEQUENTLY IN THE STOMACH, GUT, AND COLLECTING DUCTS. CELLULAR REPOPULATION OF THE DIGESTIVE TUBULES INVOLVED EPITHELIALIZATION WITH LARGE, UNDIFFERENTIATED CRYPT CELLS WHICH THEN DIFFERENTIATED INTO FUNCTIONAL SECRETORY AND ABSORPTIVE CELLS. REGENERATION IN THE STOMACH, GUT, AND COLLECTING DUCTS WAS INITIATED BY PROLIFERATIVE ISLANDS OF SMALL BASOPHILIC CELLS. MIOTIC DIVISION OF THOSE CELLS AND THEIR SUBSEQUENT DIFFERENTIATION INTO FUNCTIONAL EPITHELIAL CELLS RESULTED IN THE RAPID RESTORATION AND APPARENT RECOVERY OF THE AFFECTED TISSUES. THE RESULTS OF THESE STUDIES INDICATE THAT RADIORESISTANCE OF JUVENILE C. GIGAS MAY IN PART BE DUE TO THE REMARKABLY EFFICIENT REGENERATIVE MECHANISMS INVOLVED IN REPLACING INJURED OR LOST DIGESTIVE TISSUES.

TRENHOLM, STEVE RAY. 1977. EFFECTS OF X- AND GAMMA IRRADIATION ON THE JUVENILE PACIFIC OYSTER, CRASSOSTREA GIGAS. M.S. THESIS. OREGON STATE UNIVERSITY, CORVALLIS, OR. 75P. (ERL,GB X284).

IN THE PRESENT RESEARCH, TWO STUDIES WERE CONDUCTED. ONE WAS CONCERNED WITH DETERMINING LONG-TERM SURVIVAL AND CHANGES IN MEAN WET WEIGHT FOLLOWING EXPOSURE TO VARYING DOSES OF GAMMA RADIATION. THE PURPOSE OF THE SECOND STUDY WAS TO ANALYZE HISTOPATHOLOGICAL CHANGES IN THE DIGESTIVE TISSUES FOLLOWING EXPOSURE TO DIFFERENT DOSES OF X-GAMMA RADIATION.

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