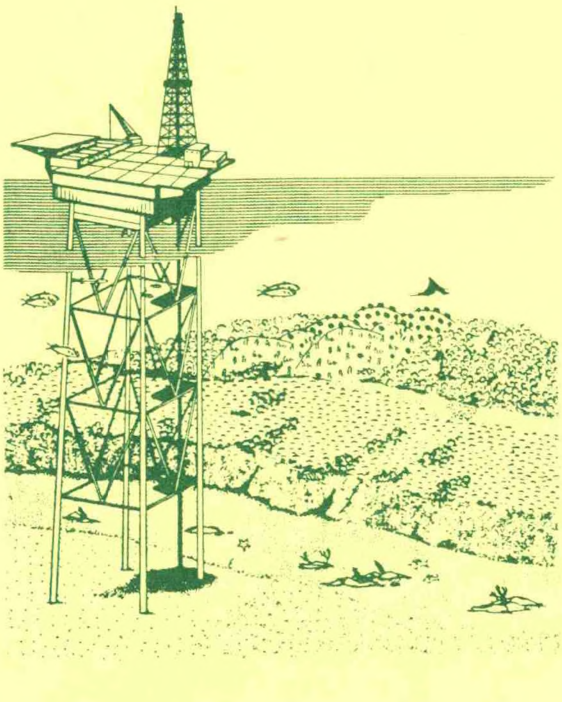
NOAA/NMFS ADMINISTRATIVE REPORT TO EPA

Ecological Effects of Energy Development on Reef Fish, Ichthyoplankton and Benthos Populations in the Flower Garden Banks of the Northwestern Gulf of Mexico, 1980—1982

Volume II Histopathology of Fishes in Relation to Drilling Operations Near Flower Garden Banks



OCTOBER 1983

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Center
Galveston Laboratory
Galveston, Texas 77550

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Volume II
Histopathology of Fishes in Relation to Drilling Operations Near Flower Garden Banks

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A FINAL REPORT TO THE ENVIRONMENTAL PROTECTION AGENCY ON WORK CONDUCTED UNDER PROVISIONS OF INTERAGENCY AGREEMENT EPA-79-D-X0514

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ABSTRACT

Fish near the Flower Garden Banks in the Gulf of Mexico were examined for gross and microscopic lesions to determine the relationship between offshore oil-well-drilling operations and the health of fish in this area. Over a two-year period, fish were collected near two active drilling platforms and from four control areas. Of the 23 species examined, most comparisons between platform and control stations were with red snapper *Lutjanus campechanus*, vermilion snapper *Rhomboplites aurorubens*, creole-fish *Paranthias furcifer*, wenchman *Pristipomoides aquilonaris*, gray triggerfish *Balistes capricus*, sash flounder *Trichopsetta ventralis*, southern hake *Urophycis floridanus* and Mexican searobin *Prionotus paralatus*.

Most grossly visible lesions were caused by parasites. The prevalence of gross lesions varied among species, averaging 10% overall. Scamp *Mycteroperca phenax* had the highest prevalence of gross lesions (75%), most related to cestode infestations. No differences in types or prevalence of gross lesions were found between fish collected from various locations.

Liver weight to body weight ratio was significantly higher in gray triggerfish, creole-fish, wenchman, and sash flounder collected near drilling platforms. Gray triggerfish had the largest livers, averaging 3.7% of body weight. Greater liver weight could result from differences in food between stations or because toxicants affected the fish near platforms.

The most common histological lesions were granulomas and other indications of chronic inflammation related to parasitism. Of parasitic lesions, only gill-inhabiting nematodes of gray triggerfish varied in

prevalence between drilling platforms and control stations, and this difference was a result of smaller gray triggerfish being collected near platforms than in control areas. Macrophage centers in the spleen, liver, and trunk kidney also increased in larger gray triggerfish and creole-fish. Most of the southern hake with hepatic fatty change were from platform areas but were not collected during the cruises when most controls were collected. The hepatic fatty change in this species may be seasonal; therefore, effects of drilling platforms on southern hake were not determined.

Red snapper, wenchman, sash flounder, creole-fish, and vermilion snapper collected near drilling platforms had more frequent or severe gill lamella epithelium hyperplasia and edema, chronic hepatitis, and hepatocyte basophilia than controls. Toxicants are suspected as the cause of these lesions because the types of lesions were consistent with a toxicosis, infectious agents were not associated with the lesions, and prevalence or severity of the lesions increased near drilling platforms that were probable sources of toxicants. The types of toxicants causing these histological lesions cannot be determined from the results of this study because the lesions found could have been caused by a wide variety of chemicals.

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ACKNOWLEDGMENTS

I thank L. R. Martin and G. S. Boland (LGL Ecological Research Associates), and R. S. Nelson, G. Gitschlag, and M. Renaud (National Marine Fisheries Service) for their cooperation during collection and field examination of specimens. Auburn University personnel assisting with this project were S. P. Malvestuto and R. B. Reed (statistical analysis), J. S. Ramsey (fish taxonomy), W. A. Rogers (parsitology), R. Garrett, W. Wieland, and R. McCann (field collection), A. Thiyagarajah and L. Hochstedler (laboratory necropsy and histological techniques), J. Hosey (photography and histological techniques), and R. D. Maxwell (field collection, histochemistry, electron microscopy, and histological techniques).

SECTION 1

INTRODUCTION

Offshore oil-well-drilling platforms are potential sources of a variety of toxicants originating from drilling fluids, drill cuttings, cooling water, produced water, deck drainage, and domestic wastes as well as additional environmental impact because of shipping activity and the physical presence of structures and pipelines (Dicks 1979). The drilling fluids pumped into the borehole during well drilling to lubricate the drilling bit, carry cuttings to the surface, seal the hole, and prevent blow-outs contain several substances toxic to fish (Sprague and Logan 1979). Drilling fluids enter the marine environment when they are discharged from platforms or by washing from discharged drill cuttings.

The Flower Garden Banks are small coral reefs in the northern Gulf of Mexico approximately 185 km south-southeast of Galveston, Texas. This area is of special interest because of its unique ecosystem (Bright and Pequegnat 1974) and its potential for energy development. These reefs are also used for fishing and recreational diving. The placement of offshore drilling platforms near the Flower Garden Banks is a potential danger to the ecosystems of these reefs because of possible environmental changes and drilling fluid toxicity to fish and invertebrates (Richards 1977; Sprague and Logan 1979; Atema et al. 1982).

Histopathology can be used to detect changes in fish exposed to toxicants (Hinton et al. 1973), but adequate control fish are important to insure that the lesions are a result of pollution (Cahn 1975). Histopathology has been used to determine the effects of pollutants on wild fish (Murchelano and Ziskowski 1977) and to demonstrate that fish were being injured by pollutants (Pierce et al. 1980; Grizzle 1981).

Although histopathology alone is not usually sufficient to identify a chemical that has injured fish, it can demonstrate that fish have been harmed by toxicants (Grizzle 1981). This information, along with a known source of pollution or chemical analysis of water or fish to identify the toxicant, indicates that suspected pollutants have an impact on the fish. Fish exposed to toxicants are more susceptible to infectious diseases (Wedemeyer et al. 1976), and histopathology is useful in determining the role of infectious agents in a disease.

The objective of this project was to determine the relationship between drilling operations and lesions in fish. Gross and histological lesions were described, and the prevalence and severity of these lesions in several fish species collected near drilling platforms and from control areas were compared. The presence of parasites and liver weights were also considered. An atlas of the prominent lesions found during this project and comparable normal organs is included in Appendix B.

SECTION 2

CONCLUSIONS AND RECOMMENDATIONS

Histological lesions and greater liver weights in fish collected near drilling platforms were consistent with chemical injury. The types of toxicants causing these changes could not be determined from the results of this study because the lesions were not specific to any particular disease. The fish affected included both reef species and bottom fishes.

Creole-fish, gray triggerfish, red snapper and vermilion snapper collected near drilling platforms were smaller than controls, but Mexican searobin and wenchman collected near drilling platforms were larger than control fish. The presence of smaller fish at the platforms was probably a result of young fish being recruited to the platform populations. Larger Mexican searobin and wenchman being associated with the platform could result from a difference in food supply because of the platform or because of a difference in the platform-area habitat existing before the platform was present.

The types of histological lesions caused by drilling fluids and by the components of drilling fluids should be determined in laboratory experiments. Such information would indicate whether the lesions found in fish collected near drilling platforms during this project were directly resultant from exposure to drilling fluid, or because of some other toxicant or secondary effect of the drilling platform on the environment.

Studies of lesions in fish near drilling platforms should be continued. Future studies should consider only species than can be collected in adequate numbers from both platform and control areas. Examination of fish in future studies should be coordinated with water analysis for drilling-fluid components. Fish collected near drilling platforms should be chemically analyzed for suspected drilling-fluid components, and tissue levels correlated to concentrations in the water near drilling platforms and to the health of the fish.

SECTION 3

METHODS

COLLECTING STATIONS

Six locations in the Flower Garden Bank area of the Gulf of Mexico were chosen as collecting stations (Table 1). Two of these stations (PLA and PLB) were centered on drilling platforms and the other stations (EFG, WFG, CNA, and BRC) were control locations. The two stations containing coral reefs (EFG and WFG) were the largest stations, varied greatly in depth (Table 1), and had bottoms covered by rocks, coral, or coral rubble. Stations PLA, CNA, and BRC had flat, mud bottoms and were approximately the same depth as the deepest parts of EFG and WFG. Station PLB included both mud bottom and reef because it was on the southeast edge of the East Flower Garden Bank and also included part of the area included in station EFG before the drilling operations began.

COLLECTION OF FISH

Fish were collected during eight cruises over a 2-year period (Table 2). During each cruise fish were sampled from two to four stations (Table 2). Station PLA was selected for sampling during cruises 1-4 because it contained the drilling platform closest to the Flower Garden Banks at that time. Fish were collected from the control station CNA during the cruises that PLA was sampled because CNA was between PLA and the WFG station. Station CNA was not sampled during cruise 2 because of time limitations. A different drilling platform was chosen for sampling after the fourth cruise because of a new

Table 1. Collecting stations.

Station	Location and description
PLA	within 2000 m of Mobil platform HIA 595-D; center of station was latitude 27° 52.31' N, longitude 93° 59.69' W, depth 119 m
PLB	within 2000 m of Mobil platform HIA-389-A; during cruises 6-8 this station included the southeastern edge of the East Flower Garden Bank; center of station was latitude 27° 54.02' N, longitude 93° 34.64' W , depth 123 m; drilling began April 1982.
EFG	East Flower Garden Bank; latitude 27° 55' N, longitude 93° 37' W, depth 23-128 m; during cruses 6-8 the area within 2000 meters of Mobil platform HIA-389-A was excluded from this station.
WFG	West Flower Garden Bank; latitude 27° 53' N, longitude 93° 49' W, depth 23-106 m
CNA	soft bottom area between West Flower Garden Bank and PLA; latitude 27° 53' N, longitude 93° 57' W, depth 113 m
BRC	soft bottom area between the East and West Flower Garden Banks; latitude 27° 53' N-27° 55' N, longtiude 93° 42' W-93° 43' W, depth 102-110 m

Table 2. Fish collecting cruises and the stations used for each crusise.

Cruise number	Starting date	Ending date	Stations sampled[a]					
1	30OCT80	6NOV80	PLA	-	WFG	EFG	CNA	-
2	22JAN81	28JAN81	PLA	-	WFG	-	-	-
3	13APR81	24APR81	PLA	-	WFG	EFG	CNA	-
4	7JUL81	18JUL81	PLA	-	WFG	EFG	CNA	-
5	16OCT81	22OCT81	-	-	WFG	EFG	-	BRC
6	27APR82	7MAY82	-	PLB	WFG	EFG	-	BRC
7	31JUL82	11AUG82	-	PLB	WFG	EFG	-	BRC
8	19OCT82	30OCT82	-	PLB	WFG	EFG	-	BRC

[a]Station abbreviations defined in Table 1.

platform (PLB) closer to the Flower Garden Banks. This platform was under construction during cruise 5, but the platform area was included in station EFG. During cruises 6-8, the drilling platform in station PLB was actively drilling. Another control station (BRC) was sampled instead of CNA during cruises when fish were not collected from PLA.

Methods of capturing fish depended on the bottom type, depth, and species desired. Most specimens were collected by trawling, spearing by scuba diver, or by hook-and-line fishing. Fish were trapped during early curises but not during cruises 5-8. Artificial habitats consisting of plastic crates with 33-cm sides and half filled with oyster shell and plastic tubes were tied to the leg of PLB during cruise 6, retrieved and reset at the end of cruise 6, and retrieved again during cruise 7.

Twenty-three species of fish were examined (Table 3), but only 13 species were from both a platform and control station (Table 4). Species were chosen to represent commercially important species, a variety of life histories and habitat preferences, and because of common occurrence in the study area.

Identification of fish species was based on keys and species descriptions in Hoese and Moore (1977). Separation of scamp *Mycteroperca phenax* and yellowmouth grouper *Mycteroperca interstitialis* was not reliable so specimens fitting the descriptions of either of these species are termed scamp in this report.

GROSS EXAMINATION OF FISH

When a fish specimen was brought onto the vessel, the external surfaces were examined as soon as possible for grossly visible lesions. If a fish

Table 3. Fish species examined (listed by families) and standard lengths (cm).

Species	Minimum	Mean	Maximum
gray triggerfish (*Balistes capriscus*; Balistidae)	11	30	47
three-eye flounder (*Ancylopsetta dilecta*; Bothidae)	10	14	17
dusky flounder (*Syacium papillosum*; Bothidae)	18	18	18
sash flounder (*Trichopsetta ventralis*; Bothidae)	5	12	16
almaco jack (*Seriola rivoliana*; Carangidae)	70	70	70
gulf hake (*Urophycis cirratus*; Gadidae)	15	21	30
southern hake (*Urophycis floridanus*; Gadidae)	17	27	36
cottonwick (*Haemulon melanurum*; Haemulidae)	17	25	34
red snapper (*Lutjanus campechanus*; Lutjanidae)	22	38	71
vermilion snapper (*Rhomboplites aurorubens*; Lutjanidae)	17	26	65
blackfin snapper (*Lutjanus buccanella*; Lutjanidae)	45	45	45
wenchman (*Pristipomoides aquilonaris*; Lutjanidae)	8	14	24
cubbyu (*Equetus umbrosus*; Sciaenidae)	13	14	15
scamp (*Mycteroperca phenax*; Serranidae)[a]	31	49	84
rock sea bass (*Centropristis philadelphica*; Serranidae)	12	16	20
yellowedge grouper (*Epinephelus flavolimbatus*; Serranidae)	29	43	49
red hind (*Epinephelus guttatus*; Serranidae)	24	32	49
rock hind (*Epinephelus adscensionis*; Serranidae)	41	41	41
creole-fish (*Paranthias furcifer*; Serranidae)	8	16	24
blackeared bass (*Serranus atrobranchus*; Serranidae)	7	8	8
red porgy (*Pagrus pagrus*; Sparidae)	23	29	34
Mexican searobin (*Prionotus paralatus*; Triglidae)	7	12	17
shortwinged searobin (*Prionotus stearnsi*; Triglidae)	7	9	11

[a]This species was not separated from yellowmouth grouper (*Mycteroperca interstitialis*)

Table 4. Number of fish examined.

Species	Station	Cruise number 1	2	3	4	5	6	7	8	total
gray triggerfish	EFG	7	0	2	8	10	4	0	9	40
	WFG	2	1	5	6	0	2	4	0	20
	PLA	0	0	13	4	0	0	0	0	17
	PLB	0	0	0	0	0	10	12	10	32
	total	9	1	20	18	10	16	16	19	109
three-eye flounder	PLA	0	1	2	0	0	0	0	0	3
	PLB	0	0	0	0	0	1	1	5	7
	CNA	0	0	1	0	0	0	0	0	1
	BRC	0	0	0	0	2	0	1	0	3
	EFG	0	0	0	0	1	0	0	0	1
	total	0	1	3	0	3	1	2	5	15
dusky flounder	EFG	1	0	0	0	0	0	0	0	1
sash flounder	PLA	0	0	2	8	0	0	0	0	10
	PLB	0	0	0	0	0	10	9	2	21
	CNA	0	0	0	3	0	0	0	0	3
	BRC	0	0	0	0	2	0	9	6	17
	EFG	0	0	0	0	2	0	0	0	2
	total	0	0	2	11	4	10	18	8	53
almaco jack	PLA	0	0	1	0	0	0	0	0	1
gulf hake	PLB	0	0	0	0	0	5	1	0	6
	EFG	0	0	0	0	1	0	0	0	1
	BRC	0	0	0	0	3	1	0	0	4
	total	0	0	0	0	4	6	1	0	11
southern hake	PLA	0	1	10	3	0	0	0	0	14
	PLB	0	0	0	0	0	2	1	0	3
	CNA	0	0	1	6	0	0	0	0	7
	BRC	0	0	0	0	1	0	1	0	2
	total	0	1	11	9	1	2	2	0	26
red snapper	CNA	2	0	1	1	0	0	0	0	4
	EFG	14	0	8	9	10	11	0	8	60
	WFG	11	26	10	9	0	3	0	8	67
	PLA	0	0	1	1	0	0	0	0	2
	PLB	0	0	0	0	0	12	10	11	33
	total	27	26	20	20	10	26	10	27	166
vermilion snapper	EFG	15	0	11	5	10	11	0	10	62
	WFG	15	33	10	13	10	11	10	10	112
	PLB	0	0	0	0	0	10	10	15	35
	total	30	33	21	18	20	32	20	35	209
blackfin snapper	EFG	0	0	1	0	0	0	0	1	2
cottonwick	EFG	19	0	10	10	2	0	0	0	41
	WFG	15	24	10	7	8	0	0	0	64
	PLB	0	0	0	0	0	5	0	0	5
	total	34	24	20	17	10	5	0	0	110
cubbyu	PLA	0	2	0	1	0	0	0	0	3
scamp	EFG	7	0	4	10	0	0	0	0	21
	WFG	4	3	2	6	0	0	0	0	15
	total	11	3	6	16	0	0	0	0	36

Table. 4. Continued

Species	Station	Cruise number								
		1	2	3	4	5	6	7	8	total
rock sea bass	PLA	1	2	0	6	0	0	0	0	9
	PLB	0	0	0	0	0	1	0	0	1
	total	1	2	0	6	0	1	0	0	10
yellowedge grouper	PLA	0	0	4	0	0	0	0	0	4
	CNA	0	0	0	1	0	0	0	0	1
	total	0	0	4	1	0	0	0	0	5
red hind	WFG	0	1	0	0	0	0	0	0	1
	EFG	0	0	0	1	0	0	0	0	1
	total	0	1	0	1	0	0	0	0	2
rock hind	EFG	0	0	1	0	0	0	0	0	1
creole-fish	WFG	0	0	0	0	10	10	10	10	40
	EFG	0	0	0	0	10	10	7	5	32
	PLB	0	0	0	0	0	12	14	11	37
	total	0	0	0	0	20	32	31	26	109
wenchman	PLA	0	1	3	9	0	0	0	0	13
	PLB	0	0	0	0	0	6	9	9	24
	CNA	0	0	14	11	0	0	0	0	25
	EFG	0	0	0	0	9	0	0	0	9
	BRC	0	0	0	0	0	10	10	8	28
	total	0	1	17	20	9	16	19	17	99
blackeared bass	PLA	0	0	0	3	0	0	0	0	3
	CNA	0	0	0	3	0	0	0	0	3
	total	0	0	0	6	0	0	0	0	6
red porgy	WFG	0	0	10	0	0	0	0	0	10
	EFG	0	0	11	0	0	0	0	0	11
	total	0	0	21	0	0	0	0	0	21
Mexican searobin	PLA	0	0	1	11	0	0	0	0	12
	PLB	0	0	0	0	0	4	10	10	24
	CNA	0	0	2	11	0	0	0	0	13
	BRC	0	0	0	0	9	10	10	9	38
	EFG	0	0	0	0	7	0	0	0	7
	total	0	0	3	22	16	14	20	19	94
shortwinged searobin	CNA	0	0	0	7	0	0	0	0	7
total for all species		113	95	151	173	107	161	139	157	1096

could not be examined immediately, it was placed in a fiberglass trough of sea water until examined. Dead fish were not used for specimens in most cases except for fish speared by divers.

The other examinations performed on the fresh specimens depended on the circumstances of the collection and fish size. When fish were collected with a trawl, most specimens were placed in fixative before an examination of internal organs because the time required for necropsy would have allowed postmortem changes. Fish collected by other methods were killed or anesthetized, weighed, measured (standard length), and then dissected. During dissection internal organs were examined for gross lesions, and selected organs were removed for histological examination. Specimens preserved whole were dissected and examined for internal gross lesions after shipment to Auburn University.

A 35-mm camera with electronic flashes and a lens capable of 1:1 reproduction ratio were used to photograph representative gross lesions. Parasites were grouped by phylum, class, or order. If the cause of a lesion was determined, it was classified by the etiological agent. Terminology for other gross lesions was obvious (i.e., fin erosion or dark color) or based on the following definitions:

Granuloma. A firm mass of fibrous connective tissue, usually darker than the normal tissue.

Cyst. A fluid-filled sac of fibrous connective tissue.

The liver was weighed during dissections of fish collected on cruises 2-8. Weights of livers recorded during dissection of fresh fish were obtained by placing the organ in a plastic bag hung on a spring scale accurate to 1 g. Livers of fish preserved whole and dissected after the cruise were weighed on a triple-beam balance.

HISTOLOGICAL EXAMINATION

Grossly visible lesions and selected organs from fish dissected during the cruise were removed and fixed in Bouin's fluid or 10% buffered formalin. Fish preserved whole during the cruise had the body cavity opened and were placed in the same types of fixatives. Organs taken from most specimens were gill, spleen, liver, stomach, trunk kidney, and olfactory organ. In addition, the skin, heart, brain, head kidney, oral mucosa, intestine, eye, mesentery, and gonad were taken from at least one specimen of each species at each station during each cruise. Other organs were obtained as additional specimens or fortuitously when one of the above organs was examined. Table 5 is a complete list of organs examined histologically.

Histological samples were transported in fixative to Auburn University, and then stored in alcohol. Each organ sample was embedded in paraffin, sectioned, and stained with hematoxylin and eosin (H&E). After examination of the H&E stained sections, some organs were resectioned and prepared with one or more of the following histochemical stains or reactions: periodic acid-Schiff, Prussian blue, Sudan black, Giemsa, or acid fast (Humason 1979). Frozen sections of selected livers suspected of having fatty change were stained in Sudan black. The frozen sections were made from liver stored in fixative.

Table 5. Number of organs examined histologically.

Organ	Cruise number 1	2	3	4	5	6	7	8	totals
thymus	0	0	0	0	0	1	0	0	1
heart	51	6	14	28	14	25	15	17	170
head kidney	39	8	9	20	5	23	10	3	117
pericardial cavity	0	0	0	0	1	0	0	0	1
spleen	96	94	151	150	20	93	100	133	837
lip	1	0	0	0	0	0	0	0	1
bile duct	0	2	3	2	0	1	0	0	8
esophagus	34	32	45	13	9	10	5	6	154
gall bladder	0	0	3	2	0	0	1	2	8
intestine	30	87	37	59	15	20	30	28	306
liver	106	92	149	164	89	126	138	139	1003
oral cavity	17	2	8	26	11	12	7	13	96
pancreas	103	90	143	118	68	92	115	125	854
pyloric cecum	3	0	0	0	0	0	0	0	3
stomach	79	64	121	27	10	14	12	14	341
bile duct	1	0	3	0	0	0	0	0	4
saccus vasculosus	0	0	6	7	2	1	4	0	20
corpsule of Stannius	1	0	4	3	0	0	0	1	9
pancreatic islet	0	2	7	5	0	0	2	6	22
pituitary gland	0	0	0	1	1	0	0	0	2
thyroid	0	0	0	2	0	0	0	0	2
trunk kidney	100	31	137	157	85	117	116	128	871
opisthonephric duct	2	0	0	0	0	0	0	0	2
urinary bladder	0	0	3	4	1	1	2	6	17
ovary	10	1	7	41	12	38	34	47	190
testis	9	2	20	34	10	20	31	30	156
ovary-testis	0	0	0	3	0	0	0	1	4
skin	19	3	9	32	11	18	18	18	128
myomeres	4	0	0	0	0	1	4	2	11
brain	19	4	11	25	14	13	14	8	108
eye	22	4	11	28	15	13	13	15	121
lateral line	4	0	2	1	0	5	2	2	16
olfactory organ	106	81	115	147	59	70	91	113	782
spinal cord	0	0	0	0	1	1	1	0	3
peripheral nerve	0	0	0	0	0	0	1	0	1
nerve ganglion	0	0	0	0	1	0	0	0	1
gill	113	95	158	163	89	125	132	145	1020
pseudobranch	3	2	1	6	3	6	0	0	21
swim bladder	3	0	3	6	0	0	3	0	15
mesentery	55	35	47	71	10	26	57	71	372
vertebra	0	0	0	0	1	0	1	0	2
TOTAL	1030	738	1224	1345	557	872	960	1073	7799

Representative histological lesions and comparable normal organs were photographed (Appendix B). If an etiological agent was identified, the lesion was categorized by the etiology. Otherwise, histological lesions and other observations were classified using the following definitions:

Acidophilic granular cells. Cells with granular, eosinophilic cytoplasm and often described as normal cells in epidermis (Roberts 1978), intestine (Bullock 1963), and blood (Kindred 1971). The presence of these cells in tissue without other change was not considered a lesion.

Atrophy. A reduction in size of an organ or tissue from either reduced cell size or number. Causes of atrophy include ischemia, malnutrition, pressure, decreased physiological demand, hormonal changes, and toxicosis.

Basophilia. Increased affinity of tissue for basic stains such as hemotoxylin.

Chromatophores. Pigment containing cells normally present in skin and, in varying quantities, in internal organs. If pigment containing cells were clustered they were termed macrophage centers (see below). Chromatophores in tissue without other changes were not considered lesions.

Congestion. An increased amount of blood in the vessels of an organ. This can result from increased function, inflammation, or decrease in venous drainage. The presence of an increased amount of blood due to increased flow of an artery to an organ is also termed active congestion or hyperemia, as distinguished from passive congestion resulting from decreased venous drainage. Separating active and passive congestion by histological observation is sometimes unreliable unless the etiology can be determined, so these were both included in this definition. Congestion is often observed in fish spleens, but the pathological importance of changes in blood content of this organ is unknown.

Dilated renal tubules. Increased lumen diameter of renal tubules. This lesion could result from increased tubular pressure, atrophy of tubular epithelium, or unknown causes. The importance of this lesion in fish is uncertain but it sometimes occurs in fish with no other signs of disease.

Edema. An accumulation of excessive fluid in tissues. This fluid is eosinophilic and displaces the tissue around it. Abnormal spaces that could result from edema were seen in some tissues but these spaces were not considered edema unless an eosinophilic fluid was observed in the space. Tissue spaces beneath epithelia without visible edematous precipitate were termed separation of epithelium and may be artifacts. Edema can result from infectious diseases, toxicosis, or trauma.

Fatty change. Accumulation of lipids in cytoplasmic vacuoles. The lipid can be demonstrated by staining with lipophilic stains if the tissue has not been exposed to solvents. The pathological significance of this observation in fish liver probably varies depending on the species. Some fish species normally have hepatic "fatty change" indicating a difference in hepatic lipid metabolism compared to other fish species or mammals. The lipid vacuoles in fish hepatocytes can be distinguished from cytoplasmic glycogen accumulations by the spherical shape and well defined edges of the lipid vacuole. Fatty change is also termed fatty degeneration.

Foreign body granuloma. Formation of granulation tissue or fibrous connective tissue capsule around a foreign object. Host response to the foreign object is usually minimal except for formation of connective tissue. The most common cause of this lesion is the presence of a parasite or injury caused as a parasite migrates.

Glycogen vacuolation. Accumulation of glycogen in the cytoplasm so that after fixation in an aqueous fixative and paraffin sectioning the cytoplasm has empty vacuoles. Glycogen accumulation in hepatocytes occurs normally in many fish species and was not considered a lesion. Glycogen vacuolation can be separated from fatty change by histochemistry or by the irregular shapes and ill-defined margins of the spaces left after the glycogen is dissolved by water. In some fish species glycogen content of hepatocytes is related to the type and quantity of food.

Hemorrhage. Escape of blood from a vessel. Hemorrhage is indicated by the presence of blood outside of vessels, and the length of time since hemorrhage occurred is indicated by the appearance of blood cells and organization of the blood that left the vessel. Hemorrhage has many causes including mechanical trauma that could accompany capture of the fish.

Hyaline degeneration. A deterioration in tissue resulting in a homogeneous, translucent, and acidophilic appearance. Hyaline deneration is a descriptive term and does not indicate any particular change in cellular composition.

Hydropic degeneration. A condition in which cells absorb water and become vacuolated and swollen. This condition was not differentiated from cloudy swelling resulting from absorption of water.

Hyperplasia. Increased cell numbers in a tissue. Hyperplasia is most commonly seen in the epithelium covering gill lamellae where it is a response to many types of toxicants, pathogens, and suboptimal environmental conditions. Gill epithelium hyperplasia can result in the spaces between lamellae filling with epithelium so that the surface area of the gills used for respiration is reduced. Hyperplasia of some tissues can result from increased physiological function.

Hypertrophy. Abnormal increase in cell size.

Inflammation, acute. Inflammation is a dynamic pathologic process affecting blood vessels and tissues adjacent to an injury caused by a pathogen, toxicant, or physical agent. Histologically, acute inflammation is indicated by dilated blood vessels, infiltration of white blood cells, and an exudate. Acute inflammation can be categorized by the nature of the exudate that occurs in the lesion.

Inflammation, chronic. A prolonged inflammation recognized by the infiltration of leukocytes or proliferation of fibroblasts. Exudate is removed or organized in a chronic lesion. Chronic inflammation is caused by a persistent agent and is characteristic of certain fungal, bacterial, and parasitic pathogens. Chronic inflammation found in this study is probably related to parasitism in most cases. Chronic inflammation resulting in a granuloma associated with a foreign body was classified separately as foreign body granuloma.

Macrophage centers. An aggregation of macrophages in internal organs. These macrophages often contain pigments resulting in some fish having dark colored viscera. Macrophage centers are a normal occurrence in many fish species but have been reported to increase due to age and certain diseases. Although not considered a lesion, this observation was recorded, and specimens from different locations were compared.

Metaplasia. The change of a fully differentiated tissue from one tissue type to another. For example, metaplasia can be the change of a mucosal or sensory epithelium to a stratified squamous epithelium.

Necrosis. The pathologic death of cells in a living organism. Necrosis is recognized histologically by nuclear pyknosis, karyolysis, or karyorrhexis and by loss of cell outline. The various types of necrotic processes are included together in this category except for sloughing of epithelium (see below). Necrosis results from irreversible cellular damage and is usually accomplished by inflammation. The death of cells after the organism dies (postmortem change) is not necrosis but can be confused with it because the changes in the dead cells are similar.

Nuclear pleomorphism. Cell nuclei that are not uniform in size or shape.

Rodlet cells. Cells containing distinctive rods in the cytoplasm, a basal nucleus, and an apparent cell wall. Usually associated with epithelia in various organs. Parasitic nature of these cells is controversial (Paterson and Desser 1981). These were not considered lesions.

Sloughing of epithelium. The loss of necrotic epithelial cells from a surface. The cells may be lost so that this condition is indicated by the absence of surface cells. Cells being sloughed may be adjacent to the affected organ. Surface cells may also separate from the underlying organ because of an artifact resulting from fixation or section preparation. Separation of epithelium because of an artifact, not considered a lesion, can be recognized by the normal appearance of the cells instead of the necrotic changes in sloughed cells.

Telangiectasis. Dilation of the terminal blood vessels of an organ. In fish, this lesion is most commonly reported in gill lamellae and is also termed aneurism. Telangiectasis in gill lamellae are known to result from several causes and are sometimes found to affect a small percentage of lamellae in healthy fish.

Thrombosis. The process of blood clot formation within the heart or blood vessels of a living animal.

Unidentified lesions. Some lesions could not be identified. All of these occurred at frequencies too low to influence the results and conclusions of this study.

ULTRASTRUCTURAL EXAMINATION

Pieces of spleen from selected red snapper, gray triggerfish, wenchman, Mexican searobin, and cottonwick collected during cruise 6 were cut into pieces approximately 1-mm maximum dimension and then fixed in phosphate-buffered glutaraldehyde at 4°C. After the fixed tissues were transported to Auburn University, they were rinsed in 4°C phosphate buffer, embedded in epoxy, sectioned at approximately 70 nm with a glass knife on an ultramicrotome, and stained with uranyl acetate and lead citrate. The same blocks of tissue in epoxy were sectioned at 1 um and stained with toluidine blue for orientation. The 70-nm sections were examined and photographed with a Phillips EM 300 electron microscope.

STATISTICAL ANALYSIS

All statistical comparisons utilized computer programs from the SAS Institute Inc., Cary, North Carolina. Arc sine of liver weight to body weight ratios were compared by analysis of covariance, adjusting means for differences in fish weight at different stations. The severity of lesions was indicated by estimating the percent of the susceptible tissues affected in the organ and assigning code values to the estimated percentages as follows: 0% = 0; < 1% = 1; 1-5% = 2; 6-20% = 3; 21-50% = 4; 51-80% = 5; 81-95% = 6; 96-100% = 7. Lesion frequency and severity in different groups of fish of the same species were compared with continuity adjusted Chi-square and the Mann-Witney test, respectively. Differences in lesion frequency or severity of $P < 0.1$ were considered significant. A t-test was used to compare mean standard lengths of fish from platform stations to controls. The relationship between fish standard length and lesion severity was determined with Spearman rank correlation.

SECTION 4

RESULTS

FISH LENGTH

There were significant differences between the standard lengths of some species collected at PLA and PLB compared to fish of the same species collected from control stations (Table 6). Creole-fish (cruises 7, 8 and all cruises combined), gray triggerfish (cruises 3, 4, 6, 7, and all cruises combined), red snapper (cruise 6), and vermilion snapper (cruise 8) were significantly smaller at PLA or PLB than were control fish. Creole-fish (cruise 6), Mexican searobin (cruise 7 and all cruises combined), and wenchman (cruises 3 and 7) were significantly larger at PLA or PLB than controls.

GROSS LESIONS

Grossly visible lesions, both external and internal, were generally related to parasitism. The types and number of gross lesions varied with the species of fish (Table 7). The granulomas found during necropsy were usually in mesenteries and were a consistent finding in scamp (75% had either granulomas or cysts containing cestodes in the mesenteries). Grossly visible parasites were nematodes, leeches, cestodes, and isopods. With the exception of parasites and lesions probably resulting from parasitism, the number of fish with gross lesions was insignificant (6 of 1096 fish examined). There were no significant differences in prevalence of parasite-related gross lesions between groups of fish within a species.

Table 6. Fish with significantly different ($P < 0.05$) mean standard length in samples collected near drilling platforms than from control areas. Standard lengths are means (sample size), and comparison was by t-test.

Species	Cruise	Mean length (mm)	
		Control	Platform
creole-fish	6	177 (20)	236 (12)
creole-fish	7	182 (17)	102 (14)
creole-fish	8	197 (15)	133 (11)
creole-fish	5-8	181 (72)	155 (37)
gray triggerfish	3	406 (7)	232 (13)
gray triggerfish	4	376 (13)	263 (4)
gray triggerfish	6	386 (6)	174 (10)
gray triggerfish	7	401 (4)	167 (12)
gray triggerfish	1-8	377 (59)	210 (49)
Mexican searobin	7	131 (9)	147 (10)
Mexican searobin	1-8	114 (46)	125 (36)
red snapper	6	454 (14)	379 (12)
vermilion snapper	8	271 (20)	232 (15)
wenchman	3	93 (14)	137 (3)
wenchman	7	154 (10)	205 (9)

Table 7. Numbers of grossly visible lesions in fishes collected during the Flower Garden Banks Project.

Species Lesions	Cruise number and station: 1 EFG	1 WFG	1 TOTL	2 WFG	3 PLA	3 EFG	3 WFG	3 TOTL	4 PLA	4 CNA	4 EFG	4 WFG	4 TOTL	5 EFG	5 WFG	5 TOTL	6 PLB	6 EFG	6 WFG	6 TOTL	7 PLB	7 EFG	7 TOTL	8 PLB	8 EFG	8 WFG	8 TOTL	Total for all cruises
red snapper																												
isopod		2	2					0			1	4	5	2		2	2	3	1	6			0	3	3		6	21
granuloma			0	3				0				1	1	1		1				0			0				0	5
dark liver			0	1				0					0			0				0			0				0	1
fish hook	1		1					0					0			0				0			0				0	1
creole-fish																												
granuloma			0					0					0	2	3	5	1			1		1	1	1	1	2	4	11
cestode			0					0					0			0		3		3			0				0	3
cyst			0					0					0			0				0		1	1				0	1
vermilion snapper																												
isopod		2	2					0					0			0				0			0			1	1	3
leech			0					0				3	3	1		1				0			0				0	4
parasite			0			1		1					0			0				0			0				0	1
granuloma	1		1	2				0					0			0				0			0				0	3
fin erosion			0					0				1	1			0				0	1		1				0	2
cottonwick																												
granuloma	1		1	4		1		1					0			0				0			0				0	6
cyst			0					0			1		1			0				0			0				0	1
isopod			0					0				1	1			0				0			0				0	1
pale liver	1		1					0					0			0				0			0				0	1
scamp																												
granuloma	7	4	11	3		3	2	5			2	3	5			0				0			0				0	24
cestode			0					0			3		3			0				0			0				0	3
nematode			0			1		1					0			0				0			0				0	1
isopod			0	1				0			1	1	2			0				0			0				0	3
gray triggerfish																												
granuloma			0	1				0	1				1			0				0			0				0	2
cyst			0					0				1	1			0		1	1	2			0				0	3
red hind																												
granuloma			0	1				0					0			0				0			0				0	1
isopod			0					0			1		1			0				0			0				0	1
blackfin snapper																												
granuloma			0			1		1					0			0				0			0				0	1
yellowedge grouper																												
granuloma			0		1			1					0			0				0			0				0	1
cestode			0					0		1			1			0				0			0				0	1
rock hind																												
granuloma			0			1		1					0			0				0			0				0	1
southern hake																												
granuloma			0		1			1					0			0				0			0				0	1
Totals	11	8	19	16	2	8	2	12	1	1	9	15	26	6	3	9	3	7	2	12	1	2	3	4	4	3	11	108

LIVER WEIGHT

Liver weight to body weight ratios varied depending on fish species (Table 8). When fish from stations with active drilling platforms were compared to fish of the same species collected during the same cruise at control stations (Table 8), significantly higher ($P < 0.05$) liver weights were present in gray triggerfish (cruises 4 and 6), wenchman (cruises 6 and 7), and creole-fish (cruise 7). There were significantly larger livers in creole-fish from EFG than from WFG during cruise 5. The red snappers collected from PLB during cruise 6 had liver weights similar to those of red snappers from EFG and significantly smaller than livers from this species collected from WFG. Comparison of liver weights in fish from all cruises combined indicated larger livers in sash flounder, gray triggerfish, red snapper, creole-fish, and wenchman from PLA or PLB than from control stations (Table 8). Mexican searobin livers from PLB and EFG were larger than those of PLA, which were collected during different cruises.

HISTOLOGICAL OBSERVATIONS

Histological observations considered to be lesions are listed in Table 9, and a complete list of lesions for each species is given in Appendix A. Other histological observations were macrophage centers, acidophilic granular cells, separation of epithelium from underlying tissue, rodlet cells, and glycogen vacuolation. Hepatic fatty change in gray triggerfish was not considered a lesion because of its consistent occurrence in this species.

Macrophages usually containing pigment were often clustered in the liver, spleen, head kidney, trunk kidney, mesentery, atrium, and less commonly in the

Table 8. Liver weight to body weight ratios (X 10^3) for fish collected during the Flower Garden Banks Project. Number in parenthesis is sample size.

Species	Station	Cruise Number 2	3	4	5	6	7	8	all cruises
three-eye flounder	PLA	20 (1)	11 (2)[a]						14 (3)
	CNA		7.7 (1)[a]						7.7 (1)
	BRC						11 (1)[a]		11 (1)
	PLB					6.7 (1)[a]	17 (1)[a]	18 (5)[a]	17 (7)
blackfin snapper	EFG		7.8 (1)						7.8 (1)
red porgy	EFG		5.7 (2)						5.7 (2)
	WFG		8.0 (10)						8.0 (10)
Mexican searobin	CNA		28 (2)[a]						28 (2)
	PLA		8.0 (1)[a]	17 (11)[a]					16 (12)
	EFG				8.1 (1)[a]				8.1 (1)
	BRC					27 (9)[a]	23 (9)[a]	24 (9)[a]	24 (27)[b]
	PLB					29 (4)[a]	22 (10)[a]	32 (10)[a]	27 (24)[b]
almaco jack	PLA		12 (1)						12 (1)
sash flounder	PLA		16 (2)[a]	19 (3)[a]					18 (5)
	EFG				19 (1)[a]				19 (1)
	BRC						16 (8)[a]	19 (6)[a]	17 (14)
	PLB					35 (10)[a]	22 (9)[a]	15 (2)[a]	27 (21)[c]
gulf hake	EFG				17 (1)[a]				17 (1)
	BRC					13 (1)			13 (1)
	PLB					22 (5)	22 (1)		22 (6)
gray triggerfish	WFG	31 (2)	38 (5)	36 (5)		29 (2)	12 (4)		30 (18)
	EFG		72 (2)	30 (8)	24 (10)	33 (4)			31 (24)
	PLB					49 (10)[d]	37 (12)		43 (22)[d]
	PLA		57 (13)	56 (4)[d]					56 (17)[d]
rock sea bass	PLA	10 (2)		11 (6)[a]					11 (8)
	PLB					20 (1)			20 (1)
cubbyu	PLA	20 (2)		5.9 (1)					15 (3)
cottonwick	WFG	11 (23)	6.6 (3)[a]	9.4 (6)	7.4 (8)				9.0 (40)
	PLB					5.4 (5)			5.4 (5)
	EFG		19 (1)	6.9 (10)	6.7 (2)				7.8 (13)

Table 8 continued...

Species	Station	Cruise Number 2	3	4	5	6	7	8	All Cruises
red snapper	WFG	8.5 (27)	8.0 (6)[a]	6.5 (10)		11 (3)			6.9 (48)
	EFG		2.1 (1)	6.0 (9)	5.2 (10)	6.6 (10)[e]			5.8 (30)
	PLB					7.3 (12)[e]	6.1 (9)		6.8 (21)
	CNA		2.0 (1)	7.3 (1)					4.6 (2)
	PLA		19 (1)	12 (1)					16 (2)[f]
creole-fish	EFG				12 (10)[e]	11 (1)	8.6 (7)		11 (18)[e]
	WFG				8.6 (10)		5.0 (3)		7.8 (13)
	PLB					8.8 (2)	22 (14)[e]	18 (1)	20 (17)[e]
scamp	WFG	8.5 (4)	4.1 (1)	5.1 (6)					6.3 (11)
	EFG		5.1 (1)	5.6 (11)					5.6 (12)
vermilion snapper	WFG	10 (31)	8.9 (5)	7.1 (13)	8.3 (10)	7.6 (11)	5.1 (10)		8.0 (78)
	PLB					8.6 (10)	6.3 (10)		20 (24)
	EFG			8.6 (5)	6.4 (10)	6.3 (9)			6.9 (24)
blackeared bass	PLA			23 (3)[a]					23 (3)
southern hake	PLA	8.0 (1)	27 (9)	16 (3)					23 (13)
	CNA		22 (1)	12 (4)					14 (5)
	BRC						29 (1)		29 (1)
	PLB					18 (2)	29 (1)		22 (3)
red hind	WFG	9.1 (2)							9.1 (2)
wenchman	CNA		12 (13)[a]	10 (2)[a]					12 (15)
	PLA		8.5 (3)[a]	16 (9)[a]					14 (12)
	EFG				17 (2)[a]				17 (2)
	BRC					14 (10)[a]	14 (10)[a]	16 (8)[a]	15 (28)
	PLB					28 (6)[ac]	14 (9)[ac]	19 (9)[a]	20 (24)[g]
yellowedge grouper	PLA		13 (4)						13 (4)
	CNA			10 (1)					10 (1)

[a] Livers were weighed after fixation.
[b] Significantly different ($P < 0.05$) than specimens from PLA.
[c] Significantly different ($P < 0.05$) than specimens from BRC.
[d] Significantly different ($P < 0.05$) than specimens from EFG and WFG.
[e] Significantly different ($P < 0.05$) thna specimens from WFG.
[f] Significantly different ($P < 0.05$) than specimens from all other stations.
[g] Significantly different ($P < 0.05$) than specimens from all stations except EFG.

Table 9. Number of histological lesions found during the Flower Garden Banks Project.

Lesion	Cruise number 1	2	3	4	5	6	7	8	totals
atrophy	0	0	1	0	0	0	0	0	1
basophilia	0	0	0	7	0	0	2	0	9
congestion	3	1	14	4	0	9	21	5	57
dilated renal tubules	1	0	3	0	0	0	0	0	4
edema	13	9	18	22	5	11	10	15	103
fatty change	0	0	0	12	2	5	14	9	42
foreign body granuloma	78	49	63	32	6	29	7	29	293
hemorrhage	0	1	9	0	0	2	0	0	12
hyaline degeneration	1	0	0	0	0	0	0	0	1
hydropic degeneration	1	0	0	0	0	1	0	0	2
hyperplasia	4	5	4	0	2	6	6	18	45
hypertrophy	0	0	0	0	1	0	0	1	2
inflammation, acute	2	3	2	4	0	0	0	15	26
inflammation, chronic	25	19	16	14	12	20	21	1	128
metaplasia	1	0	0	0	0	0	0	0	1
necrosis	6	8	7	7	3	2	3	1	37
nuclear pleomorphism	0	0	0	0	0	0	1	0	1
sloughing of epithelium	0	3	11	7	7	2	3	1	34
telangiectasis	9	3	4	7	5	7	7	10	52
thrombosis	0	0	0	0	0	0	1	0	1
unidentified lesions	5	2	3	2	3	0	5	8	28
epitheliocystis	2	4	2	3	3	2	1	3	20
bacteria, unidentified	0	0	2	0	0	0	0	3	5
protozoa, sporozoan	4	5	8	3	5	5	2	7	39

(continued)

Table 9 continued...

Lesion	Cruise number 1	2	3	4	5	6	7	8	totals
protozoa, flagellate	0	0	0	0	0	0	1	0	1
protozoa, ciliate	0	0	1	0	0	0	1	1	3
trematode	15	5	6	19	1	4	12	6	68
cestode	8	13	13	14	5	0	2	9	64
nematode	8	11	23	39	11	8	17	21	138
crustacean (except isopods)	0	0	1	0	0	6	1	3	11
isopod	0	0	0	0	1	2	0	0	3
parasite, unidentified	9	3	0	4	0	5	0	0	21
Totals	195	144	211	200	72	126	166	166	1,280

gonads. These pigmented macrophage centers have been referred to as melanin-macrophage centers (Roberts 1975), although they often have pigments other than melanin and occasionally have no pigment of any kind. Because macrophage centers are a normal constituent of internal organs in many fish species, they were not considered lesions in this study.

Pigments in macrophage centers of the spleen, trunk kidney, head kidney, liver, and heart from five fish species were identified as melanin, lipofuscin, or hemosiderin (Table 10). The pigments were identified by natural color, histochemistry, and ultrastructure. Melanin consisted of dark brown or black granules that were bleached by peracetic acid (Pearse 1972). Ultrastructurally, melanin was homogeneous, electron-dense, ovoid bodies averaging 35 by 52 nm in size. Lipofuscin is positive with periodic acid-Schiff (Luna 1968) and appeared ultrastructurally as amorphous, moderately electron-dense material or as masses of swirled fibers. Hemosiderin is positive for the Prussian blue reaction (Humason 1979). Ultrastructurally hemosiderin appeared as clumped, electron-dense particles with diameters typically in the 5 to 8 nm range.

The type of pigments present depended on the species and organ (Table 10). The frequency of macrophage center occurrence in creole-fish livers and trunk kidneys was higher in specimens collected in control areas than in those from platforms (Table 11). The percentage of organ volume occupied by macrophage centers was higher in gray triggerfish spleens and in creole-fish spleens, livers, and trunk kidneys from control areas than from platforms (Table 12). The volume of spleen, liver, and trunk kidney occupied by macrophage centers increased in larger gray triggerfish, creole-fish, cottonwick, vermilion snapper, red snapper, Mexican searobin, sash flounder,

Table 10. Pigments found during histological and ultrastructural examination of organs from five fish species during the Flower Garden Banks Project. H = Hemosiderin, L = Lipofuscin, M = Melanin.

	Organ				
Species	spleen	trunk kidney	liver	head kidney	heart
red snapper	H,L,M	H,L,M	H,L,M	H,L,M	L
gray triggerfish	H,L,M	H,L,M	H,L,M	H,L,M	L
cottonwick	H,L,M	H,L,M	H,L,M	H,L,M	L
Mexican searobin	H,L,M	H,L,M	H,L,M	L,M	L
wenchman	H,L,M	H,L,M	H,L,M	L,M	L

Table 11. Histological observations having significantly different (P<0.1) prevalences in fish collected near drilling platforms compared to control fish. Samples were compared by continuity adjusted Chi-square.

Species	Cruise	Observation	Organ	Frequency(N) control	Frequency(N) platform	Probability[a]
creole-fish	6	any acute lesion[b]	all	0 (12)	42 (12)	0.0444
	7	macrophage centers	liver	100 (9)	11 (9)	0.0009
	8	chronic inflammation	liver	0 (12)	36 (11)	0.0805
	8	congestion	spleen	100 (4)	0 (8)	0.0049
	5-8	congestion	spleen	76 (17)	24 (25)	0.0024
	5-8	edema	gill	0 (63)	8 (37)	0.0915
	5-8	any acute lesion	gill	2 (63)	19 (37)	0.0069
	5-8	any acute lesion	all	8 (64)	24 (37)	0.0439
	5-8	epithelial separation	gill	52 (63)	84 (37)	0.0033
	5-8	macrophage centers	liver	100 (36)	18 (11)	0.0001
	5-8	macrophage centers	trunk kidney	90 (10)	0 (5)	0.0052
gray triggerfish	3	nematodes	gill	57 (7)	0 (13)	0.0138
	1-8	nematodes	gill	53 (57)	8 (48)	0.0001
red snapper	3	hyperplasia	gill	0 (19)	100 (1)	0.0341
	8	epithelial separation	gill	62 (13)	100 (11)	0.0707
	1-8	epithelial separation	gill	54 (117)	76 (33)	0.0397
sash flounder	4	basophilia	liver	0 (2)	100 (5)	0.0855
southern hake	1-8	fatty change	liver	22 (9)	75 (16)	0.0330
	1-8	any acute lesion	liver	22 (9)	75 (16)	0.0330
	1-8	any acute lesion	all	33 (9)	76 (17)	0.0841
vermilion snapper	1-8	edema	gill	6 (160)	18 (33)	0.0361
	1-8	any acute lesion	gill	16 (160)	30 (33)	0.0811
wenchman	3	hyperplasia	gill	0 (14)	67 (3)	0.0235

[a]The listed values are the probabilities that there is no difference between samples.

[b]Lesions included were congestion, edema, hemorrhage, telangiectasis, fatty change, hyperplasia, hypertrophy, pleomorphic nuclei, acute inflammation, and necrosis.

Table 12. Histological observations having significant difference ($P < 0.1$) in severity between fish collected near drilling platforms and control fish. Comparison was with the Mann-Whitney test.

Species	Cruise	Observation	Organ	Mean quantity[a] (N) control	Mean quantity[a] (N) platform	Probability[b]
creole-fish	7	macrophage centers	liver	1.89 (9)	0.11 (9)	0.0006
	8	congestion	spleen	4.25 (4)	0.00 (8)	0.0085
		macrophage centers	spleen	3.20 (5)	1.38 (8)	0.0043
		macrophage centers	liver	2.00 (6)	0.50 (2)	0.0668
	5-8	congestion	spleen	3.24 (17)	1.36 (25)	0.0211
		epithelial separation	gill	1.11 (63)	1.76 (37)	0.0128
		macrophage centers	spleen	2.65 (17)	1.48 (21)	0.0001
		macrophage centers	liver	1.89 (36)	0.18 (11)	0.0001
		macrophage centers	trunk kidney	1.40 (10)	0.00 (5)	0.0071
gray triggerfish	3	nematodes	gill	1.14 (7)	0.00 (13)	0.0433
		macrophage centers	spleen	3.20 (5)	2.00 (8)	0.0043
	4	macrophage centers	spleen	3.10 (7)	2.00 (3)	0.0227
	6	macrophage centers	spleen	3.00 (3)	2.00 (6)	0.0282
	7	fatty change	liver	2.50 (4)	6.42 (12)	0.0153
		macrophage centers	spleen	3.00 (2)	2.00 (11)	0.0934
	8	macrophage centers	spleen	3.00 (8)	2.38 (8)	0.0406
	1-8	nematodes	gill	1.07 (57)	0.13 (48)	0.0001
		fatty change	liver	5.93 (59)	6.53 (47)	0.0469
		macrophage centers	spleen	3.09 (34)	2.08 (36)	0.0001
Mexican searobin	8	epithelial separation	gill	2.14 (7)	0.88 (8)	0.0562
red snapper	8	epithelial separation	gill	1.46 (13)	3.18 (11)	0.0050
	1-8	epithelial separation	gill	1.61 (117)	2.21 (33)	0.0610
sash flounder	4	basophilia	liver	0.00 (2)	5.60 (5)	0.0814
	7	epithelial separation	gill	2.56 (9)	1.44 (9)	0.0851
	1-8	epithelial separation	gill	3.43 (21)	2.42 (26)	0.0740
southern hake	1-8	fatty change	liver	1.56 (9)	5.00 (16)	0.0445
wenchman	3	hyperplasia	gill	0.00 (14)	1.33 (14)	0.0890

[a] The percentage of the organ affected by the lesion was estimated and the following code values assigned: 1 = less than 1%, 2 = 1-5%, 3 = 6-20%, 4 = 21-50%, 5 = 51-80%, 6 = 81-95%, and 7 = 95-100%.

[b] Number listed is the probability of no difference between samples.

and wenchman (Table 13). The differences in macrophage centers in fish from different locations is probably related to the difference in size of the creole fish and gray triggerfish from the control versus platform stations (Table 6).

Another cell type observed in several species was acidophilic granular cells. These cells were common in some of the species examined during this study, especially sash flounder and red porgy. Acidophlic granular cells were seen most frequently in the submucosa of the intestine and stomach, hematopoietic tissue of the trunk kidney, and areolar connective tissue of mesentery. They were present in many specimens that did not have lesions and were not observed to be associated with inflammation during this study.

Separations of epithelia from the underlying tissues occurred in the intestinal mucosa, olfactory organ, and gill lamella. These separations were considered artifacts and not included in the lesion list if no edematous fluid or inflammatory exudate was in the space under the epithelium and the epithelial cells appeared normal. If degeneration of the epithelium was detected, the lesion was described as epithelial sloughing. However, the epithelial separation from gill lamellae was more common or affected more of the gill surface in some specimens than in others so significant differences are considered below.

Most histological lesions found in fish examined during this project were parasites, chronic lesions probably caused by parasites, or acute lesions including those that could result from exposure to toxicants. Because of the difference in the life histories, habitat, and phylogenetic position of the

Table 13. Histological observations with significant correlation ($P < 0.1$) between percentage of organ volume affected and fish standard length. Spearman correlation coefficients and the probability that there is a significant correlation is given.

Observation	Species	Cruise	Organ	Correlation	Probability
macrophage centers	cottonwick	1	liver	0.5117	0.0033
			trunk kidney	0.4952	0.0040
			spleen	0.3953	0.0686
		2	liver	0.4040	0.0559
			spleen	0.6180	0.0017
		3	trunk kidney	0.5701	0.0108
		5	trunk kidney	0.6049	0.0639
		6	liver	1.0000	0.0001
		1-8	liver	0.3401	0.0004
			trunk kidney	0.4729	0.0001
			spleen	0.3495	0.0010
	creole-fish	5	trunk kidney	0.4701	0.0569
		6	liver	0.6007	0.0025
			trunk kidney	0.5147	0.0597
			spleen	0.5962	0.0244
		7	trunk kidney	0.7718	0.0012
			spleen	0.7424	0.0001
		8	trunk kidney	0.7674	0.0001
			spleen	0.6989	0.0006
		5-8	trunk kidney	0.6948	0.0001
			liver	0.7465	0.0001
			spleen	0.7784	0.0001
	gray triggerfish	3	spleen	0.7143	0.0013
		4	trunk kidney	0.7978	0.0001
		6	liver	0.6078	0.0125
			trunk kidney	0.6056	0.0129
			spleen	0.8018	0.0010
		7	liver	0.7212	0.0016
			trunk kidney	0.8672	0.0001
			spleen	0.4278	0.0983
		8	liver	0.7126	0.0013

Table 13 continued....

Observation	Species	Cruise	Organ	Correlation	Probability
			trunk kidney	0.6786	0.0054
			spleen	0.7782	0.0001
		1-8	liver	0.5148	0.0001
			trunk kidney	0.6876	0.0001
			spleen	0.6546	0.0001
	Mexican searobin	4	trunk kidney	0.7975	0.0057
			spleen	0.7354	0.0099
		5	trunk kidney	0.9258	0.0080
		8	spleen	0.5926	0.0075
		1-8	trunk kidney	0.2211	0.0679
			spleen	0.2313	0.0597
	red snapper	1	spleen	-0.3516	0.0782
		3	spleen	0.5332	0.0187
		8	trunk kidney	0.7316	0.0004
		1-8	trunk kidney	0.3101	0.0005
	sash flounder	5	trunk kidney	0.9487	0.0513
		1-8	trunk kidney	0.3422	0.0266
			spleen	0.1020	0.0585
	vermilion snapper	2	liver	0.3307	0.0742
		3	spleen	0.4052	0.0684
		6	trunk kidney	0.3696	0.0991
		1-8	liver	0.1451	0.0476
			spleen	0.1621	0.0453
	wenchman	3	trunk kidney	0.6718	0.0044
			spleen	0.6814	0.0103
		6	spleen	0.8199	0.0068
		7	trunk kidney	0.5414	0.0167
			spleen	0.7704	0.0008
		1-8	liver	0.4503	0.0001
			trunk kidney	0.2991	0.0074
			spleen	0.6133	0.0001
nematodes	gray triggerfish	3	gill	0.6289	0.0030
		6	gill	0.4539	0.0892
		7	gill	0.7187	0.0038
		8	gill	0.5853	0.0085
		1-8	gill	0.5836	0.0001

fish species examined, each species was considered separately. Comparisons of specimens from different stations were made by cruise and then, for some species, for the entire project. Because of the lack of fish from a drilling platform station during cruises 1 and 2, fish from the first three cruises are compared together.

Cruises 1-3

Red snappers collected during the first three cruises often had foreign body granulomas and chronic inflammation associated with the presence of parasites. Other red snapper histological lesions included edema, hyperplasia, and telangiectasis in gills, hemorrhage in olfactory organs, and congestion of spleen, olfactory organs, and livers. Edema in gill lamellae was the only non-parasitic lesion present in red snapper from all three crusies. Of the 92 red snapper gills examined for these cruises, 22% were edematous, but the occurance of this lesion in fish from different stations was similar. The frequency of gill epithelium hyperplasia was significantly higher ($P < 0.05$) at PLA than at control stations during cruise 3 although only one specimen was from PLA (Table 11).

The common lesions of vermilion snappers collected during the first two cruises were probably all related to parasites. During cruise 3, congestion and edema were present in low percentages of vermilion snappers. Lesions in this species were generally similar at different stations.

The most common finding in scamp was the grossly visible cestode lesions and most histological lesions in this species were also related to parasitism. Hyperplasia of the gill epithelium occurred in two of four fish examined from WFG during cruise 1 but did not occur at other stations or for other cruises. Edema was present in 18% of the 11 gills from EFG and in 30% of the ten gills from WFG for cruise 3.

Cottonwick histological lesions were generally related to parasitism. For cruise 1, telangiectasis occurred in 11% of the cottonwick gills from EFG but in none of the gills from WFG. Edema occurred in two of 15 cottonwick gills from WFG during Cruise 1 and in one of ten gills from EFG during Cruise 3.

In addition to parasite-related lesions, edema, congestion, and telangiectasis were present in gray triggerfish. This species collected during cruise 3 was one of only three opportunities during the first three cruises to compare fish from PLA to the same species from other stations. The gray triggerfish from PLA had 27% and 15% frequencies of splenic congestion and gill telangiectasis, respectively, lesions not found in this species from other stations. Gill edema also occurred in gray triggerfish from PLA and WFG but not in those from EFG. A significant difference ($P < 0.05$) between stations was the absence of nematode infection in gills from the 13 specimens examined from PLA during cruise 3, while 57% of those from other stations combined during the first three cruises were infected (Table 11 and 12).

Wenchmen were collected from both PLA and CNA during cruise 3; however, the small sample size at PLA (3) hinders this comparison. Only three of the 34 organs from fish collected at PLA had lesions, similar to the frequency at CNA. Most lesions at CNA probably resulted from parasite infestations. A significant difference between wenchmen from these two stations was the higher frequency ($P < 0.05$) and greater severity ($P < 0.1$) of gill hyperplasia at PLA compared to CNA (Tables 11 and 12).

Red porgy was examined only during cruise 3 and only from WFG and EFG. Gills from this species had more lesions than other organs. The most frequently observed histological lesion was gill edema (24%) which was slightly more prevalant at WFG (30%) than at EFG (18%).

Other species of fish examined during cruise 1 (rock sea bass and dusky flounder), cruise 2 (red hind, wenchman, southern hake, three-eye flounder, rock sea bass, and cubbyu), and cruise 3 (yellowedge grouper, blackfin snapper, southern hake, three-eye flounder, sash flounder, Mexican searobin, red hind, and almaco jack) had sample sizes two small to be used as indicators of the lesions present in these species.

Cruise 4

There were seven species collected from PLA and at least one other station during Cruise 4, but one of these species, red snapper, was represented by only one specimen at PLA. Rock sea bass and cubbyu were collected from PLA only and cottonwick, scamp, shortwinged searobin, vermilion snapper, and yellowedge grouper were collected during cruise 4 but not from PLA.

The most frequent histological lesion in red snapper was edema in gill lamellae. This lesion occurred in fish from all stations and the number of red snapper examined from PLA was too low for a reliable comparison between stations.

Gray triggerfish from PLA had a higher frequency of edema and telangiectasis in gill lamellae than those from EFG or WFG. The gray triggerfish gills from PLA were not infected by the nematode present in gray triggerfish gills from other stations.

Mexican searobin, wenchman, and blackeared bass from PLA and CNA had only parasite-related lesions occurring in more than one fish, and there were no significant differences in prevalence of lesions in this species.

Sash flounder from PLA had fatty change and significantly greater ($P < 0.1$) prevalence of heptic basophilia; this change was not present in sash flounder from CNA.

Southern hake from CNA had fatty change in hepatocytes and gill edema that were not found in this species collected at PLA.

Cruise 5

Specimens were not obtained from a station with an active drilling platform during cruise 5 but were sampled from the region of the East Flower Garden that was included in the PLB station during cruises 6-8. Most of the types of histological lesions found in fish from other cruises were present in fish from cruise 5.

Gray triggerfish had a 70% prevalence of nematodes in the gills. This was the only lesion found in this species. Cottonwicks had 10-13% prevalence of hepatic fatty change, gill lamella telangiectasis, and chronic inflammation and epithelial sloughing of the olfactory epithilium. Red snapper had a 20% prevalence of gill lamella edema and a 30% prevalence of olfactory organ epitheial sloughing. Creole-fish had a 20% prevalence of chronic inflammation of the liver and a 10% prevalence of hepatic necrosis. Mexican searobins had no acute lesions. Wenchman had a 20% prevalence of gill lamella telangiectasis, edema, and hyperplasia. Vermilion snappers had 10-20% prevalence of gill lamella edema and telangiectasis, chronic liver inflammation, and olfactory organ epithelial sloughing. Sash flounder did not have lesions except those related to parasitism. Gulf hake had a 25% prevalence of hepatic fatty change. The only lesion found in southern hake was chronic inflammation in the one intestine examined.

Cruise 6

There were seven species collected from PLB and at least one other station during cruise 6. None of the specimens collected from artificial habitats were included in this report because they were species for which controls were not available. An additional five species were collected at PLB that had been collected at a control station during other cruises. The three-eye flounder, rock sea bass, cottonwick, and gulf hake collected at PLB had no lesions except those related to parasites. In addition, the prevalence of the only non-parasitic lesion in gray triggerfish collected at PLB was only 11%. There were no significant differences ($P > 0.1$) in prevalence or severity of gray triggerfish lesions during cruise 6.

Red snappers from PLB had a variety of histological lesions. The most prevalent lesion was edema in gill lamellae (36%). Prevalence of other lesion types (heptic fatty change, hemorrhage in olfactory organ, and hyperplasia and telangiectasis in gills) was less than 20%, but 75% of the fish had some type of non-parasitic lesion, 50% had chronic, non-parasitic lesions, and 42% had acute non-parasitic lesions. The number of red snappers collected from other stations during cruise 6 was insufficient for comparison.

Creole-fish from PLB had a 67% prevalence (significantly higher than controls, $P < 0.05$) of acute non-parasitic lesions (Table 11) and an 83% prevalence of both acute and chronic non-parasitic lesions. However, most of the acute lesions were splenic congestion or gill lamellae telangiectasis, only 25% of these fish had acute lesions other than congestion and telangiectasis. Except for splenic congestion, acute lesions were absent from creole-fish collected from other stations during cruise 6.

Mexican searobins from PLB had gill telangiectasis (25%) and liver fatty change (25%) in addition to the chronic and parasitic lesions. These acute lesions were absent from BRC Mexican searobins collected during cruise 6.

Wenchman from PLB had gill lamella edema (40%) and trunk kidney necrosis (17%) for a 50% prevalence of acute non-parasitic lesions. These lesions were not present in wenchman collected at BRC during cruise 6, but one of the BRC wenchman had gill epithelium hyperplasia.

Vermilion snapper from PLB had gill lamella edema (30%), gill lamella telangiectasis (10%), and sloughing of the olfactory organ epithelium that were not present in this species collected from WFG. However, WFG vermilion snappers had hemorrhage in the liver (9%) and gill epithelium hyperplasia (18%).

Sash flounder from PLB had liver fatty change (20%) and gill epithelium hyperplasia (9%). This species was not collected at other stations during cruise 6.

Only one southern hake liver was examined and it had fatty change. No other identified non-parasitic lesions were present in this species, which was collected only at PLB during cruise 6.

Cruise 7

There were eight species collected from PLB and at least one control station during Cruise 7. An additional two species were collected at PLB that had been collected at a control station during other cruises. The three-eye flounder and gulf hake collected at PLB had no lesions except those related to parasites.

Gray triggerfish from PLB had gill lamellae hyperplasia and telangiectasis, splenic congestion, and olfactory organ epithelial sloughing, but at prevalences of 14% or less. Gill lamellae hyperplasia and olfactory organ epithelial sloughing also occurred in this species collected at WFG. Fatty change was consistently present in gray triggerfish livers from all cruises, but during cruise 7 the percentage of the liver affected was significantly ($P < 0.5$) less in control fish (Table 12). This difference indicated a change in the control fish because all other gray triggerfish, including controls from previous cruises, had livers similar to the specimens from PLB.

Red snappers from PLB had several types of lesions but most had a prevelance of less than 12%. The most prevalent acute lesions were gill lamella edema (33%) and telangiectasis (22%). Chronic inflammation of the liver and pancreas each had a prevalence of 22%. Red snappers were not collected from other stations during cruise 7.

Four creole-fish were collected from artificial habitats attached to the leg of the drilling platform in station PLB. No significant differences were found between the creole-fish from artificial habitats and those speared at PLB. Creole-fish from PLB had a 27% prevalence of splenic congestion and a 7% prevalence of gill lamella telangiectasis and edema. However, the specimens from WFG had a 86% prevalence of splenic congestion and the specimens from EFG had a 17% prevalence of gill lamella telangiectasis and hyperplasia. One creole-fish from both EFG and WFG had olfactory organ epithelial sloughing. Chronic inflammation of the liver or olfactory organ occured in fish from all stations.

Mexican searobins from PLB had 10% or less prevalence of acute non-parasitic lesions. The specimens from BRC had a 56% prevalence of fatty change and an 11% prevalence of gill lamella edema.

Wenchman from PLB had a 22% prevalence of trunk kidney congestion and a 13% prevalence of gill lamella edema and telangiectasis. In addition, there was an 11% prevalence of fatty change and pleomorphic nuclei in the liver. Wenchman from BRC had a 50% prevalence of trunk kidney congestion and a 10% prevalence of gill lamella telangiectasis and hyperplasia.

The only identified acute non-parasitic lesion in vermilion snappers from PLB was gill lamella edema (10%). Specimens from WFG had a 10% prevalence of gill lamella hyperplasia and olfactory organ epithelial sloughing.

Sash flounder from PLB had liver fatty change (22%). Specimens from BRC had a 50% prevalence of liver fatty change and an 11% prevalence of gill lamella edema. Although the separation of epithelium from gill lamellae was considered an artifact unless an edematous precipatate was present, the percentage of the gill lamella epithelium separating from the lamellae was significantly less ($P < 0.1$) in sash flounder from PLB than from CNA.

Only one southern hake was examined from PLB, and the only acute lesion in it was a thrombus in a stomach blood vessel. One specimen was examined from BRC, and it did not have any acute lesions.

Cruise 8

There were seven species collected from PLB and at least one other station during cruise 8. One additional species was collected at PLB that had been collected at a control station during other cruises. The three-eye flounder collected at PLB had no lesions except those related to parasites.

Gray triggerfish from PLB had gill lamellae hyperplasia and telangiectasis, and olfactory organ epithelial sloughing, but these lesions were also in gray triggerfish from EFG. Only the gill lamella hyperplasia was more prevalent at PLB.

Red snappers from PLB had gill lamella edema, telangiectasis, and hyperplasia. The gill lamella edema and hyperplasia were also found in red snappers from EFG and WFG, but the gill lamella telangiectasis was present in the specimens from PLB only. Chronic inflammation of the liver, pancreas, and olfactory organ were present in red snappers from PLB and WFG. The mean percentage of the gill with separation of the lamellar epithlelium was significantly higher ($P < 0.01$) at PLB. The prevalence of gill lamella epithelium separation was also significantly higher at PLB ($P < 0.1$).

Creole-fish from PLB had a 9% prevalence of gill lamella edema, a lesion not present in creole fish from other stations. Creole-fish from both WFG and EFG had significantly more prevalent ($P < 0.01$) splenic congestion than those from PLB, and creole fish from EFG had a 50% prevalence of bacteria in liver sinusoids. Fish from PLB had a significantly higher prevalence of chronic inflammation of the liver than specimens from other stations.

Mexican searobins from PLB had a 30% prevalence of hepatic fatty change compared to 11% at BRC. Other acute non-parasitic lesions in this species were gill lamella hyperplasia and hypertrophy, both with a prevalence of 13%, and specimens from BRC also had gill lamella hyperplasia with a prevalence of 14%. The specimens from BRC had a 14% prevalence of gill lamella edema, and telangiectasis.

Wenchman from PLB had a 11% prevalence of gill lamella edema and telangiectasis, but wenchman from BRC had similar prevalence of these lesions. In addition, there was an 11% prevalence of fatty change in the liver of PLB fish.

The vermilion snappers from PLB had gill lamella edema (14%), telangiectasis (7%), and hyperplasia (29%), and hepatic congestion (7%). They also had a 14% prevalence of chronic inflammation of the liver, a lesion not found in this species from other stations. Specimens from WFG had a 25%

prevalence of gill lamella hyperplasia, and 14% prevalence of hepatic fatty change. Those from EFG had 10% prevalence of gill lamella edema.

The only non-parasitic lesion identified in sash flounder from PLB was hepatic fatty change (100%). Specimens from BRC also had a 20% prevalence of hepatic fatty change.

<u>All cruises combined</u>

When fish from platform areas were compared to controls with data from all cruises combined, several significant differences were found (Tables 11 and 12). The severity and prevalence of splenic congestion were less in creole-fish from PLB ($P < 0.05$). The frequency of gill lamellae edema, acute lesions in gills, and acute lesions in either the liver, trunk kidney, olfactory organ, gill, or mesentery were greater in creole-fish from PLB (Tables 11 and 12). The prevalence and severity of gray triggerfish gill nematodes were significantly less ($P < 0.01$) in specimens from platform areas than in controls. Gray triggerfish from the control stations also had a lower percentage of the liver affected by fatty change ($P < 0.05$). Red snappers from platform stations had a greater percentage ($P < 0.1$) of the gill affected by and a higher prevalence ($P < 0.05$) of gill lamellae epithelial separation. Sash flounder from platform stations had less of the gill affected by gill lamellae epithelial separation than control fish ($P < 0.1$). Southern hake from platform containing stations had a greater prevalence of and a greater percentage of the liver affected by hepatic fatty change than controls ($P < 0.05$). Southern hake from platform areas also had a higher prevalence of acute lesions in the liver and in any organ than controls ($P < 0.1$), but these differences resulted from the high prevalence of fatty change in fish from PLA. Vermilion snappers from platform stations had a higher prevalence of gill lamella edema and acute gill lesions than controls ($P < 0.05$ and $P < 0.1$, respectively).

SECTION 5

DISCUSSION

Most grossly visible lesions in fish from both drilling platform and control areas were related to parasitism. Granulomas and fluid-filled cysts in the mesenteries were most common in scamp and creole-fish and were caused by the cestodes sometimes found within these lesions. Granulomas and tubular formations of fibrous connective tissue were frequent findings in histological sections and were correlated to the presence of parasites migrating through or encysted in visceral organs. No change in the prevalence of granulomas in fishes collected near drilling platforms was detected.

Except for the formation of a fibrous capsule around tissue dwelling cestodes and nematodes, there was only minor host reaction to most parasites found in fishes from the Flower Garden Banks. Monogenetic trematodes and isopods were the most common gill and skin parasites, respectively, but no tissue response was visible at the attachment site. Leeches were uncommon on fishes collected during this study but did cause inflammation at their attachment site. Other parasites were relatively uncommon and caused no visible tissue reaction.

Gray triggerfish had nematodes in lymph and blood vessels of the gill filaments; similar parasites were not found in other species. The prevalence of these nematodes varied between cruises and at different locations, with a significantly reduced prevalence at drilling platform locations for some cruises and for all cruises combined because smaller fish were collected at the platforms. The nematode infestation increased in larger fish; the older fish may be more susceptible to infection, or may have more opportunities to become infected.

The smaller size of creole-fish and gray triggerfish at platforms than at control sites is probably a result of recruitment of these species to the platforms. Spearing by scuba divers was the primary method of collecting both of these species at the platforms, and most were collected within a few meters of the platform. Gray triggerfish from control stations were usually collected by hook-and-line fishing so the difference in sizes of gray triggerfish may be biased by the difference in collection method. The reason for the larger creole-fish at the platform during cruise 6 is not known but could be related to food availability. Red snappers and vermilion snappers were not collected as close to the platforms as creole-fish and gray triggerfish, but the smaller red snappers and vermilion snappers at platform areas compared to control sites may also be related to recruitment of young fish at the platform. The larger wenchman and Mexican searobins from platform areas could result from differences in habitat that were present before the platforms were constructed or as a result of increased food supply because of the environmental effects of the platforms.

The higher prevalence and larger percentage of organ volume occupied by macrophage centers in creole-fish and gray triggerfish from control areas than from platform areas is probably related to the larger size of fish from control areas. Hemosiderin and lipofuscin are pigments that accumulate in macrophages of fish with increasing age and may cause the larger macrophage centers. There were no indications in this study that the number or size of macrophage centers or the type of pigments they contained were related to disease.

The reason for the higher liver weight in fishes collected near platforms during cruises 4, 6, and 7 is not known. Changes in food supply, either quantitative or qualitative, could result in alteration of lipid and glucose metabolism and cause accumulation of these substances in hepatocytes. If food habits of fish near the platforms changed, perhaps this difference can be documented by food-habits studies. Changes in lipid content of hepatocytes were not found during the histological examination of the fish with increased liver weights, indicating that lipid metabolism was not affected. Another explanation for the greater liver weight could be the direct action of toxicants on liver size. The mechanisms involved in toxicant-related increases in liver weight may be related to hepatic enzyme induction (Tan et al. 1981).

The separation of epithelium from gill lamellae was a frequent observation in fish from all stations during the present study and may be caused or exaggerated by the techniques of fish capture, fixation, or tissue storage. This change in the gills may also indicate a defect in the basal lamina of the epithelium or a degeneration of the epithelium. This observation was not considered a lesion during this study because of its common occurrence in fish from control locations and the possibility that it was an artifact. The significant changes in prevalence and severity of gill epithelium separation in specimens from platform areas was inconsistent; it increased in creole-fish and red snapper but decreased in Mexican searobin and sash flounder. Additional study of the causes of separation of epithelium from gill lamellae is needed to determine the role of toxicants in causing this change.

Gonads of fishes collected near production platforms in the Gulf of Mexico had acidophilic granular cells, chromatophores (pigmented macrophages), leukocytic infiltration, degeneration, encapsulated cysts, helminths, and protozoa (Stott et al. 1980, 1981). Effects of production platforms on gonadal histology was considered minimal. Comparison of fish collected near production platforms in the Gulf of Mexico to fish examined in the present study are of interest because of the similarities in the habitat and species examined. The helminth lesions, leukocytic infiltrations, acidophilic granular cells, and pigmented macrophages in fish from the production-platform studies were similar to those seen in fish from the Flower Garden Banks area.

Some of the histological lesions in silverside Menidia beryllina exposed to whole crude oil (Solangi and Overstreet 1982) were also found during the present study in fish near drilling platforms: hyperplasia of gill lamella epithelium, separation of gill lamellae epithelium from underlying tissue, hepatic fatty change, and necrosis of olfactory epithelium. Hogchocker Trinectes maculatus were less responsive histologically to crude oil than silversides (Solangi and Overstreet 1982). Both of these species had other lesions not found in fishes collected near drilling platforms.

Plaice Pleuronectes platessa collected from an area contaminated by the Amoco Cadiz oil spill had hyperplasia of gill lamellar epithelium, telangiectasis of gill lamellae, and hepatic necrosis (Haensly et al. 1982), lesions also found in fish near drilling platforms in the present study. However, the predominant lesions in plaice collected from the oil-spill area were fin and tail necrosis, hyperplasia and hypertrophy of gill lamellar mucous cells, gastric gland degeneration, decreased hepatocellular lipid vacuolation, increased concentration of hepatic macrophage centers, and lateral trunk muscle fiber degeneration. Except for the decreased hepatocellular kipid vacuolation in gray triggerfish from PLB, these lesions were not found in higher prevalences or severity in fish from drilling platform areas than in control fish.

The lesions in fish exposed to petroleum during laboratory studies (Malins 1982) were not specific to petroleum toxicity or were not found in fish collected near drilling platforms during the present study. Lesions resulting from exposure to petroleum are of interest because petroleum is a possible pollutant from drilling platforms, but existing information about petroleum toxicity and the results of this project are insufficient to determine the role of petroleum in causing the lesions of fish near drilling platforms.

The comparison of fish collected at drilling platforms to those of the same species collected during the same cruise from control stations is the most direct way of determining whether drilling operations are related to occurrence of lesions. This type of comparison was possible for specimens from cruises 3-4 and 6-8. Gray triggerfish (cruises 3-4), sash flounder (cruise 4), and wenchman (cruise 3) collected at station PLA had lesions not found or present at lower frequencies in fish of the same species collected during the same cruises at control stations. Of the specimens collected at PLB, most differences were seen in fish from cruise 6 (creole-fish, Mexican searobin, wenchman, and vermilion snapper).

Fish collected near drilling platform HIA 595-D (PLA) had histological lesions that could be caused by exposure to a toxicant. The gill lamella epithelium hyperplasia on red snappers and wenchman was the most important finding in fish from PLA because it is a lesion often associated with exposure of fish to water-borne toxicants, it was present on two species, and was significantly more prevalent at the drilling location than at the control area. The basophilic hepatocytes in sash flounder from the area near HIA 595-D were also of interest, but the causes of this change are not known. Most of the southern hake from platform areas were collected during cruise 3 when only one control was collected. The difference in fatty change between southern hake from cruise 3 and those from other cruises may be related to seasonal changes in hepatocyte lipid content; effect of platforms on hepatic lipid content of this species is not known.

The greater prevalence of gill lamella edema, hepatic chronic inflammation, and the presence of at least one acute histological lesion in creole-fish collected near HIA 389-A (PLB) were consistent with exposure to a toxicant. Splenic congestion in control creole-fish indicates that accumulation of blood in the spleen is a response to trauma (caputre by hook-and-line or spearing); this response was inhibited in most of the creole-fish collected near the platform. Vermilion snapper collected near PLB also had higher frequencies of histological lesions that could have resulted from exposure to toxicants. The identity of the toxicants producing these lesions can not be determined from the results of this study because the responses of the fish were similar to those seen after exposure to a variety of chemicals.

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APPENDIX A

HISTOLOGICAL LESIONS IN FISH EXAMINED DURING THE FLOWER GARDEN BANKS PROJECT

Tables A-1 through A-8 list the histological lesions found in each species examined during cruises 1-8. Observations that were not considered lesions are not included. Hepatic fatty change is not included for gray triggerfish because it occurred in almost all specimens and is probably a normal condition for this species. Crustaceans refer to all members of this class except isopods, which are listed separately.

Table A-1 Histological lesions in fish collected during Cruise 1. The numbers listed are the frequencies of occurance in the organs examined (number of organs examined in parenthesis).

Species	Lesion	Organ	Station EFG	WFG	CNA	Total
red snapper	edema	gill	4 (14)	4 (11)	0 (2)	8 (27)
	hydropic degeneration	trunk kidney	0 (14)	0 (11)	1 (2)	1 (27)
	foreign body granuloma	heart	4 (6)	0 (1)	1 (1)	5 (8)
		stomach	2 (11)	1 (8)	1 (2)	4 (21)
		intestine	1 (2)	0 (1)	0 (1)	1 (4)
		gill	1 (14)	0 (11)	0 (2)	1 (27)
		pancreas	0 (14)	1 (19)	0 (2)	1 (25)
		testis	0 (1)	1 (1)	---	1 (2)
		mesentery	0 (6)	1 (7)	---	1 (13)
	protozoan	olfactory	2 (14)	0 (10)	0 (2)	2 (26)
		mesentery	0 (6)	1 (7)	---	1 (13)
	nematode	liver	1 (14)	0 (10)	0 (2)	1 (26)
		mesentery	1 (6)	1 (7)	---	1 (13)
	acute inflammation	liver	1 (14)	0 (10)	0 (2)	1 (26)
	parasite, unidentifed	intestine	0 (2)	0 (1)	1 (1)	1 (4)
		stomach	1 (11)	0 (8)	1 (2)	2 (21)
	cestode	liver	2 (14)	1 (10)	0 (2)	3 (26)
	trematode	gill	2 (14)	2 (11)	0 (2)	4 (27)
		heart	1 (6)	0 (1)	0 (1)	1 (8)
	telangiectasis	gill	1 (14)	2 (11)	1 (2)	4 (27)
	chronic inflammation	liver	0 (14)	1 (10)	1 (2)	2 (26)
		heart	0 (6)	1 (1)	0 (1)	1 (8)
		stomach	2 (11)	0 (8)	0 (2)	2 (21)
	unidentified	stomach	1 (11)	0 (8)	0 (2)	1 (21)
	congestion	liver	1 (14)	0 (10)	0 (2)	1 (26)
	fatty change	liver	0 (14)	0 (10)	2 (2)	2 (26)
vermilion snapper	foreign body granuloma	heart	1(11)	0 (12)	---	1 (23)
		head kidney	1(8)	1 (9)	---	2 (17)
		esophagus	1(7)	2 (10)	---	3 (17)
		gill	0(15)	1 (15)	---	1 (30)
		liver	1(13)	0 (14)	---	1 (27)
		stomach	4(12)	0 (7)	---	4 (12)
		trunk kidney	1(11)	0 (11)	---	1 (22)
		intestine	2(6)	1 (1)	---	3 (7)
	chronic inflammation	liver	0(13)	3 (14)	---	3 (27)
	parasite	stomach	0(12)	1 (7)	---	1 (19)
	necrosis	liver	1(13)	0 (14)	---	1 (27)
		gill	0(15)	1 (15)	---	1 (30)

Table A-1 continued...

Species	Lesion	Organ	Station EFG	WFG	CNA	Total
	telangiectasis	pancreas	1 (15)	0 (14)	---	1 (29)
	hyaline degeneration	liver	0 (13)	1 (14)	---	1 (27)
	hyperplasia	gill	1 (15)	1 (15)	---	2 (30)
	metaplasia	olfactory	1 (15)	0 (14)	---	1 (29)
	acute inflammation	olfactory	1 (15)	0 (14)	---	1 (29)
	nematode	mesentery	1 (11)	0 (7)	---	1 (18)
	protozoan	liver	0 (13)	1 (14)	---	1 (27)
	trematode	gill	1 (15)	1 (15)	---	2 (30)
	cestode	intestine	1 (6)	0 (1)	---	1 (7)
		stomach	0 (12)	1 (7)	---	1 (19)
		liver	1 (13)	0 (14)	---	1 (27)
	unidentified	trunk kidney	1 (11)	0 (11)	---	1 (22)
		gill	1 (15)	0 (15)	---	1 (30)
	edema	gill	0 (15)	2 (15)	---	2 (30)
scamp	foreign body granuloma	heart	0 (4)	2 (2)	---	2 (6)
		head kidney	1 (3)	0 (3)	---	1 (6)
		spleen	2 (7)	1 (4)	---	3 (11)
		intestine	1 (3)	1 (2)	---	2 (5)
		liver	1 (7)	0 (4)	---	1 (11)
		pancreas	1 (4)	0 (3)	---	1 (7)
		stomach	2 (7)	1 (3)	---	3 (10)
		trunk kidney	5 (6)	1 (4)	---	6 (10)
		testis	3 (3)	---	---	3 (3)
		olfactory	1 (6)	0 (3)	---	1 (9)
		mesentery	2 (5)	0 (2)	---	2 (7)
		brain	0 (1)	1 (2)	---	1 (3)
		gill	0 (7)	1 (4)	---	1 (11)
	unidentified	liver	1 (7)	0 (4)	---	1 (11)
	congestion	head kidney	1 (3)	0 (3)	---	1 (6)
	fatty change	liver	1 (7)	1 (4)	---	2 (11)
	dilated renal tubules	trunk kidney	1 (6)	0 (4)	---	1 (10)
	parasite	spleen	0 (7)	1 (4)	---	1 (11)
	chronic inflammation	heart	0 (4)	1 (2)	---	1 (6)
		head kidney	1 (3)	1 (3)	---	2 (6)
		intestine	0 (3)	1 (2)	---	1 (5)
		stomach	0 (7)	1 (3)	---	1 (10)
		trunk kidney	1 (6)	2 (4)	---	3 (10)
		olfactory	0 (6)	2 (3)	---	2 (9)
		gill	0 (7)	1 (4)	---	1 (11)
	nematode	stomach	1 (7)	0 (3)	---	1 (10)

Table A-1 continued...

Species	Lesion	Organ	Station EFG	WFG	CNA	Total
	trematode	gill	5 (7)	2 (4)	—	7 (11)
		olfactory	1 (6)	0 (3)	—	1 (9)
	cestode	mesentery	1 (7)	0 (4)	—	1 (11)
		stomach	1 (7)	0 (3)	—	1 (11)
	hyperplasia	gill	0 (7)	2 (4)	—	2 (11)
cottonwick	foreign body granuloma	testis	—	1 (2)	—	1 (2)
		spleen	0 (13)	1 (9)	—	1 (22)
		stomach	3 (16)	8 (12)	—	11 (28)
		heart	1 (6)	0 (3)	—	1 (9)
		liver	0 (17)	3 (14)	—	3 (31)
		trunk kidney	0 (18)	3 (14)	—	3 (32)
	unidentified	gill	2 (19)	0 (15)	—	2 (34)
	chronic inflammation	intestine	1 (6)	0 (4)	—	1 (10)
		liver	0 (17)	1 (14)	—	1 (31)
		trunk kidney	0 (18)	1 (14)	—	1 (32)
		gill	0 (19)	1 (15)	—	1 (34)
		olfactory	0 (16)	1 (15)	—	1 (31)
	necrosis	liver	1 (17)	0 (14)	—	1 (31)
	parasite	heart	1 (3)	0 (2)	—	1 (5)
		liver	0 (17)	1 (14)	—	1 (31)
		skin	0 (2)	1 (2)	—	1 (4)
	nematode	stomach	1 (16)	0 (12)	—	1 (28)
		mesentery	0 (11)	1 (3)	—	1 (14)
	congestion	spleen	1 (13)	0 (9)	—	1 (22)
	telangiectasis	gill	2 (19)	1 (15)	—	3 (34)
	edema	gill	0 (19)	2 (15)	—	2 (34)
gray trigger-fish	nematode	gill	4 (7)	0 (2)	—	4 (9)
	edema	gill	0 (7)	1 (2)	—	1 (9)
	foreign body granuloma	intestine	0 (3)	1 (1)	—	1 (4)
	necrosis	liver	1 (7)	0 (2)	—	1 (9)
	cestode	esophagus	1 (5)	0 (2)	—	1 (7)
dusky flounder	telangiectasis	gill	1 (1)	—	—	1 (1)
	nematode	mesentery	1 (1)	—	—	1 (1)
	unidentified	trunk kidney	1 (1)	—	—	1 (1)
	fatty change	liver	1 (1)	—	—	1 (1)

Table A-2 Histological lesions in fish collected during Cruise 2. The numbers listed are the frequencies of occurance in the organs examined (number of organs examined in parenthesis).

Species	Lesion	Organ	Station WFG	PLA	Total
red snapper	chronic inflammation	liver	4 (26)	---	4 (26)
		intestine	2 (25)	---	2 (25)
		pancreas	2 (26)	---	2 (26)
		stomach	1 (22)	---	1 (22)
		gill	1 (26)	---	1 (26)
	hemorrhage	gill	1 (26)	---	1 (26)
	telangiectasis	gill	1 (26)	---	1 (26)
	hyperplasia	intestine	1 (25)	---	1 (25)
		gill	1 (26)	---	1 (26)
	sloughing	olfactory	1 (26)	---	1 (26)
	parasite	gill	1 (26)	---	1 (26)
	cestode	intestine	2 (25)	---	2 (25)
		liver	2 (26)	---	2 (26)
	sporozoan	olfactory	4 (26)	---	4 (26)
	acute inflammation	liver	1 (26)	---	1 (26)
		pancreas	1 (26)	---	1 (26)
	necrosis	liver	3 (26)	---	3 (26)
		olfactory	1 (26)	---	1 (26)
	unidentified	gill	3 (26)	---	3 (26)
		trunk kidney	1 (8)	---	1 (8)
	foreign body granuloma	intestine	7 (25)	---	7 (25)
		pancreas	2 (26)	---	2 (26)
		liver	1 (26)	---	1 (26)
		stomach	1 (22)	---	1 (22)
		mesentery	1 (12)	---	1 (12)
	edema	gill	5 (26)	---	5 (26)
		liver	1 (26)	---	1 (26)
	nematode	intestine	4 (25)	---	4 (25)
		mesentery	2 (12)	---	2 (12)
vermilion snapper	foreign body granuloma	intestine	8 (30)	---	8 (30)
		liver	1 (31)	---	1 (31)
		stomach	5 (18)	---	5 (18)
		esophagus	2 (21)	---	2 (21)
	unidentified	spleen	1 (33)	---	1 (33)
	edema	liver	2 (31)	---	2 (31)
	telangiectasis	gill	1 (33)	---	1 (33)
	hyperplasia	gill	2 (33)	---	2 (33)
	acute inflammation	olfactory	1 (31)	---	1 (31)
		gill	1 (33)	---	1 (33)

Table A-2 continued...

Species	Lesion	Organ	Station WFG	PLA	Total
	sloughing	gill	1 (33)	---	1 (33)
		olfactory	1 (31)	---	1 (31)
	cestode	intestine	3 (30)	---	3 (30)
		liver	1 (31)	---	1 (31)
		pancreas	1 (32)	---	1 (32)
	nematode	intestine	1 (30)	---	1 (30)
	sporozoan	spleen	1 (33)	---	1 (33)
	trematode	gill	3 (33)	---	3 (33)
	chronic inflammation	spleen	1 (33)	---	1 (33)
		intestine	2 (30)	---	2 (30)
	necrosis	liver	1 (31)	---	1 (31)
		olfactory	1 (31)	---	1 (31)
scamp	nematode	mesentery	1 (2)	---	1 (2)
	trematode	gill	1 (3)	---	1 (3)
	chronic inflammation	head kidney	1 (3)	---	1 (3)
	foreign body granuloma	spleen	1 (3)	---	1 (3)
cottonwick	foreign body granuloma	intestine	4 (20)	---	4 (20)
		stomach	4 (22)	---	4 (22)
		trunk kidney	3 (8)	---	3 (8)
		heart	1 (2)	---	1 (2)
		liver	1 (23)	---	1 (23)
		mesentery	1 (10)	---	1 (10)
	parasite	stomach	1 (10)	---	1 (10)
	chronic inflammation	liver	1 (23)	---	1 (23)
		stomach	1 (22)	---	1 (22)
	cestode	intestine	1 (20)	---	1 (20)
		stomach	1 (22)	---	1 (22)
	congestion	spleen	1 (23)	---	1 (23)
	edema	gill	1 (24)	---	1 (24)
	telangiectasis	gill	1 (24)	---	1 (24)
	hyperplasia	gill	1 (24)	---	1 (24)
gray trigger-fish	nematode	gill	1 (1)	---	1 (1)
three-eye flounder	chronic inflammation	intestine	---	1 (1)	1 (1)
	foreign body granuloma	mesentery	---	1 (1)	1 (1)
	cestode	intestine	---	1 (1)	1 (1)
	nematode	mesentery	---	1 (1)	1 (1)
	fatty change	liver	---	1 (1)	1 (1)

Table A-2 continued...

Species	Lesion	Organ	Station WFG	Station PLA	Total
rock sea bass	foreign body granuloma	esophagus	---	1 (2)	1 (2)
		liver	---	1 (2)	1 (2)
	chronic inflammation	spleen	---	1 (2)	1 (2)
	parasite	intestine	---	1 (2)	1 (2)
	nematode	mesentery	---	1 (1)	1 (1)
	unidentified	gill	---	1 (2)	1 (2)
cubbyu	cestode	intestine	---	1 (2)	1 (2)
southern hake	foreign body granuloma	intestine	---	1 (1)	1 (1)
	trematode	esophagus	---	1 (1)	1 (1)
	fatty change	liver	---	1 (1)	1 (1)
red hind	cestode	mesentery	100 (1)	---	100 (1)

Table A-3 Histological lesions in fish collected during Cruise 3. The numbers listed are the frequencies of occurance in the organs examined (number of organs examined in parenthesis).

Species	Lesion	Organ	Station EFG	WFG	CNA	PLA	Total
red snapper	edema	gill	3 (8)	4 (10)	1 (1)	0 (1)	8 (20)
	hemorrhage	olfactory	1 (8)	0 (10)	1 (1)	1 (1)	3 (20)
	sloughing	olfactory	1 (8)	0 (10)	1 (1)	0 (1)	2 (20)
	cestode	liver	0 (8)	1 (10)	0 (1)	1 (1)	2 (20)
	nematode	intestine	---	0 (3)	1 (1)	---	1 (4)
	foreign body granuloma	liver	0 (8)	0 (10)	1 (1)	0 (1)	1 (20)
		stomach	0 (8)	0 (6)	1 (1)	1 (1)	2 (16)
		intestine	---	3 (3)	1 (1)	---	4 (4)
	congestion	olfactory	1 (8)	0 (10)	0 (1)	0 (1)	1 (20)
		spleen	0 (8)	1 (10)	---	---	1 (10)
	sporozoan	olfactory	0 (8)	3 (10)	0 (1)	0 (1)	3 (20)
	fatty change	liver	0 (8)	1 (10)	1 (1)	0 (1)	2 (20)
	hyperplasia	gill	0 (8)	0 (10)	0 (10)	1 (1)	1 (20)
	necrosis	liver	1 (8)	0 (10)	0 (10)	0 (1)	1 (20)
vermilion snapper	congestion	spleen	2 (11)	1 (10)	---	---	3 (21)
		liver	1 (11)	0 (10)	---	---	1 (21)
	acute inflammation	olfactory	1 (11)	0 (10)	---	---	1 (21)
	foreign body granuloma	liver	1 (11)	0 (10)	---	---	1 (21)
	nematode	liver	0 (11)	1 (10)	---	---	1 (21)
		mesentery	1 (1)	0 (3)	---	---	1 (4)
	trematode	gill	1 (11)	1 (10)	---	---	2 (21)
	edema	gill	0 (11)	1 (10)	---	---	1 (21)
	chronic inflammation	liver	1 (11)	0 (10)	---	---	1 (21)
	sporozoan	liver	0 (11)	1 (10)	---	---	1 (21)
	cestode	intestine	1 (1)	0 (1)	---	---	1 (2)
scamp	foreign body granuloma	spleen	1 (4)	0 (2)	---	---	1 (6)
		trunk kidney	1 (4)	1 (2)	---	---	2 (6)
	trematode	gill	1 (4)	0 (2)	---	---	1 (6)
	necrosis	liver	1 (4)	0 (2)	---	---	1 (6)

Table A-3 continued...

Species	Lesion	Organ	Station EFG	WFG	CNA	PLA	Total
	crustacean	gill	0 (4)	1 (2)	---	---	1 (6)
	fatty change	liver	0 (4)	1 (2)	---	---	1 (6)
	dilated renal tubules	trunk kidney	0 (4)	2 (2)	---	---	2 (6)
cottonwick	nematode	mesentery	2 (6)	0 (5)	---	---	2 (11)
	foreign body granuloma	liver	1 (10)	0 (9)	---	---	1 (19)
		stomach	2 (10)	0 (7)	---	---	2 (17)
		trunk kidney	1 (9)	0 (10)	---	---	1 (19)
	edema	gill	1 (10)	0 (10)	---	---	1 (20)
	chronic inflammation	stomach	1 (10)	0 (7)	---	---	1 (17)
	telangiectasis	liver	1 (10)	0 (9)	---	---	1 (19)
gray trigger-fish	edema	gill	0 (2)	1 (5)	---	2(13)	2 (20)
	congestion	spleen	0 (2)	0 (4)	---	3(11)	3 (17)
	telangiectasis	gill	0 (2)	0 (5)	---	3(13)	2 (20)
	trematode	gill	0 (2)	1 (5)	---	0(13)	1 (20)
	unidentified	gill	0 (2)	0 (5)	---	1(13)	1 (20)
	hemorrhage	spleen	0 (2)	0 (4)	---	1(11)	1 (17)
	chronic inflammation	liver	0 (2)	0 (5)	---	1(13)	1 (20)
	foreign body granuloma	esophagus	0 (2)	0 (1)	---	1(6)	1 (9)
		intestine	---	0 (1)	---	1(3)	1 (4)
	sloughing	olfactory	0 (2)	0 (4)	---	2(10)	2 (16)
	cestode	intestine	---	0 (1)	---	1(3)	1 (4)
	nematode	gill	1 (2)	3 (5)	---	0(13)	4 (20)
three-eye flounder	nematode	stomach	---	---	0 (1)	2 (2)	2 (3)
		liver	---	---	0 (1)	1 (2)	1 (3)
		mesentery	---	---	1 (1)	---	2 (1)
	chronic inflammation	liver	---	---	0 (1)	1 (1)	1 (2)
	bacteria	olfactory organ	---	---	0 (1)	1 (1)	1 (2)
	cestode	intestine	---	---	---	2 (2)	2 (2)
	foreign body granuloma	stomach	---	---	0 (1)	2 (2)	2 (3)

Table A-3 continued...

Species	Lesion	Organ	EFG	WFG	CNA	PLA	Total
			Station				
	ciliate	liver	---	---	0 (1)	1 (2)	1 (3)
		olfactory	---	---	1 (1)	0 (2)	1 (3)
	sporozoan	urinary bladder	---	---	---	1 (1)	1 (1)
southern hake	foreign body granuloma	stomach	---	---	---	6 (9)	6(9)
		esophagus	---	---	---	1 (3)	1(3)
		mesentery	---	---	0 (1)	2 (1)	2(2)
		liver	---	---	0 (1)	3 (10)	3(11)
		intestine	---	---	0 (1)	1 (1)	1(2)
	fatty change	liver	---	---	0 (1)	0 (10)	10(11)
	necrosis	liver	---	---	0 (1)	1 (10)	1(11)
		trunk kidney	---	---	0 (1)	2 (10)	2(11)
	sloughing	olfactory	---	---	0 (1)	6 (9)	6(10)
		trunk kidney	---	---	0 (1)	1 (10)	1(11)
	cestode	intestine	---	---	1 (1)	0 (1)	1(2)
		mesentery	---	---	1 (1)	0 (3)	1(4)
		esophagus	---	---	---	1 (3)	1(3)
	chronic inflammation	stomach	---	---	---	1 (9)	1(9)
	unidentified	gill	---	---	0 (1)	3 (10)	3(11)
rock hind	foreign body granuloma	spleen	1 (1)	---	---	---	1 (1)
		liver	1 (1)	---	---	---	1 (1)
		stomach	1 (1)	---	---	---	1 (1)
		trunk kidney	1 (1)	---	---	---	1 (1)
		olfactory	1 (1)	---	---	---	1 (1)
		testis	1 (1)	---	---	---	1 (1)
	congestion	spleen	1 (1)	---	---	---	1 (1)
blackfin snapper	chronic inflammation	pancreas	1 (1)	---	---	---	1 (1)
red porgy	edema	gill	2 (11)	3 (10)	---	---	5 (21)
	chronic inflammation	olfactory spleen	0 (10)	1 (10)	---	---	1 (20)
		trunk kidney	1 (11)	0 (9)	---	---	1 (20)
	foreign body granuloma	stomach	1 (8)	1 (10)	---	---	2 (18)
		spleen	1 (10)	1 (10)	---	---	1 (20)
		intestine	1 (2)	0 (1)	---	---	1 (3)
	nematode	mesentery	1 (1)	0 (1)	---	---	1 (2))

Table A-3 continued...

Species	Lesion	Organ	Station EFG	WFG	CNA	PLA	Total
	sporozoan	liver	0 (11)	1 (10)	---	---	1 (21)
		pancreas	1 (11)	0 (10)	---	---	1 (21)
	hemorrhage	liver	1 (11)	0 (10)	---	---	1 (21)
	acute inflammation	gill	1 (11)	0 (10)	---	---	1 (21)
	sloughing	olfactory	1 (11)	0 (10)	---	---	1 (21)
Mexican sea-robin	hemorrhage	liver	---	---	1 (2)	---	1 (2)
	foreign body granuloma	stomach	---	---	2 (4)	0 (1)	2 (5)
	nematode	stomach	---	---	0 (2)	1 (1)	1 (3)
	trematode	gill	---	---	0 (2)	1 (1)	1 (3)
wenchman	hemorrhage	spleen	---	---	1 (10)	0 (3)	1 (13)
		trunk kidney	---	---	2 (13)	0 (3)	2 (16)
	telangiectasis	gill	---	---	1 (14)	0 (3)	1 (17)
	hyperplasia	gill	---	---	2 (14)	0 (3)	2 (17)
	chronic inflammation	pancreas	---	---	1 (14)	0 (3)	1 (17)
		liver	---	---	1 (14)	0 (3)	1 (17)
		stomach	---	---	0 (14)	1 (3)	1 (17)
	necrosis	pancreas	---	---	1 (14)	0 (3)	1 (17)
		trunk kidney	---	---	1 (13)	0 (3)	1 (16)
	congestion	liver	---	---	1 (14)	0 (3)	1 (17)
	bacteria	gill	---	---	0 (14)	1 (3)	1 (17)
	epitheliocytsis	olfactory	---	---	1 (10)	0 (3)	1 (13)
	foreign body granuloma	mesentery	---	---	5 (8)	0 (1)	5 (9)
		stomach	---	---	3 (14)	0 (3)	3 (17)
		pancreas	---	---	1 (14)	0 (3)	1 (17)
	sloughing	stomach	---	---	1 (14)	0 (3)	1 (17)
	dilated renal tubes	liver	---	---	0 (14)	1 (3)	1 (17)
	cestode	intestine	---	---	1 (12)	0 (2)	1 (14)
	nematode	mesentery	---	---	3 (8)	0 (1)	3 (9)
	trematode	gill	---	---	1 (14)	0 (3)	1 (17)
almaco jack	congestion	spleen	---	---	---	1 (1)	1 (1)
	edema	gill	---	---	---	1 (1)	1 (1)

Table A-3 continued...

Species	Lesion	Organ	Station EFG	WFG	CNA	PLA	Total
	chronic inflammation	trunk kidney	---	---	---	1 (1)	1 (1)
	foreign body granuloma	stomach	---	---	---	1 (1)	1 (1)
	sloughing	stomach	---	---	---	1 (1)	1 (1)
	hyperplasia	gill	---	---	---	1 (1)	1 (1)
sash flounder	nematode	mesentery	---	---	---	2 (2)	2 (2)
		stomach	---	---	---	1 (2)	1 (2)
	foreign body granuloma	stomach	---	---	---	1 (2)	1 (2)
		mesentery	---	---	---	1 (2)	1 (2)
	fatty change	liver	---	---	---	2 ( )	2 ( )
	cestode	intestine	---	---	---	2 (2)	2 (2)
	chornic inflammation	stomach	---	---	---	1 (2)	1 (2)
		intestine	---	---	---	1 (2)	1 (2)
yellowedge grouper	foreign body granuloma	spleen	---	---	---	1 (4)	1 (4)
		intestine	---	---	---	1 (1)	1 (1)
	telangiectasis	gill	---	---	---	1 (4)	1 (4)
	congestion	spleen	---	---	---	1 (4)	1 (4)

Table A-4 Histological lesions in fish collected during Cruise 4. The numbers listed are the frequencies of occurance in the organs examined (number of organs examined in parenthesis).

Species	Lesion	Organ	Station EFG	WFG	CNA	PLA	Total
gray trigger-fish	congestion	spleen	1 (8)	0 (5)	---	0 (4)	1 (17)
	parasite	trunk kidney	0 (8)	2 (5)	---	0 (4)	2 (17)
	nematode	gill	2 (8)	5 (5)	---	0 (4)	7 (17)
	edema	gill	3 (8)	1 (5)	---	3 (4)	7 (17)
	telangiectasis	gill	0 (8)	1 (5)	---	2 (4)	3 (17)
	trematode	gill	0 (8)	2 (5)	---	1 (4)	3 (17)
	cestode	intestine	---	1 (2)	---	1 (1)	2 (3)
		esophagus	---	1 (1)	---	0 (1)	1 (2)
rock sea bass	nematode	pancreas	---	---	---	1 (5)	1 (5)
		mesentery	---	---	---	1 (4)	1 (4)
	epitheliocytsis	gill	---	---	---	1 (6)	1 (6)
	foreign body granuloma	mesentery	---	---	---	1 (4)	1 (4)
cubbyu	nematode	mesentery	---	---	---	1 (1)	1 (1)
cottonwick	foreign body granuloma	stomach	2 (1)	1 (2)	---	---	3 (1)
		trunk kidney	2 (10)	0 (6)	---	---	2 (16)
		liver	0 (10)	1 (7)	---	---	1 (17)
		olfactory	0 (10)	1 (7)	---	---	1 (17)
	acute inflammation						
	sloughing	olfactory	0 (10)	1 (7)	---	---	1 (17)
	edema	gill	0 (10)	3 (7)	---	---	3 (17)
	telangiectasis	gill	0 (10)	2 (7)	---	---	2 (17)
	cestode	intestine	---	1 (1)	---	---	1 (1)
	basophilia	liver	0 (10)	1 (7)	---	---	1 (17)
red snapper	edema	gill	6 (9)	6 (9)	1 (1)	1 (1)	14 (20)
	unidentified	trunk kidney	0 (9)	1 (1)	0 (1)	0 (1)	1 (20)
	telangiectasis	gill	1 (9)	0 (9)	0 (1)	0 (1)	1 (20)
	hyperplasia	gill	3 (9)	1 (9)	0 (1)	0 (1)	4 (20)
	chronic inflammation	pancreas	0 (9)	1 (7)	0 (1)	0 (1)	1 (18)
		gill	0 (9)	1 (9)	0 (1)	0 (1)	1 (20)
	foreign body granuloma	intestine	0 (1)	3 (3)	---	---	3 (4)
		liver	1 (9)	0 (8)	0 (1)	0 (1)	1 (19)
	fatty change	liver	1 (9)	1 (8)	1 (1)	0 (1)	3 (19)
	nematode	mesentery	0 (2)	1 (8)	1 (1)	---	2 (11)
		intestine	1 (1)	0 (3)	0 (0)	---	11 (4)
	hypertrophy	gill	1 (9)	1 (9)	0 (1)	0 (1)	2 (20)
	cestode	liver	1 (9)	1 (8)	0 (1)	0 (1)	2 (19)
	necrosis	liver	0 (9)	1 (8)	0 (1)	0 (1)	1 (19)
	sloughing	olfactory	0 (9)	1 (9)	1 (1)	0 (1)	2 (20)
	acanthocephalan	mesentery	0 (2)	1 (8)	0 (1)	---	1 (11)
	sporozoan	ovary	0 (1)	0 (1)	1 (1)	0 (1)	1 (4)

Table A-4 Continued...

Species	Lesion	Organ	EFG	WFG	CNA	PLA	Total
			Station				
wenchman	foreign body granuloma	mesentery	---	---	5 (6)	1 (4)	6 (10)
		pancreas	---	---	1 (11)	1 (7)	2 (18)
		stomach	---	---	1 (2)	0 (1)	1 (3)
		gill	---	---	0 (11)	1 (9)	1 (20)
	epitheliocystis	gill	---	---	1 (11)	0 (9)	1 (20)
	chronic inflammation	liver	---	---	0 (10)	1 (9)	1 (19)
	sloughing	olfactory	---	---	0 (11)	1 (9)	1 (20)
	basophilia	liver	---	---	1 (9)	0 (9)	1 (18)
	nematode	mesentery	---	---	1 (6)	1 (4)	2 (10)
		olfactory	---	---	0 (11)	1 (9)	1 (20)
	cestode	intestine	---	---	2 (9)	0 (5)	2 (14)
		stomach	---	---	1 (2)	0 (1)	1 (3)
	fatty change	liver	---	---	1 (10)	0 (9)	1 (19)
	unidentified parasite	stomach	---	---	1 (2)	0 (1)	1 (3)
vermilion snapper	sloughing	gill	1 (5)	1 (13)	---	---	2 (18)
		olfactory	0 (5)	1 (12)	---	---	1 (17)
	epitheliocystis	gill	0 (5)	1 (13)	---	---	1 (18)
	telangiectasis	gill	1 (5)	0 (13)	---	---	1 (18)
	fatty change	liver	0 (5)	1 (13)	---	---	1 (18)
	acute inflammation	olfactory	0 (5)	2 (12)	---	---	2 (17)
	sporozoan	gill	0 (5)	1 (13)	---	---	1 (18)
	edema	gill	0 (5)	3 (13)	---	---	3 (18)
		liver	0 (5)	1 (13)	---	---	1 (18)
	foreign body granuloma	mesentery	0 (1)	2 (8)	---	---	2 (9)
		pancreas	0 (5)	1 (13)	---	---	1 (18)
		intestine	0 (1)	1 (2)	---	---	1 (3)
	necrosis	liver	0 (5)	3 (13)	---	---	3 (18)
	trematode	gill	0 (5)	2 (13)	---	---	2 (18)
		esophagus	0 (1)	1 (3)	---	---	1 (4)
blackeared bass	nematode	mesentery	---	---	2 (2)	1 (2)	3 (4)
		stomach	---	---	1 (1)	---	1 (1)
		ovary	---	---	0 (1)	1 (2)	1 (3)
	foreign body granuloma	liver	---	---	1 (3)	0 (3)	1 (6)
	cestode	intestine	---	---	2 (2)	---	2 (3)
		stomach	---	---	1 (1)	---	1 (1)
		mesentery	---	---	1 (2)	0 (2)	1 (4)
	telangiectasis	pseudobranch	---	---	1 (1)	0 (1)	1 (2)
	necrosis	stomach	---	---	1 (1)	---	1 (1)
	chronic inflammation	stomach	---	---	1 (1)	---	1 (1)

Table A-4 Continued...

Species	Lesion	Organ	Station EFG	WFG	CNA	PLA	Total
sash flounder	nematode	mesentery	---	---	1 (2)	2(5)	3 (7)
		intestine	---	---	0 (2)	1(3)	1 (5)
	foreign body granuloma	mesentery	---	---	1 (2)	3(4)	4 (6)
		intestine	---	---	1 (2)	1(3)	2 (5)
		stomach	---	---	0 (1)	1(2)	1 (3)
		pancreas	---	---	1 (1)	0(2)	1 (3)
	edema	gill	---	---	1 (2)	1(5)	2 (7)
	cestode	intestine	---	---	0 (2)	1(3)	1 (5)
		mesentery	---	---	1 (2)	2(4)	3 (6)
	trematode	intestine	---	---	0 (2)	1(3)	1 (5)
	basophilia	liver	---	---	0 (2)	5(5)	5 (7)
	fatty change	liver	---	---	0 (2)	2(5)	2 (5)
	chronic inflammation	gill	---	---	2 (2)	0(5)	2 (7)
southern hake	nematode	mesentery	---	---	2 (2)	2(2)	4 (4)
	unidentified	gill	---	---	1 (5)	0(3)	1 (8)
	hypertrophy	gill	---	---	0 (5)	1(3)	1 (8)
	acute inflammation	pancreas	---	---	0 (2)	1(1)	1 (3)
	foreign body granuloma	stomach	---	---	1 (1)	---	1 (1)
	chronic inflammation	gill	---	---	3 (5)	0(3)	3 (8)
	fatty change	liver	---	---	2 (6)	0(3)	2 (9)
	edema	gill	---	---	2 (5)	0(3)	2 (8)
	cestode	intestine	---	---	0 (2)	1(1)	1 (3)
yellowedge grouper	foreign body granuloma	intestine	---	---	1 (1)	---	1 (1)
		liver	---	---	1 (1)	---	1 (1)
		trunk kidney	---	---	1 (1)	---	1 (1)
	necrosis	liver	---	---	1 (1)	---	1 (1)
scamp	foreign body grauloma	spleen	1 (9)	0 (6)	---	---	1 (15)
		trunk kidney	0 (8)	2 (6)	---	---	2 (14)
		gill	0 (9)	1 (5)	---	---	1 (14)
		mesentery	0 (2)	1 (2)	---	---	1 (4)
		ovary-testis	0 (0)	1 (1)	---	---	1 (1)
	trematode	gill	7 (9)	2 (5)	---	---	9 (14)
		liver	0 (9)	1 (6)	---	---	1 (15)
	congestion	spleen	2 (9)	---	---	---	2 (9)
	parasite	spleen	0 (9)	1 (6)	---	---	1 (15)
	chronic inflammation	liver	0 (9)	1 (6)	---	---	1 (15)
		olfactory	0 (5)	1 (5)	---	---	1 (11)
	edema	gill	0 (9)	1 (5)	---	---	1 (14)

Table A-4 Continued...

Species	Lesion	Organ	Station EFG	WFG	CNA	PLA	Total
Mexican searobin	nematode	mesentery	---	---	1 (5)	4 (7)	6 (12)
		ovary	---	---	1 (5)	0 (1)	1 (6)
		olfactory	---	---	0 (9)	1 (8)	1 (17)
		liver	---	---	0 (11)	1 (11)	1 (12)
	foreign body granuloma	mesentery	---	---	40 (5)	14 (7)	25 (12)
	cestode	liver	---	---	0 (11)	2 (11)	2 (22)
		intestine	---	---	0 (3)	1 (8)	1 (11)
	congestion	spleen	---	---	1 (9)	0 (11)	1 (20)
	fatty change	liver	---	---	1 (11)	0 (11)	1 (22)
	necrosis	liver	---	---	1 (11)	0 (11)	1 (22)
	flagellate	gill	---	---	1 (10)	0 (11)	1 (21)
	chronic inflammation	gill	---	---	2 (10)	0 (11)	2 (21)
	trematode	stomach	---	---	1 (2)	0 (2)	1 (4)
		bile duct	---	---	1 (1)	---	1 (1)
shortwinged searobin	fatty change	liver	---	---	2 (7)	---	2 (7)
	sporozoan	olfactory	---	---	1 (5)	---	1 (5)

Table A-5 Histological lesions in fish collected during Cruise 5. The numbers listed are the frequencies of occurance in the organs examined (number of organs examined in parenthesis).

Species	Lesion	Organ	Station EFG	Station WFG	Station BRC	Total
gray triggerfish	nematode	gill	7 (10)	---	---	7 (10)
cottonwick	foreign body granuloma	mesentery	1 (1)	0 (1)	---	1 (2)
	fatty change	liver	0 (2)	1 (8)	---	1 (10)
	telangiectasis	gill	0 (2)	1 (8)	---	1 (10)
	chronic inflammation	olfactory	0 (1)	1 (7)	---	1 (8)
	sloughing	olfactory	0 (1)	1 (7)	---	1 (8)
red snapper	epitheliocystis	gill	2 (10)	---	---	1 (10)
	nematode	liver	1 (10)	---	---	1 (10)
	protozoan	olfactory	1 (10)	---	---	1 (10)
	edema	gill	2 (10)	---	---	2 (10)
	sloughing	olfactory	3 (10)	---	---	3 (10)
	cestode	liver	2 (10)	---	---	2 (10)
	telangiectasis	gill	1 (10)	---	---	1 (10)
	hyperplasia	gill	1 (10)	---	---	1 (10)
	hypertrophy	gill	1 (10)	---	---	1 (10)
creole-fish	chronic inflammation	liver	3 (10)	1 (10)	---	4 (20)
	necrosis	liver	2 (10)	0 (10)	---	2 (20)
	foreign body granuloma	stomach	1 (1)	---	---	1 (1)
Mexican searobin	isopod	olfactory	1 (1)	---	0 (1)	1 (2)
	sporozoan	nerve ganglion	---	---	1 (1)	1 (1)
wenchman	unidentified	gill	1 (5)	---	---	1 (5)
	edema	gill	1 (5)	---	---	1 (5)
	telangiectasis	gill	1 (5)	---	---	1 (5)
	hyperplasia	gill	1 (5)	---	---	1 (5)
	foreign body granuloma	mesentery	1 (5)	---	---	1 (1)
vermilion snapper	edema	gill	1 (10)	1 (10)	---	2 (20)
	telangiectasis	gill	1 (10)	1 (10)	---	2 (20)
	chronic inflammation	liver	2 (10)	2 (10)	---	4 (20)
	sloughing	olfactory	2 (9)	1 (10)	---	3 (19)
	sporozoan	liver	2 (10)	0 (10)	---	2 (20)
		olfactory	0 (9)	1 (10)	---	1 (19)

Table A-5 continued...

Species	Lesion	Organ	Station EFG	Station WFG	Station BRC	Total
	unidentified	trunk kidney	1 (10)	0 (10)	---	1 (20)
	foreign body granuloma	stomach	1 (1)	0 (1)	---	1 (2)
	necrosis	liver	1 (10)	0 (10)	---	1 (20)
	trematode	gill	0 (10)	1 (10)	---	1 (20)
sash flounder	foreign body granuloma	mesentery	1 (1)	---	0 (2)	1 (3)
	cestode	intestine	1 (2)	---	0 (2)	1 (4)
	nematode	mesentery	0 (1)	---	2 (2)	2 (3)
gulf hake	fatty change	liver	0 (1)	---	1 (3)	1 (4)
	chronic inflammation	stomach	0 (1)	---	1 (1)	1 (2)
		mesentery	0 (1)	---	1 (1)	1 (2)
	foreign body granuloma	stomach	1 (1)	---	0 (1)	1 (2)
	cestode	pericardial cavity	---	---	1 (1)	1 (1)
		intestine	0 (1)	---	1 (1)	1 (2)
	nematode	mesentery	0 (1)	---	1 (1)	1 (2)
southern hake	epitheliocystis	olfactory	---	---	1 (1)	1 (1)
	chronic inflammation	intestine	---	---	1 (1)	1 (1)

Table A-6 Histological lesions in fish collected during Cruise 6. The numbers listed are the frequencies of occurance in the organs examined (number of organs examined in parenthesis).

Species	Lesion	Organ	Station BRC	Station EFG	Station WFG	Station PLB	Total
three-eye flounder	sporozoan	trunk kidney	---	---	---	1 (1)	1 (1)
gray triggerfish	congestion	spleen	---	0 (3)	0 (1)	1 (9)	1 (13)
	hyperplasia	gill	---	1 (4)	0 (1)	0 (10)	1 (15)
	chronic inflammation	heart	---	---	---	1 (5)	1 (5)
	nematode	gill	---	2 (4)	0 (1)	0 (10)	2 (15)
rock sea bass	foreign body granuloma	stomach	---	---	---	1 (1)	1 (1)
cottonwick	chronic inflammation	heart	---	---	---	1 (2)	1 (2)
	foreign body granuloma	heart	---	---	---	2 (2)	1 (2)
		trunk kidney	---	---	---	1 (5)	1 (5)
		mesentery	---	---	---	1 (1)	1 (1)
	cestode	intestine	---	---	---	1 (1)	1 (1)
red snapper	unidentified	trunk kidney	---	---	0 (2)	1 (11)	1 (13)
	edema	gill	---	---	1 (2)	4 (11)	5 (13)
	hemorrhage	olfactory	---	---	0 (2)	1 (12)	1 (14)
	telangiectasis	gill	---	---	0 (2)	1 (11)	1 (13)
	fatty change	liver	---	---	0 (3)	1 (12)	1 (15)
	hyperplasia	gill	---	---	0 (2)	1 (11)	1 (13)
	chronic inflammation	liver	---	---	1 (3)	1 (12)	2 (15)
		gill	---	---	0 (2)	2 (11)	2 (13)
		spleen	---	---	0 (1)	2 (12)	2 (13)
	foreign body granuloma	spleen	---	---	0 (1)	1 (12)	1 (13)
		intestine	---	---	1 (1)	0 (1)	1 (2)
		liver	---	---	0 (3)	1 (12)	1 (15)
		pancreas	---	---	0 (3)	1 (12)	1 (15)
	sloughing	olfactory	---	---	0 (2)	1 (12)	1 (14)
	cestode	intestine	---	---	1 (1)	0 (1)	1 (2)
	nematode	mesentery	---	---	---	1 (2)	1 (2)
	sporozoan	olfactory	---	---	0 (2)	3 (12)	3 (14)
	trematode	gill	---	---	1 (2)	0 (11)	1 (13)
creole-fish	epitheliocystis	gill	---	0(2)	0 (10)	1 (12)	1 (24)
	congestion	spleen	---	1(1)	1 (2)	3 (11)	5 (14)
	edema	gill	---	0(2)	0 (10)	1 (12)	1 (24)
	telangiectasis	spleen	---	0(1)	0 (2)	1 (11)	1 (14)
		gill	---	0(2)	0 (10)	3 (12)	3 (24)

Table A-6 continued...

Species	Lesion	Organ	Station BRC	EFG	WFG	PLB	Total
	hydropic degeneration	gill	---	0 (2)	0 (10)	1 (12)	1 (24)
	chronic inflammation	liver	---	0 (2)	1 (9)	4 (12)	5 (23)
	foreign body	liver	---	0 (2)	2 (9)	1 (12)	3 (23)
	granuloma	mesentery	---	0 (1)	0 (3)	1 (3)	1 (7)
	necrosis	liver	---	0 (2)	0 (9)	1 (12)	1 (23)
Mexican searobin	epitheliocystis	gill	1 (10)	---	---	0 (4)	1 (14)
	congestion	spleen	2 (9)	---	---	0 (3)	2 (12)
		liver	1 (10)	---	---	0 (4)	1 (14)
	telangiectasis	gill	0 (10)	---	---	1 (4)	1 (14)
	fatty change	liver	0 (10)	---	---	1 (4)	1 (14)
	chronic	liver	0 (10)	---	---	1 (4)	1 (14)
	inflammation	mesentery	0 (2)	---	---	1 (1)	1 (3)
	foreign body granuloma	liver	1 (10)	---	---	0 (4)	1 (14)
	isopod	olfactory	1 (5)	---	---	1 (3)	2 (8)
	nematode	liver	1 (10)	---	---	0 (4)	1 (14)
wenchman	edema	gill	0 (9)	---	---	2 (5)	2 (14)
	hyperplasia	gill	1 (9)	---	---	0 (5)	1 (14)
	chronic	liver	1 (9)	---	---	0 (6)	1 (15)
	inflammation	pancreas	0 (9)	---	---	1 (5)	1 (14)
	necrosis	trunk kidney	0 (9)	---	---	1 (6)	1 (15)
	nematode	mesentery	0 (1)	---	---	1 (2)	1 (3)
vermilion snapper	edema	gill	---	---	0 (11)	3 (10)	3 (21)
	hemorrhage	liver	---	---	1 (11)	0 (10)	1 (21)
	telangiectasis	gill	---	---	0 (11)	1 (10)	1 (21)
	hyperplasia	gill	---	---	2 (11)	0 (10)	2 (21)
	foreign body	intestine	---	---	0 (1)	1 (1)	1 (2)
	granuloma	liver	---	---	2 (11)	2 (10)	4 (21)
		trunk kidney	---	---	0 (11)	1 (10)	1 (21)
		mesentery	---	---	0 (1)	1 (2)	1 (3)
	sloughing	olfactory	---	---	0 (1)	1 (10)	1 (11)
	cestode	liver	---	---	2 (11)	0 (10)	2 (21)
	sporozoa	myomere	---	---	---	1 (1)	1 (1)
	trematode	gill	---	---	1 (11)	2 (10)	3 (21)
sash flounder	unidentified	trunk kidney	---	---	---	2 (9)	2 (9)
	fatty change	liver	---	---	---	1 (10)	2 (10)
	hyperplasia	gill	---	---	---	1 (9)	1 (9)
	chronic	skin	---	---	---	1 (3)	1 (3)
	inflammation	spleen	---	---	---	1 (7)	1 (7)
	foreign body	spleen	---	---	---	1 (7)	1 (7)
	granuloma	stomach	---	---	---	(1)	1 (7)

Table A-6 continued...

Species	Lesion	Organ	Station BRC	EFG	WFG	PLB	Total
gulf hake	unidentified	gill	---	---	---	1 (5)	1 (5)
	chronic inflammation	liver	0 (1)	---	---	1 (5)	1 (6)
	foreign body granuloma	liver	0 (1)	---	---	2 (5)	2 (6)
		stomach	0 (1)	---	---	1 (1)	1 (2)
		trunk kidney	0 (1)	---	---	2 (5)	2 (6)
	cestode	intestine	---	---	---	1 (1)	1 (1)
	nematode	mesentery	---	---	---	2 (2)	2 (2)
southern hake	unidentified	gill	0 (1)	---	---	1 (2)	1 (3)
	fatty change	liver	0 (1)	---	---	1 (1)	1 (2)
	cestode	intestine	---	---	---	1 (1)	1 (1)
	nematode	mesentery	---	---	---	1 (1)	1 (1)

Table A-7 Histological lesions in fish collected during Cruise 7. The numbers listed are the frequencies of occurance in the organs examined (number of organs examined in parenthesis).

Species	Lesion	Organ	Station BRC	EFG	WFG	PLB	Total
three-eye flounder	edema	gill	1 (1)	---	---	0 (1)	1 (2)
	foreign body granuloma	mesentery	0 (1)	---	---	1 (1)	1 (2)
	trematode	gill	0 (1)	---	---	1 (1)	1 (2)
gray triggerfish	congestion	spleen	---	0 (1)	0 (4)	1 (11)	1 (16)
	telangiectasis	gill	---	0 (1)	0 (3)	1 (10)	1 (14)
	hyperplasia	gill	---	0 (1)	1 (3)	1 (10)	2 (14)
	foreign body	heart	---	---	1 (1)	0 (1)	1 (2)
	granuloma	mesentery	---	---	0 (1)	1 (5)	1 (6)
	sloughing	olfactory	---	0 (1)	1 (4)	1 (7)	2 (12)
	nematode	gill	---	1 (1)	2 (3)	0 (10)	3 (14)
	trematode	gill	---	1 (1)	2 (3)	0 (10)	3 (14)
red snapper	congestion	liver	---	---	---	1 (9)	1 (9)
	edema	liver	---	---	---	1 (9)	1 (9)
		gill	---	---	---	3 (9)	3 (9)
	telangiectasis	gill	---	---	---	2 (9)	2 (9)
	hyperplasia	gill	---	---	---	1 (9)	1 (9)
	chronic	liver	---	---	---	2 (9)	2 (9)
	inflammation	pancreas	---	---	---	2 (9)	2 (9)
		trunk kidney	---	---	---	1 (1)	1 (10)
		spleen	---	---	---	1 (1)	1 (1)
	foreign body granuloma	intestine	---	---	---	1 (1)	1 (1)
	necrosis	gill	---	---	---	1 (9)	1 (9)
	nematode	intestine	---	---	---	1 (1)	1 (1)
	sporozoan	olfactory	---	---	---	1 (1)	1 (1)
	trematode	gill	---	---	---	2 (9)	2 (9)
creole-fish	unidentified	gill	---	1 (6)	0 (10)	0 (14)	1 (30)
	congestion	spleen	---	1 (5)	6 (7)	3 (11)	10 (23)
	edema	gill	---	0 (6)	0 (10)	1 (14)	1 (30)
	telangiectasis	gill	---	1 (6)	0 (10)	1 (14)	2 (30)
	hyperplasia	gill	---	1 (6)	0 (10)	0 (14)	1 (30)
	chronic	liver	---	0 (7)	3 (10)	2 (14)	5 (31)
	inflammation	olfactory	---	1 (7)	1 (8)	0 (9)	2 (24)
	foreign body	heart	---	1 (1)	0 (1)	0 (1)	1 (3)
	granuloma	spleen	---	1 (5)	0 (7)	0 (11)	1 (23)
		liver	---	0 (7)	0 (10)	4 (14)	4 (31)
	necrosis	olfactory	---	1 (7)	1 (8)	0 (9)	2 (24)

Table A-7 continued...

Species	Lesion	Organ	Station BRC	EFG	WFG	PLB	Total
Mexican searobin	epitheliocystis	gill	0 (9)	---	---	1 (10)	1 (19)
	congestion	spleen	0 (9)	---	---	1 (9)	1 (18)
	edema	gill	1 (9)	---	---	0 (10)	1 (19)
	fatty change	liver	5 (9)	---	---	1 (10)	6 (19)
	foreign body granuloma	mesentery	0 (4)	---	---	1 (3)	2 (7)
	crustacean	olfactory	1 (8)	---	---	0 (8)	1 (16)
	cestode	gall bladder	---	---	---	1 (1)	1 (1)
	nematode	olfactory	1 (8)	---	---	0 (8)	1 (16)
		mesentery	2 (4)	---	---	0 (3)	2 (7)
	flagellate	gill	0 (9)	---	---	1 (10)	1 (19)
	trematode	gill	1 (9)	---	---	1 (10)	1 (19)
wenchman	congestion	trunk kidney	5 (10)	---	---	2 (9)	7 (19)
		gill	1 (10)	---	---	0 (8)	1 (18)
	edema	gill	0 (10)	---	---	1 (8)	1 (18)
	telangietasis	gill	1 (10)	---	---	1 (8)	2 (18)
	fatty change	liver	0 (10)	---	---	1 (9)	1 (19)
	hyperplasia	gill	1 (10)	---	---	0 (8)	1 (18)
	pleomorphic nuclei	liver	0 (10)	---	---	1 (9)	1 (19)
	foreign body	spleen	0 (9)	---	---	1 (6)	1 (15)
	granuloma	liver	0 (10)	---	---	2 (9)	2 (19)
		myomeres	---	---	---	1 (1)	1 (1)
		olfactory	0 (10)	---	---	1 (9)	1 (19)
	nematode	liver	1 (10)	---	---	0 (9)	1 (19)
	sporozoan	olfactory	0 (10)	---	---	1 (9)	1 (19)
	trematode	gill	0 (10	---	---	1 (8)	1 (18)
vermilion snapper	unidentified	trunk kidney	---	---	0 (10)	1 (8)	1 (18)
	edema	gill	---	---	0 (9)	1 (10)	1 (19)
	hyperplasia	gill	---	---	1 (9)	1 (10)	1 (19)
	chronic	liver	---	---	1 (10)	1 (10)	2 (20)
	inflammation	trunk kidney	---	---	1 (10)	0 (8)	1 18)
	foreign body	intestine	---	---	1 (1)	0 (1)	1 (2)
	granuloma	liver	---	---	1 (10)	2 (10)	3 (20)
	sloughing	olfactory	---	---	1 (10)	0 (1)	1 (11)
	trematode	gill	---	---	1 (9)	2 (10)	3 (19)
sash flounder	unidentified	trunk kidney	1 (9)	---	---	1 (9)	2 (18)
	edema	gill	1 (9)	---	---	0 (9)	1 (18)
	fatty change	liver	5 (10)	---	---	2 (19)	7 (19)
	chronic	intestine	0 (6)	---	---	1 (3)	1 (9)
	inflammation	liver	0 (10)	---	---	0 (9)	1 (19)
		mesentery	0 (10)	---	---	1 (3)	1 (13)

Table A-7 continued...

Species	Lesion	Organ	Station BRC	EFG	WFG	PLB	Total
	foreign body granuloma	intestine	1 (6)	---	---	0 (3)	1 (9)
		liver	1 (10)	---	---	0 (9)	1 (19)
		stomach	0 (3)	---	---	1 (1)	1 (4)
		trunk kidney	1 (9)	---	---	0 (9)	1 (18)
		mesentery	5 (10)	---	---	2 (3)	7 (13)
	nematode	mesentery	7 (10)	---	---	2 (3)	9 (13)
	ciliate	gill	1 (9)	---	---	0 (9)	1 (18)
	trematode	intestine	1 (6)	---	---	0 (3)	1 (9)
gulf hake	unidentified	gill	---	---	---	1 (1)	1 (1)
	foreign body granuloma	stomach	---	---	---	1 (1)	1 (1)
southern hake	thrombosis	stomach	---	---	---	1 (1)	1 (1)
	chronic inflammation	heart	1 (1)	---	---	0 (1)	1 (2)
		olfactory	0 (1)	---	---	1 (1)	1 (2)
	foreign body granuloma	intestine	0 (1)	---	---	1 (1)	1 (2)
		liver	0 (1)	---	---	1 (1)	1 (2)
		stomach	---	---	---	1 (1)	1 (1)

Table A-8 Histological lesions in fish collected during Cruise 8. The numbers listed are the frequencies of occurrance in the organs examined (number of organs examined in parenthesis).

Species	Lesion	Organ	BRC	EFG	WFG	PLB	TOTAL
			STATION				
three-eye flounder	foreign body granuloma	liver	---	---	---	1 (5)	1 (5)
		trunk kidney	---	---	---	1 (5)	1 (5)
	cestode	intestine	---	---	---	1 (1)	1 (1)
	nematode	liver	---	---	---	1 (5)	1 (5)
		mesentery	---	---	---	3 (5)	3 (5)
	sporozoan	trunk kidney	---	---	---	1 (5)	1 (5)
		urinary bladder	---	---	---	3 (4)	3 (4)
	trematode	gill	---	---	---	1 (5)	1 (5)
gray triggerfish	edema	gill	---	1 (9)	---	0 (10)	1 (19)
	telangiectasis	gill	---	2 (9)	---	1 (10)	3 (19)
	hyperplasia	gill	---	1 (9)	---	3 (10)	4 (19)
	chronic inflammation	liver	---	1 (9)	---	1 (8)	2 (17)
	sloughing	olfactory	---	1 (4)	---	0 (6)	1 (10)
	nematode	gill	---	3 (9)	---	3 (10)	6 (19)
	trematode	gill	---	0 (9)	---	1 (10)	1 (19)
red snapper	epitheliocytis	gill	--	0 (8)	0 (5)	1 (11)	1 (24)
	edema	gill	--	2 (8)	2 (5)	2 (11)	6 (24)
	telangiectasis	gill	--	0 (8)	0 (5)	2 (11)	2 (24)
	hyperplasia	gill	--	1 (8)	32 (5)	3 (11)	6 (24)
	chronic inflammation	liver	--	0 (7)	1 (5)	32 (10)	3 (22)
		pancreas	--	0 (7)	1 (5)	0 (11)	1 (23)
		olfactory organ	--	0 (8)	0 (4)	1 (9)	1 (21)
	foreign body granuloma	heart	--	--	1 (1)	0 (1)	1 (2)
		spleen	--	0 (5)	1 (5)	0 (11)	1 (21)
		liver	--	1 (7)	0 (5)	0 (10)	1 (22)
		pancreas	--	0 (7)	0 (5)	1 (11)	1 (23)
		trunk kidney	--	0 (8)	0 (3)	2 (8)	2 (19)
		mesentery	--	1 (4)	0 (3)	0 (6)	1 (13)
	cestode	liver	--	0 (7)	0 (5)	1 (10)	1 (22)
	nematode	mesentery	--	0 (4)	0 (3)	1 (6)	1 (13)
	sporozoan	ovary	--	0 (2)	1 (3)	0 (4)	1 (9)
		olfactory	--	0 (8)	0 (4)	1 (9)	1 (21)
	trematode	gill	--	0 (8)	0 (5)	2 (11)	2 (24)
creole-fish	bacteria	liver	--	2 (4)	0 (8)	0 (11)	2 (23)
		trunk kidney	--	1 (4)	0 (9)	0 (8)	1 (21)
	epitheliocytis	gill	--	0 (5)	0 (10)	1 (11)	1 (26)
	congestion	spleen	--	2 (3)	2 (8)	0 (9)	4 (20)
	edema	gill	--	0 (5)	0 (10)	1 (11)	1 (26)
	chronic inflammation	liver	--	0 (4)	0 (8)	4 (11)	4 (23)

Table A-8 continued...

Species	Lesion	Organ	BRC	EFG	WFG	PLB	TOTAL
			STATION				
	foreign body	liver	--	0(4)	2 (8)	2 (11)	4 (23)
	granulation	trunk kidney	--	0(4)	1 (9)	0 (8)	1 (21)
		liver	--	0(4)	0 (8)	4 (11)	4 (23)
	necrosis	trunk kidney	--	0(4)	0 (9)	1 (8)	1 (21)
	ciliate	gill	--	0(5)	1 (10)	0 (11)	1 (26)
Mexican searobin							
	edema	gill	1 (7)	--	--	0 (8)	1 (15)
	telangiectasis	gill	1 (7)			0 (8)	1 (15)
	fatty change	liver	1 (9)	--	--	3 (10)	4 (19)
	hyperplasia	gill	1 (7)	--	--	1 (8)	2 (15)
	hypertrophy	gill	0 (7)	--	--	1 (8)	1 (15)
	foreign body	liver	1 (9)	--	--	1 (10)	2 (19)
	granuloma	mesentery	1 (6)	--	--	0 (7)	1 (13)
	crustacean	olfactory	1 (8)	--	--	2 (8)	3 (16)
	cestode	mesentery	1 (6)	--	--	0 (7)	1 (13)
	nematode	liver	1 (9)	--	--	1 (10)	2 (19)
		mesentery	3 (6)	--	--	3 (7)	6 (13)
	trematode	intestine	1 (3)	--	--	0 (2)	1 (5)
wenchman	unidentified	olfactory	2 (6)	--	--	0 (8)	2 (14)
	edema	gill	1 (7)	--	--	1 (9)	2 (16)
	telangietasis	gill	1 (7)	--	--	1 (9)	2 (16)
	fatty change	liver	0 (6)	--	--	1 (9)	1 (15)
	foreign body	trunk kidney	0 (6)	--	--	1 (9)	1 (15)
	granuloma	mesentery	0 (3)	--	--	0 (6)	2 (9)
	cestode	liver	0 (6)	--	--	1 (9)	1 (15)
		mesentery	0 (3)	--	--	1 (6)	1 (9)
vermilion snapper	unidentified	trunk kidney	--	0 (10)	1 (7)	1 (12)	2 (29)
		gill	--	0 (10)	1 (8)	0 (14)	1 (32)
	epitheliocytis	olfactory	--	0 (9)	0 (8)	1 (13)	1 (30)
	congestion	liver	--	0 (9)	0 (7)	1 (14)	1 (30)
	edema	gill	--	1 (10)	0 (8)	2 (14)	3 (32)
	telangiectasis	gill	--	0 (10)	0 (8)	1 (14)	1 (32)
	fatty change	liver	--	0 (9)	1 (7)	0 (14)	1 (30)
	hyperplasia	gill	--	0 (10)	2 (8)	4 (14)	6 (32)
	chronic	liver	--	0 (9)	0 (7)	2 (14)	2 (30)
	inflammation	pancreas	--	1 (9)	0 (7)	0 (15)	1 (31)
		olfactory	--	1 (9)	0 (8)	1 (13)	2 (30)
	foreign body	intestine	--	0 (1)	0 (1)	1 (1)	1 (3)
	granuloma	stomach	--	--	1 (1)	0 (1)	1 (2)

Table A-8 continued...

Species	Lesion	Organ	STATION BRC	EFG	WFG	PLB	TOTAL
		trunk kidney	---	1 (10)	0 (7)	0(12)	1 (29)
		mesentery	---	0 (2)	1 (5)	0 (4)	1 (11)
	cestode	intestine	---	0 (1)	0 (1)	0(1)	1 (3)
	sprozozoan	trunk kidney	---	1 (10)	0 (7)	0 (12)	0 (29)
	trematode	gill	---	0 (10)	1 (8)	0 (14)	1 (32)
sash flounder	unidentified	trunk kidney	2 (4)	---	---	1 (2)	3 (6)
	fatty change	liver	1 (5)	---	---	2 (2)	3 (7)
	foreign body	stomach	1 (1)	---	---	---	1 (1)
	granuloma	testis	1 (3)	---	---	---	1 (3)
		mesentery	2 (4)	---	---	1 (1)	3 (5)
	cestode	myomere	1 (1)	---	---	---	1 (1)
		mesentery	2 (4)	---	---	0 (1)	2 (5)
	nematode	mesentery	1 (4)	---	---	1 (1)	2 (5)

APPENDIX B

ATLAS OF LESIONS AND COMPARABLE NORMAL ORGANS FROM FISH COLLECTED DURING THE FLOWER GARDEN BANKS PROJECT

This atlas contains representative lesions from fish collected in the vicinity of drilling platforms and from control areas near the Flower Garden Banks (Table B-1). Normal organs from these fish are included for comparison to the lesions and as examples of the organs examined (Table B-2). Additional observations (Table B-3) are included in the atlas because of thier possible significance in determining the effects of drilling platforms on fish. Photographs are grouped by organs. Representative lesions and normal organs in the figures are typical of the general appearance of the lesion or organ in most species examined unless stated otherwise.

Table B-1. Lesions illustrated in this atlas (listed alphabetically)

Lesion	Figure Number
cestode	18
congestion	19
cyst	3
edema	6
fatty change	18
granuloma	2,20,23
hyperplasia	7
inflammation	33
isopod	1
nematode	9,10,23,38
sloughing of epithelium	33
sporozoan parasite	34
telangiectasis	8
trematode	3,11

Table B-2. Organs illustrated in this atlas (listed alphabetically)

Organ	Figure Number
brain	35
eye	36
fin	1
gill	4-11
head kidney	28
heart	39
intestine	21-23
liver	15-20
mesentery	2,3,38
olfactory organ	32-34
oral mucosa	24
ovary	31
pseudobranch	41
skin	40
spinal cord	37
spleen	25-27,42-44
stomach	12-14
testis	30
vertebra	37

Table B-3. Observations other than lesions (listed alphabetically)

Observation	Figure Number
acidophilic granular cells	13,14
glycogen vacuolation	16
macrophage center	26,29,42-44
probable fixation artifact	5

FIGURE CAPTIONS

Figure 1. Isopods attached to the caudal fin of a vermilion snapper.

Figure 2. Granuloma in mesentery of a scamp. This type of lesion probably results from parasite infestation.

Figure 3. Histological section of a grossly visible cyst from the mesentery of a cottonwick. The encystment of a larval digenetic trematode, seen in the center of the lesion, caused the lesion (X 60).

Figure 4. Normal gill from a vermilion snapper. The normal gills of other species were similar (X 500).

Figure 5. Separation of epithelium from gill lamellae in a wenchman. The pathological significance of this observation is uncertain, and it may be an artifact in most cases. This condition was distinguished from gill lamella edema by the presence of a precipitate in the edematous condition (X 1225)

Figure 6. Edema of the gill lammella in a red snapper. Note the eosinophilic precipitate under the gill lammella epithelium (X 460).

Figure 7. Hyperplasia and hypertrophy of gill lammella epithelium in a vermilion snapper. The lesion consists of an increase in the number of gill lammella epithelial cells (X 635).

Figure 8. Telangiectasis of gill lammella in gray triggerfish. This lesion results in pooling of blood in the expanded gill lammella sinusoids (X 180).

Figure 9. Nematodes in lymph vessels and blood vessels of a gray triggerfish gill filament (X 125).

Figure 10. Higher magnification of the nematodes in gray triggerfish gill filaments (X 470).

Figure 11. Monogenetic trematodes on gray triggerfish gills (X 125).

Figure 12. Normal stomach from southern hake (X 200).

Figure 13. Stomach of sash flounder with acidophilic granular cells in the submucosa. These cells were a consistent finding in this species and were not considered as a type of lesion unless accompanied by inflammation (X 150).

Figure 14. Higher magnification of the acidophilic granular cells of the stomach submucosa seen in Figure 13 (X 480).

Figure 15. Normal liver of wenchman (X 470).

Figure 16. Liver of a red snapper with hepatocyte vacuolation caused by accumulation of glycogen (X 1500).

Figure 17. Liver of a gray triggerfish with normal pancreatic acini and lipid filling the cytoplasm of all most hepatocytes. The accumalation of lipid in hepatocytes is characteristic of the normal liver in gray triggerfish (X 1500).

Figure 18. Cestode in a bile duct within the liver of a red snapper. Hepatic fatty change is also evident but is probably not related to the parasite. Although the cestode appeared to obstruct the bile duct, bile stasis was not evident. Normal pancreatic acini surround the hepatic portal veins (X 165).

Figure 19. Congestion of sinusoids in vermilion snapper liver (X 460).

Figure 20. Granuloma in red snapper liver. The outer portion of the lesion is infiltrated with lymphocytes. This common type of lesion is probably parasite related (X 460).

Figure 21. Normal intestine from a vermilion snapper (X 65).

Figure 22. Cestode attached to the intestinal mucosal epithelium of a gray triggerfish. No host response occurred because of this parasite (X 500).

Figure 23. Nematode encysted in the submucosa of a red snapper intestine, and foreign body granulomas related to the nematode infestation (X 165).

Figure 24. Normal oral mucosa of a red snapper with a taste bud and prominent goblet cells (X 500).

Figure 25. Normal spleen from a red snapper with splenic artery, vein, and nerves in the center of the photograph (X 125).

Figure 26. Pigmented macrophage centers in a cottonwick spleen. This species has more macrophage centers than other species examined, and melanin was the predominant pigment (X 160).

Figure 27. Fibrous connective tissue capsules surrounding pigmented macrophage centers in a cottonwick spleen. Macrophge centers are not usually encapsulated and the cause of the encapsulation is unknown (X 180).

Figure 28. Normal head kidney from a gray triggerfish (X 180).

Figure 29. Normal vermilion snapper trunk kidney with a pigmented macrophage center (X 460).

Figure 30. Normal testis from a cottonwick (X 150).

Figure 31. Normal ovary from a scamp (X 200).

Figure 32. Normal olfactory epithelium from a cottonwick (X 500).

Figure 33. Epithelial sloughing and catarrhal inflammation of the olfactory epithelium in the gray triggerfish (X 1220).

Figure 34. Microsporozoans in olfactory organ lamella of a red snapper. Except for a thin capsule, no host response occurred (X 460).

Figure 35. Normal brain from a cottonwick. The part of the brain illustrated is the cortex of the optic lobe (X 150).

Figure 36. Normal retina from the eye of a gray triggerfish (X 180).

Figure 37. Transverse section of a normal spinal cord and vertebra from a blackeared bass (X 50) .

Figure 38. Nematodes in the mesentery of a blackeared bass. A thin capsule was the only host response to these parasites (X 125)

Figure 39. Normal ventricular myocardium of a cottonwick heart (X 120).

Figure 40. Normal gray triggerfish skin (X 65).

Figure 41. Telangiectasis in a blackeared bass pseudobranch. The portions of the pseudobranch not affected by the telangiectasis appeared normal (X 125).

Figure 42. Electron micrograph of melanin granules in a macrophage center of a cottonwick spleen (X 36,200).

Figure 43. Electron micrograph of hemosiderin in a Mexican searobin spleen macrophage center (X 58,800).

Figure 44. Electron micrograph of lipofuscin in a macrophage center of a gray triggerfish spleen (X 12,600).

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1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Histopathology of fishes in relation to drilling operations near Flower Garden Banks		5. REPORT DATE 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) John M. Grizzle		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Fisheries and Allied Aquacultures Auburn University, Alabama 36849		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO. NA80-GA-C0074
12. SPONSORING AGENCY NAME AND ADDRESS National Marine Fisheries Service Galveston Laboratory 4700 Avenue U Galveston, Texas 77550		13. TYPE OF REPORT AND PERIOD COVERED Draft 4Sep80 - 2May83 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

Fish near the Flower Garden Banks in the Gulf of Mexico were examined for gross and microscopic lesions to determine relationships between oil-well-drilling operations and the health of fish in this area. Fish were collected near two, active drilling platforms and from four control areas, and most comparisons between locations were with red snapper, vermilion snapper, creole-fish, wenchman, gray triggerfish, sash flounder, southern hake, and Mexican searobin. For some reef species, smaller fish were collected at platform locations, probably because of recruitment of young fish. Most lesions were caused by parasites. Some fish species collected near drilling platforms had higher liver/body weight ratios and more frequent or severe acute, histological lesions than controls. Toxicants are suspected as the cause of the acute, histological lesions and higher liver weights because the types of lesions were consistent with a toxicosis, infectious agents were not associated with the acute lesions, and prevalence or severity of the lesions increased near drilling platforms that were probable sources of toxicants. The types of lesions were not specific for exposure to any particular chemical so the identity of the toxicant is not known.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
pathology, histology, marine fishes, reefs, offshore drilling, drilling fluids	Gulf of Mexico, Flower Garden Banks	57 Y 68 D 97 R

18. DISTRIBUTION STATEMENT RELEASE TO PUBLIC	19. SECURITY CLASS (This Report) UNCLASSIFIED	21. NO. OF PAGES
	20. SECURITY CLASS (This page) UNCLASSIFIED	22. PRICE

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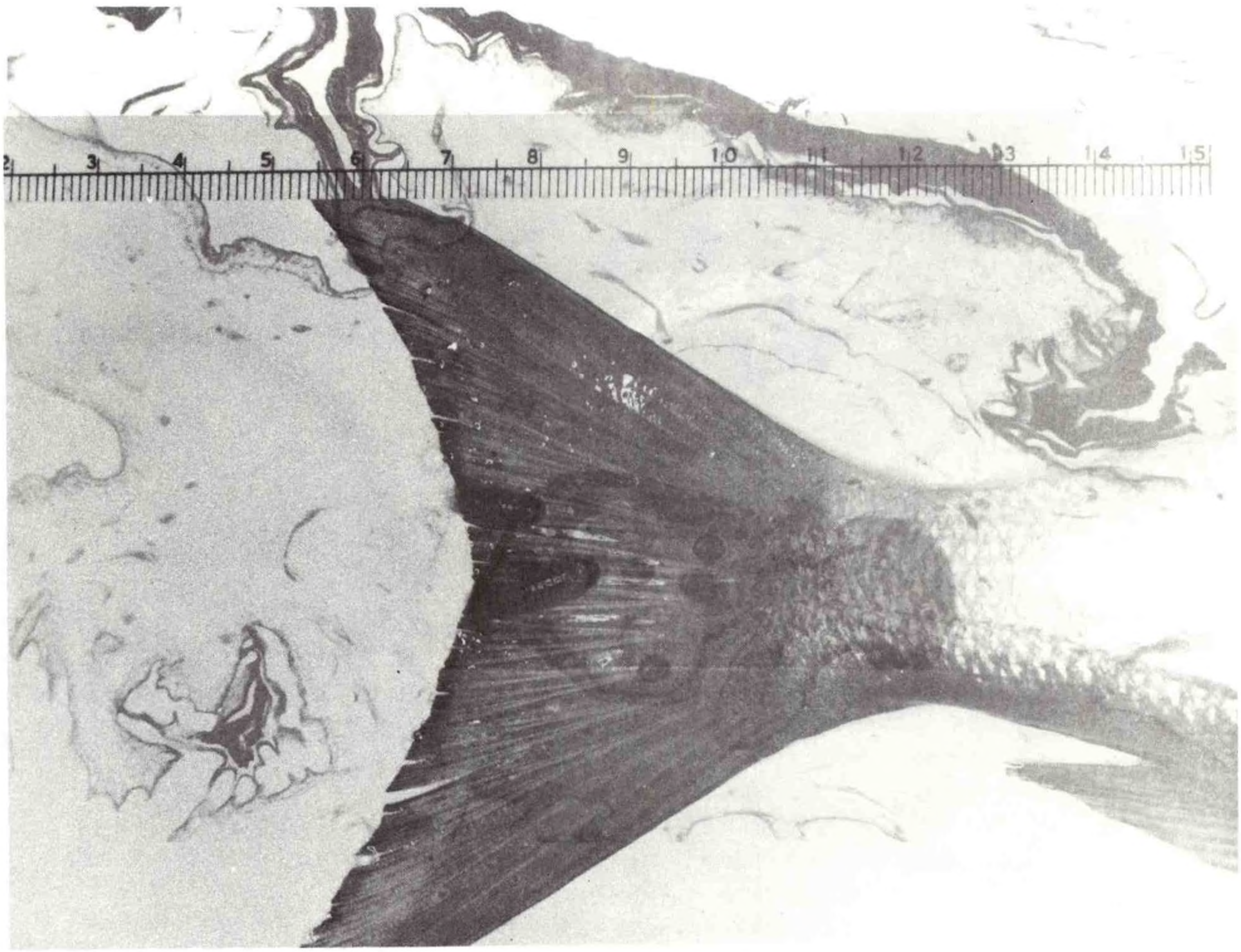

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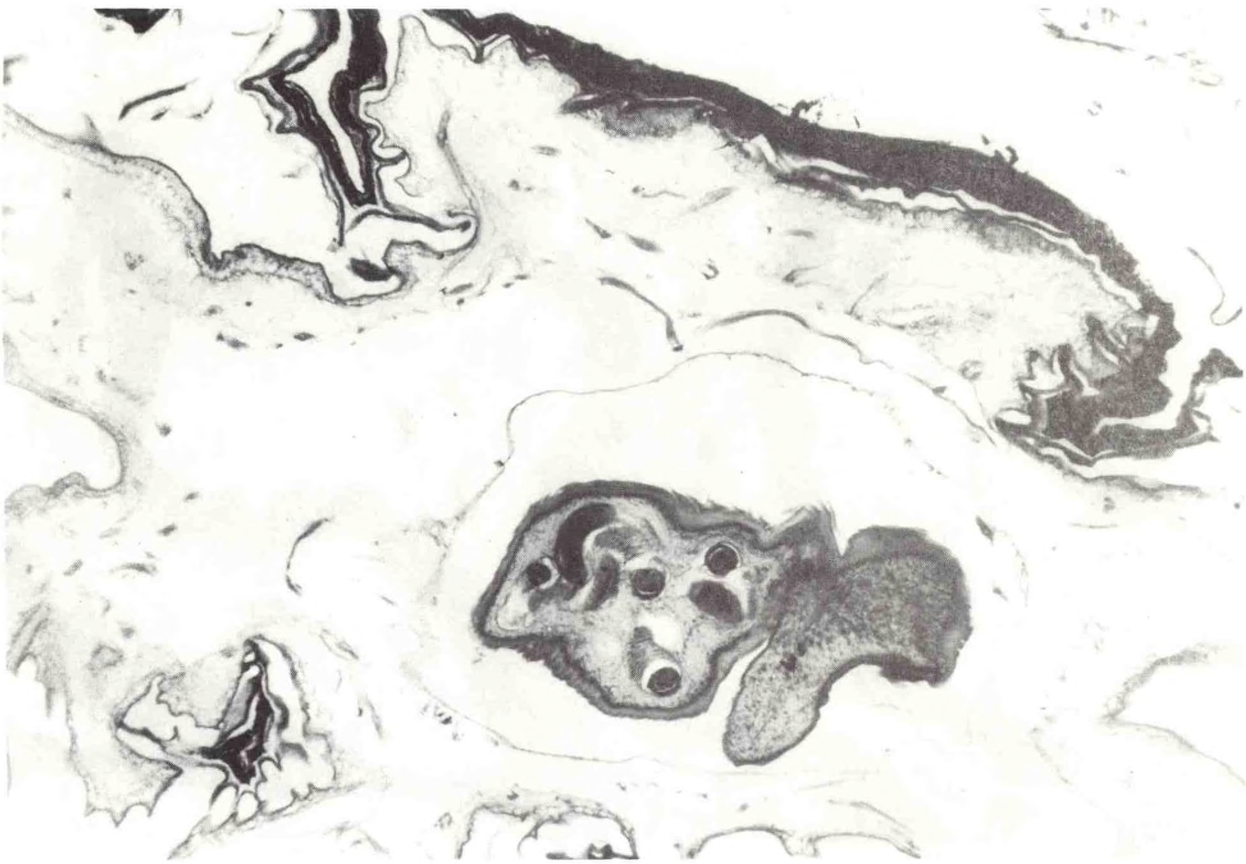

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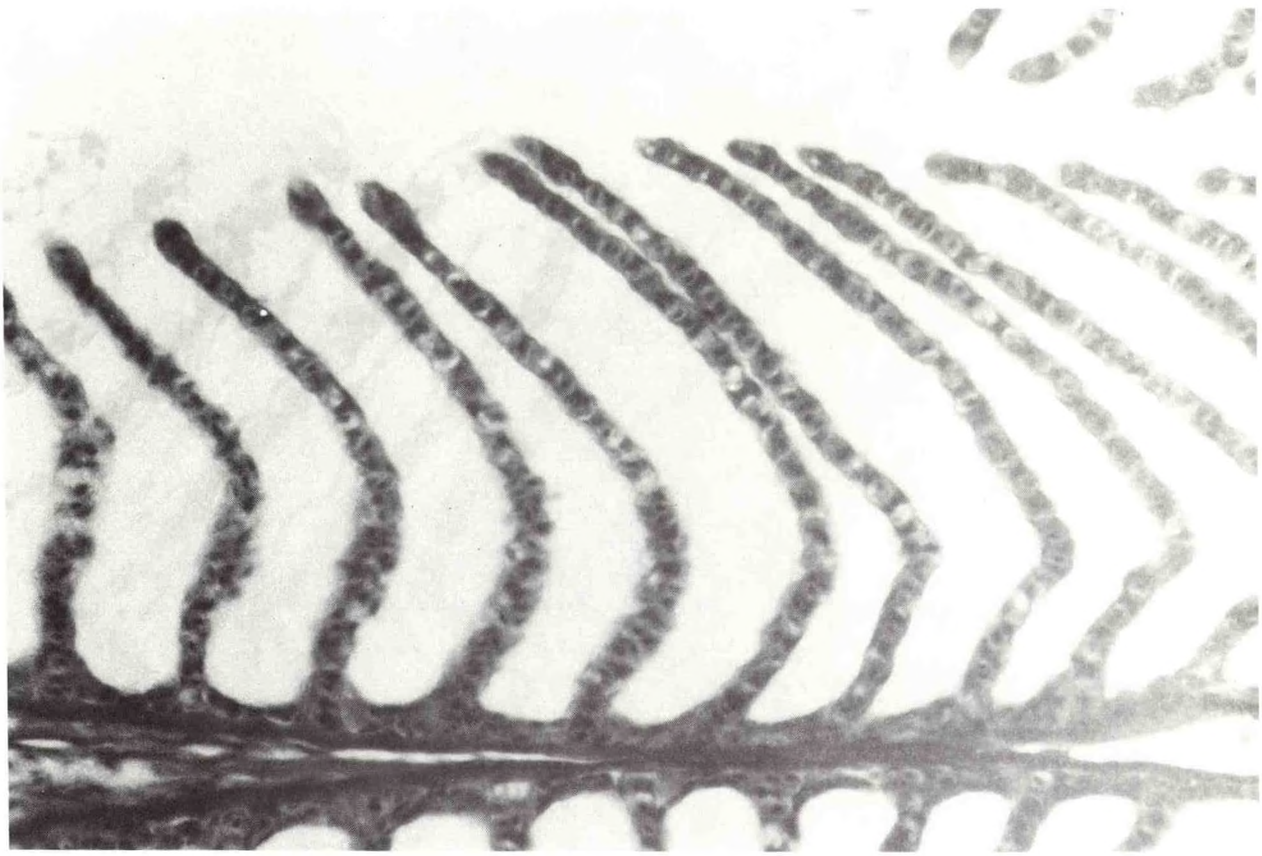

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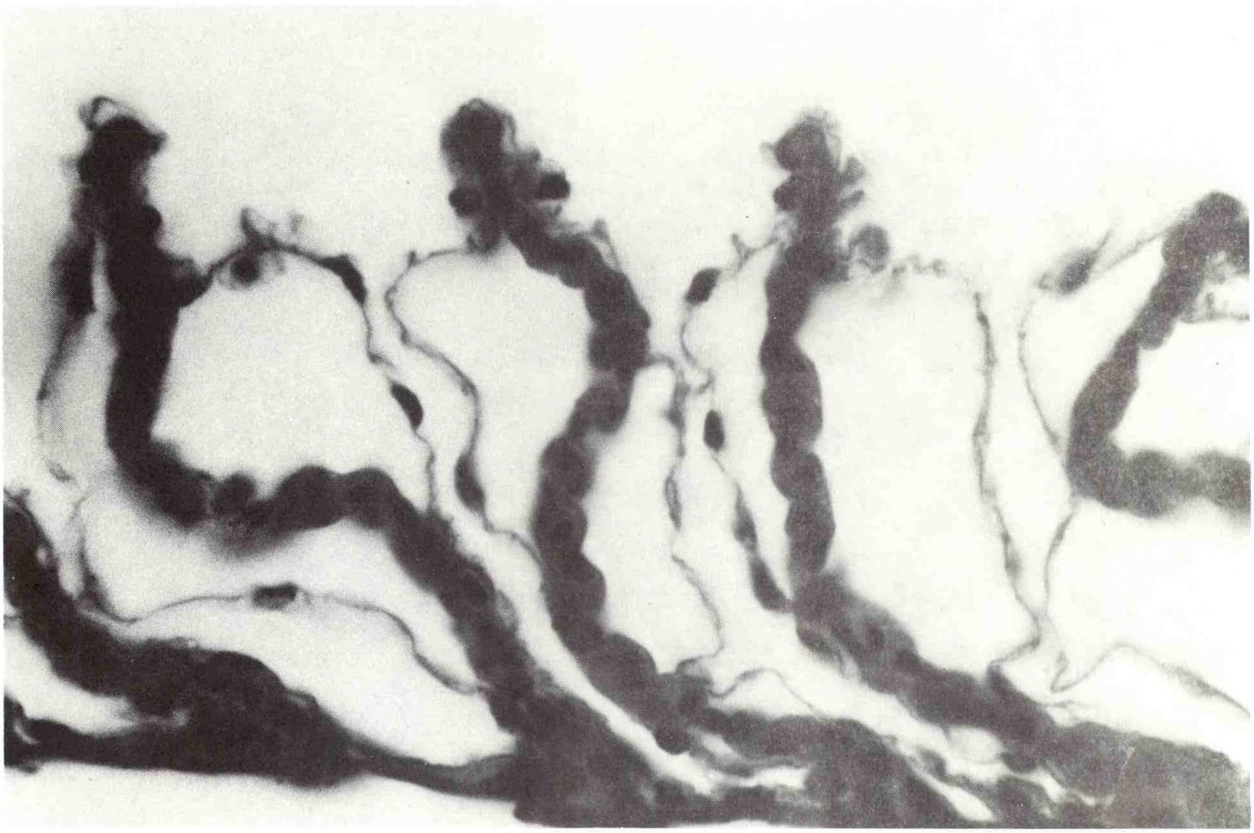

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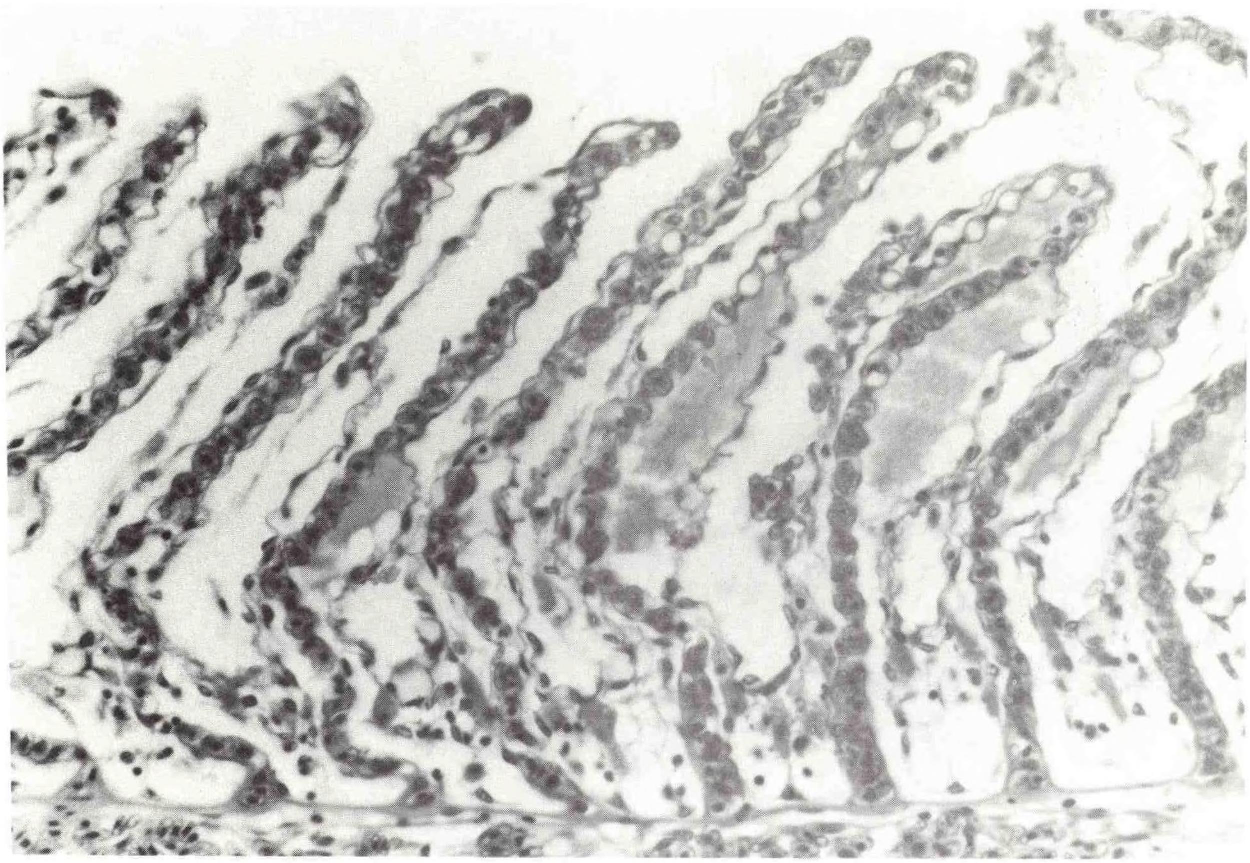

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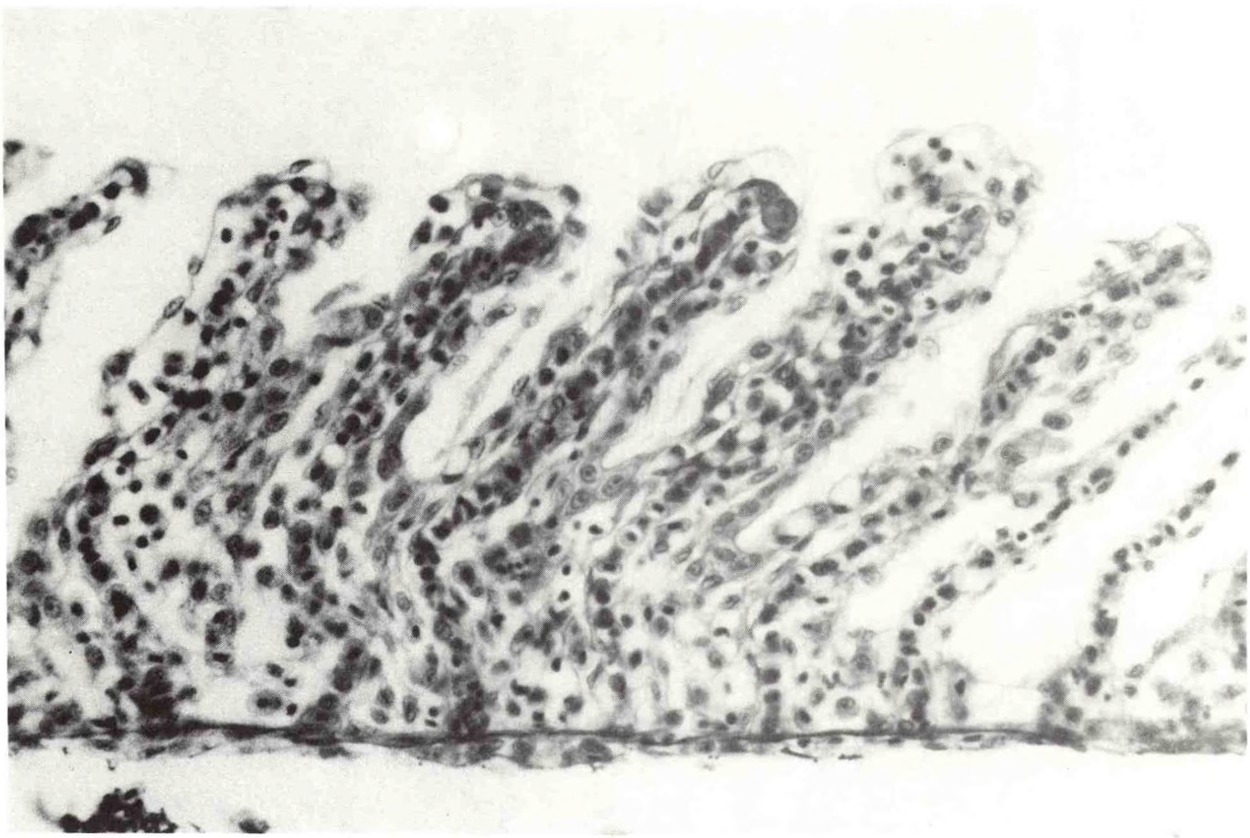

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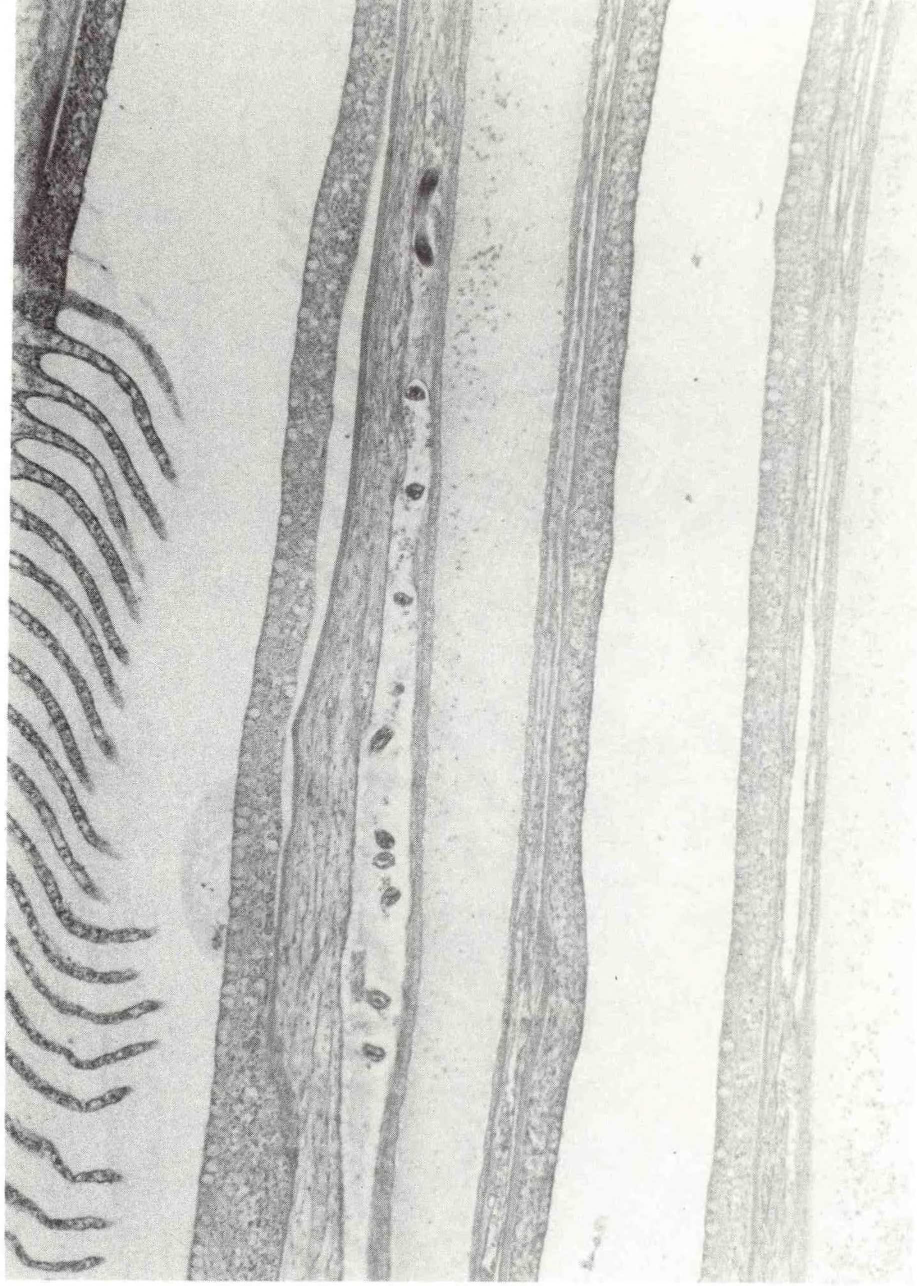

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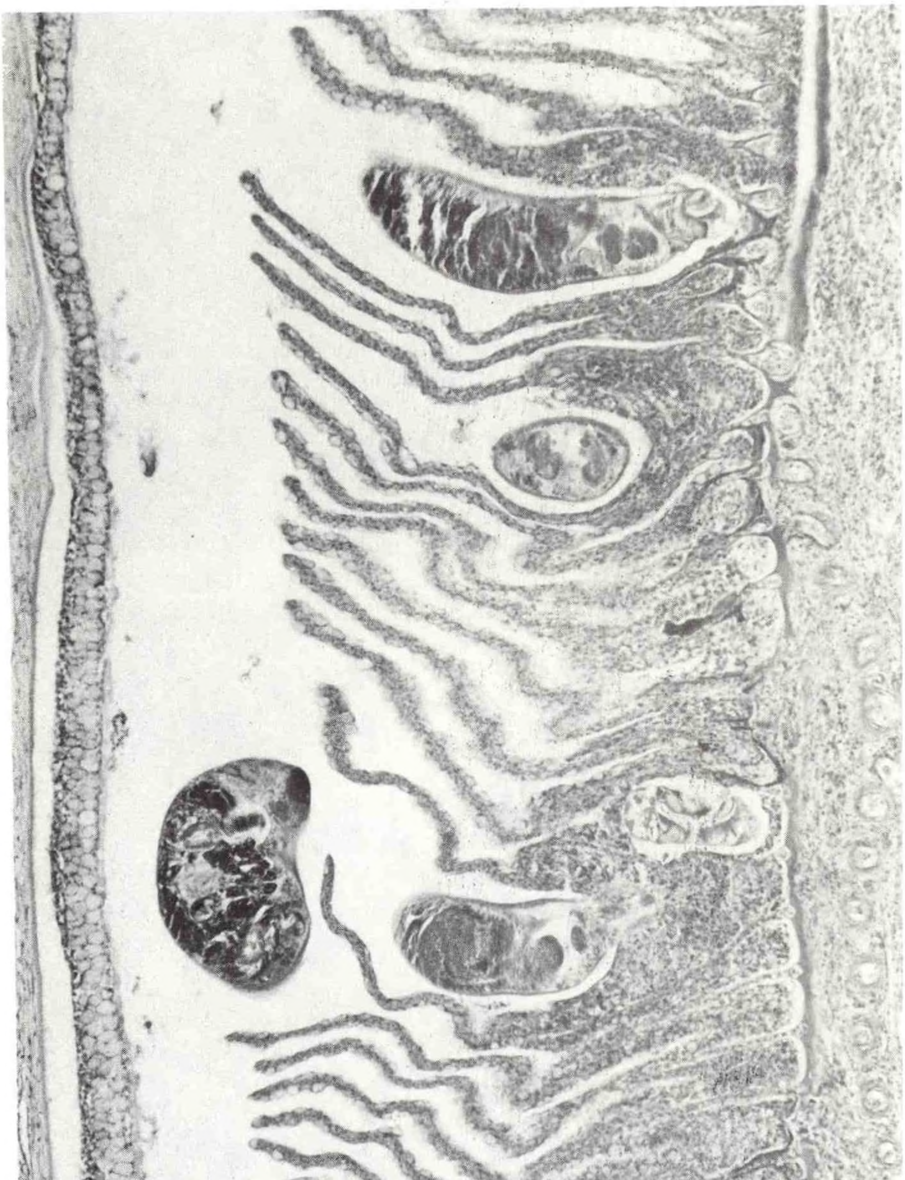

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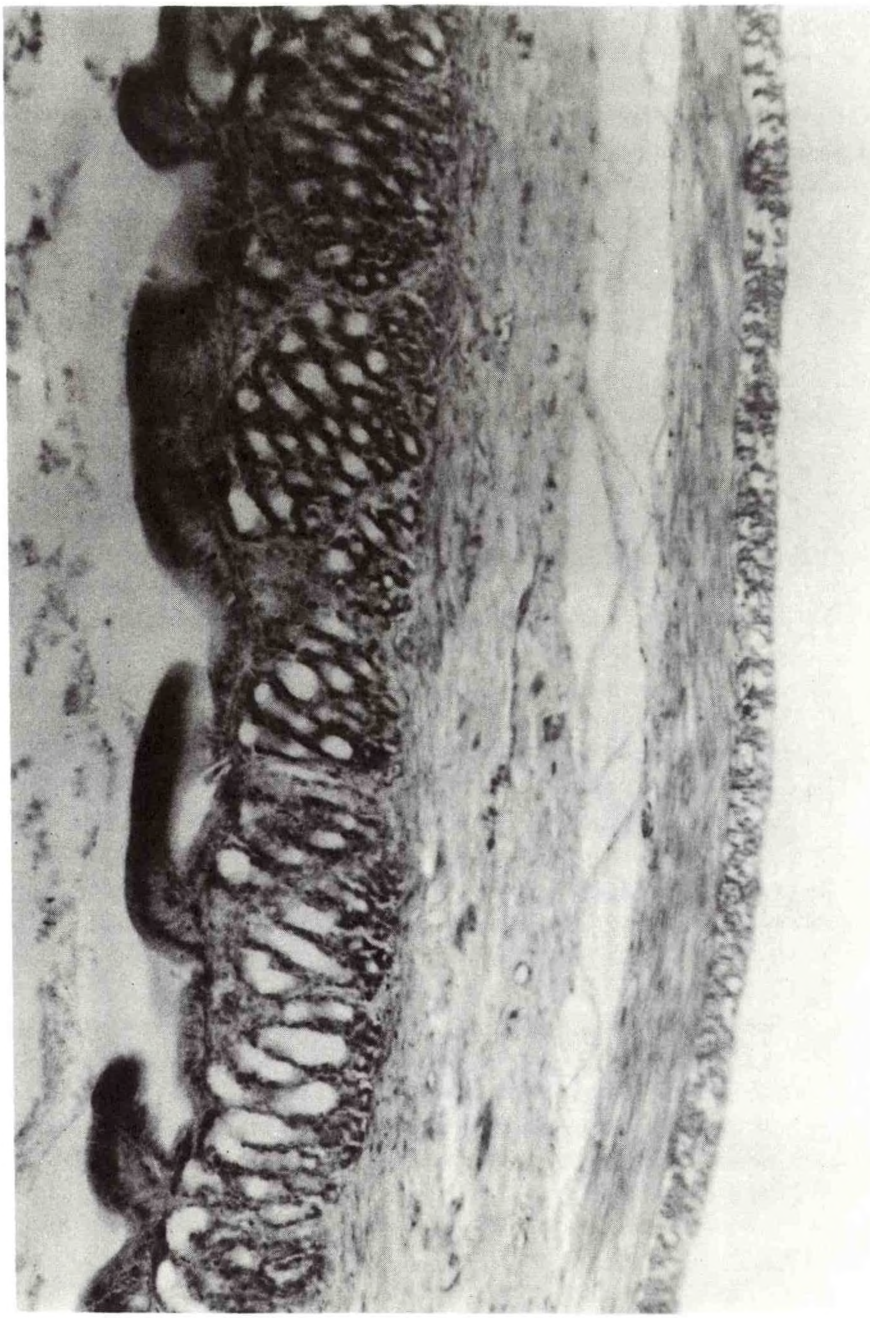

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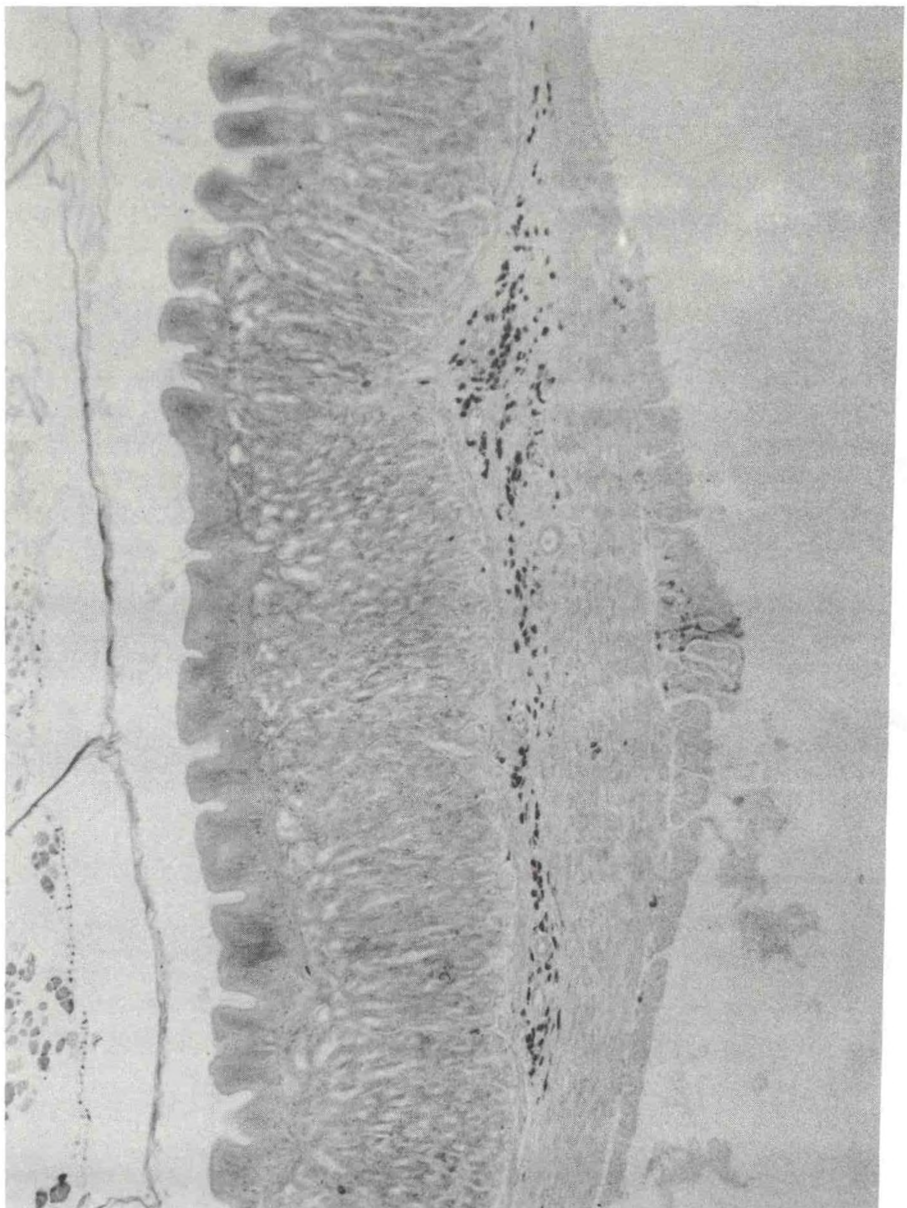

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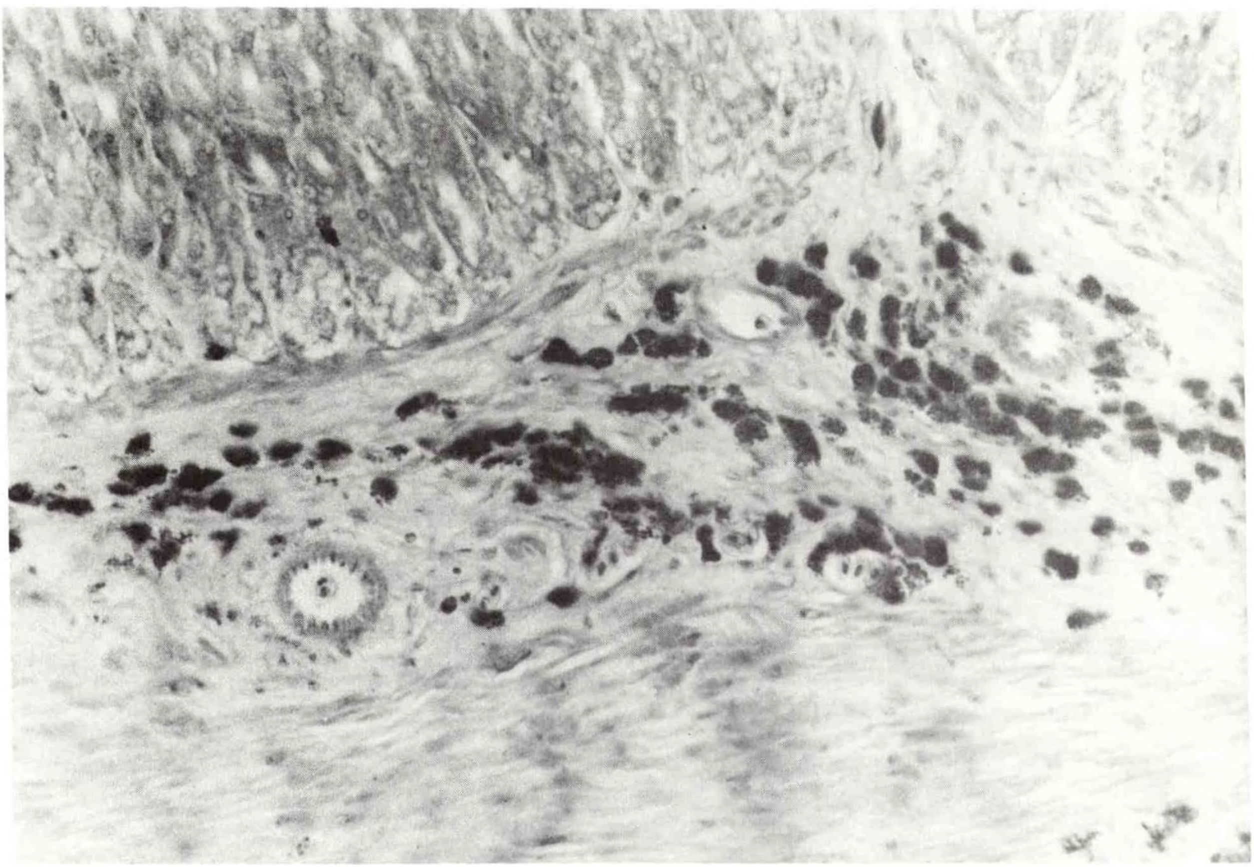

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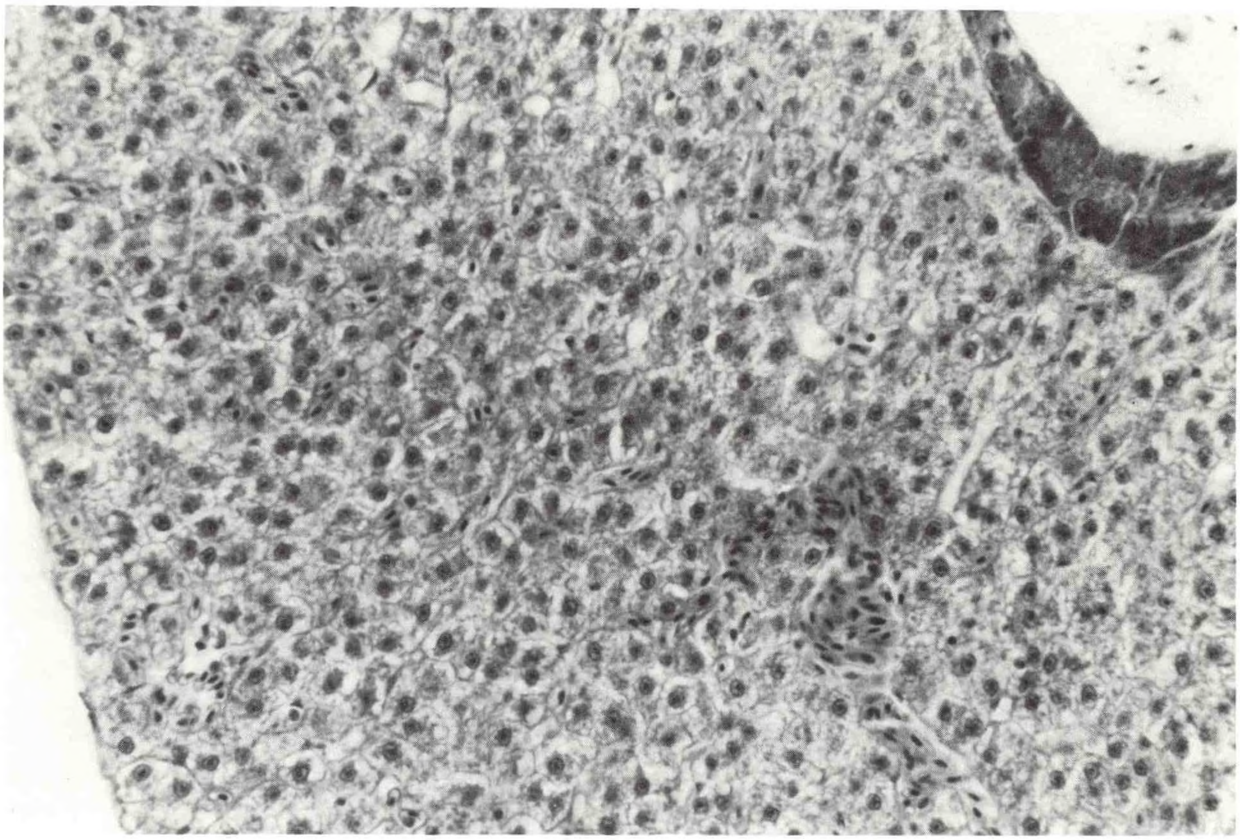

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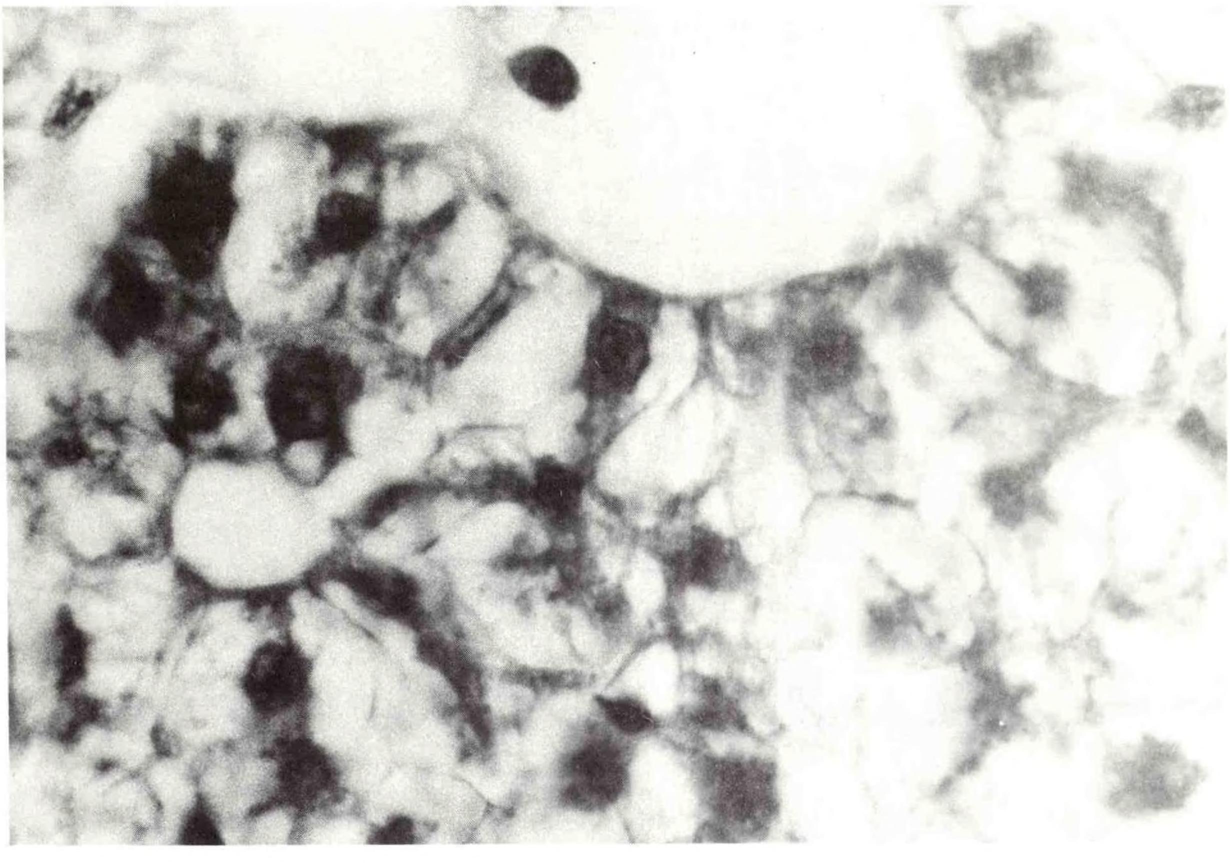

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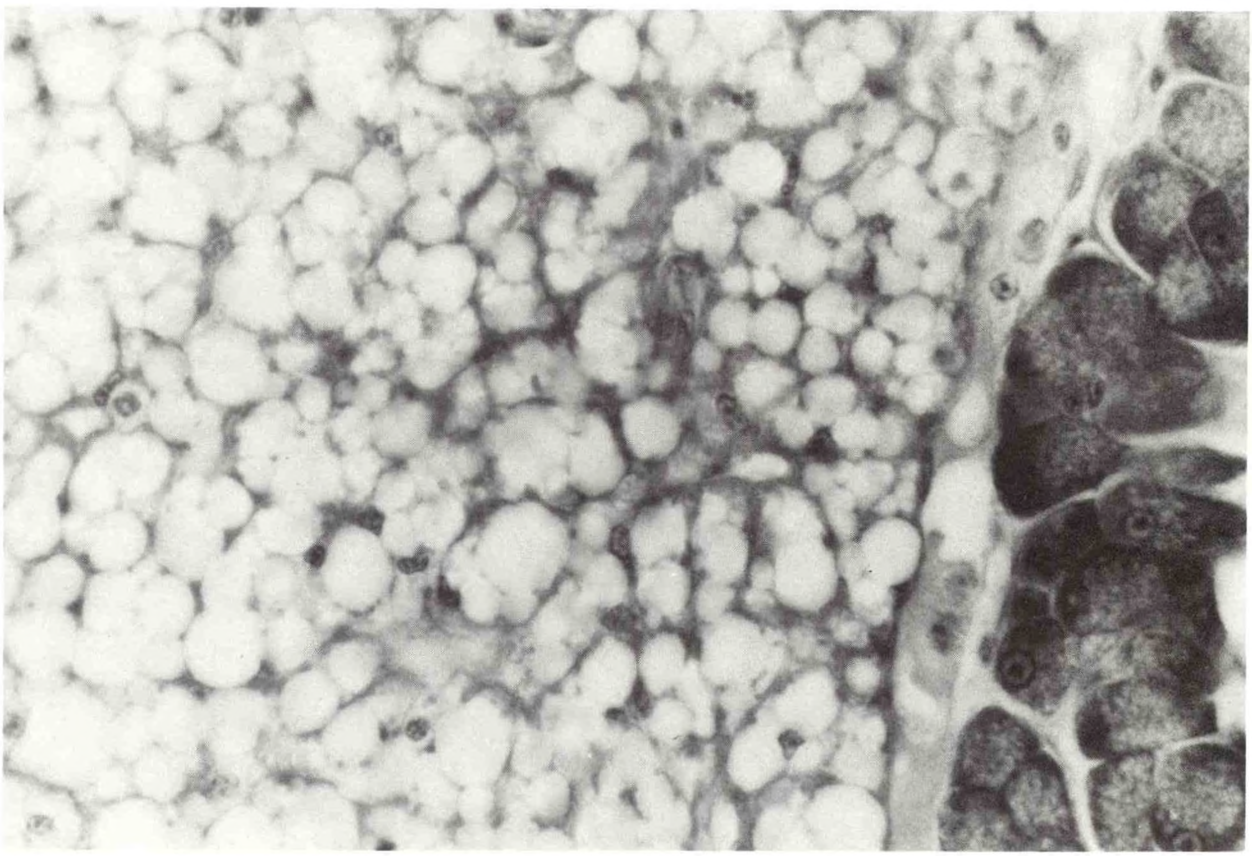

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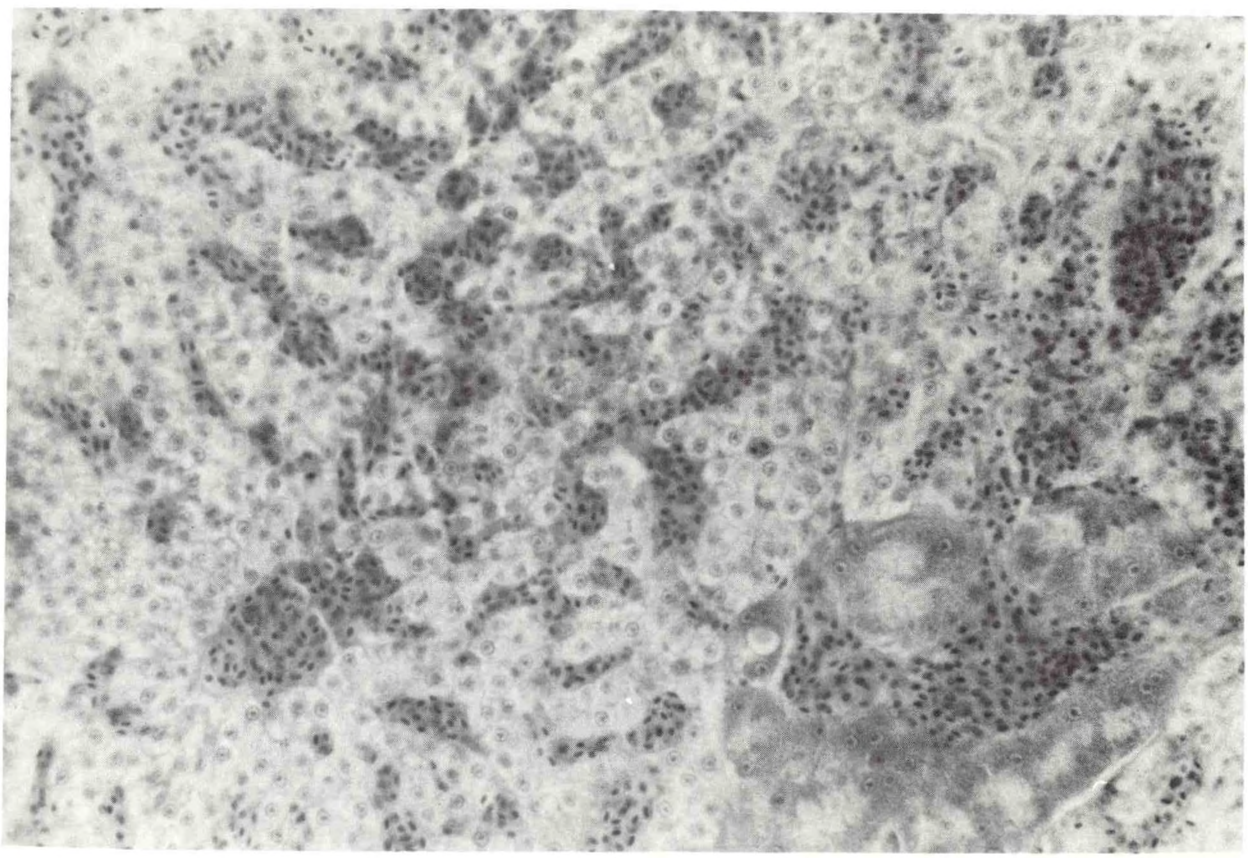

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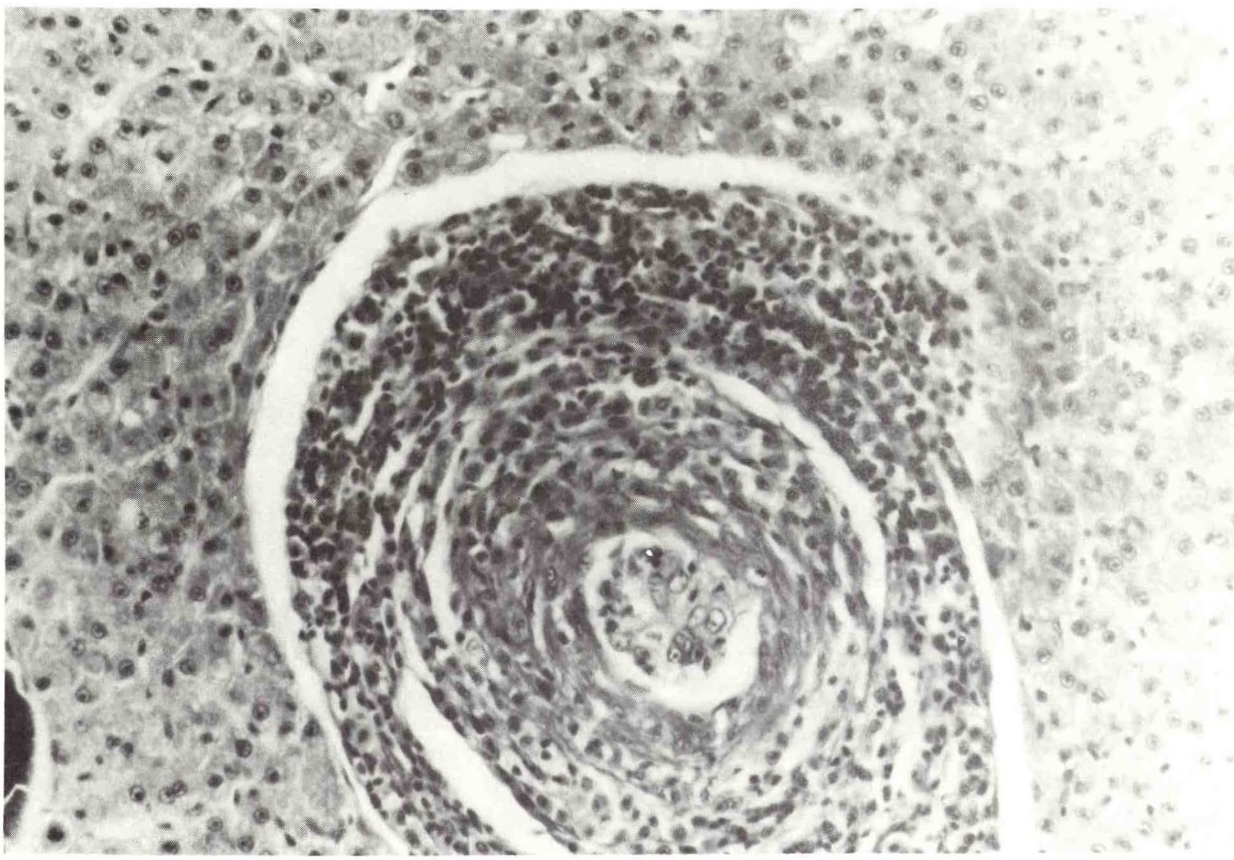

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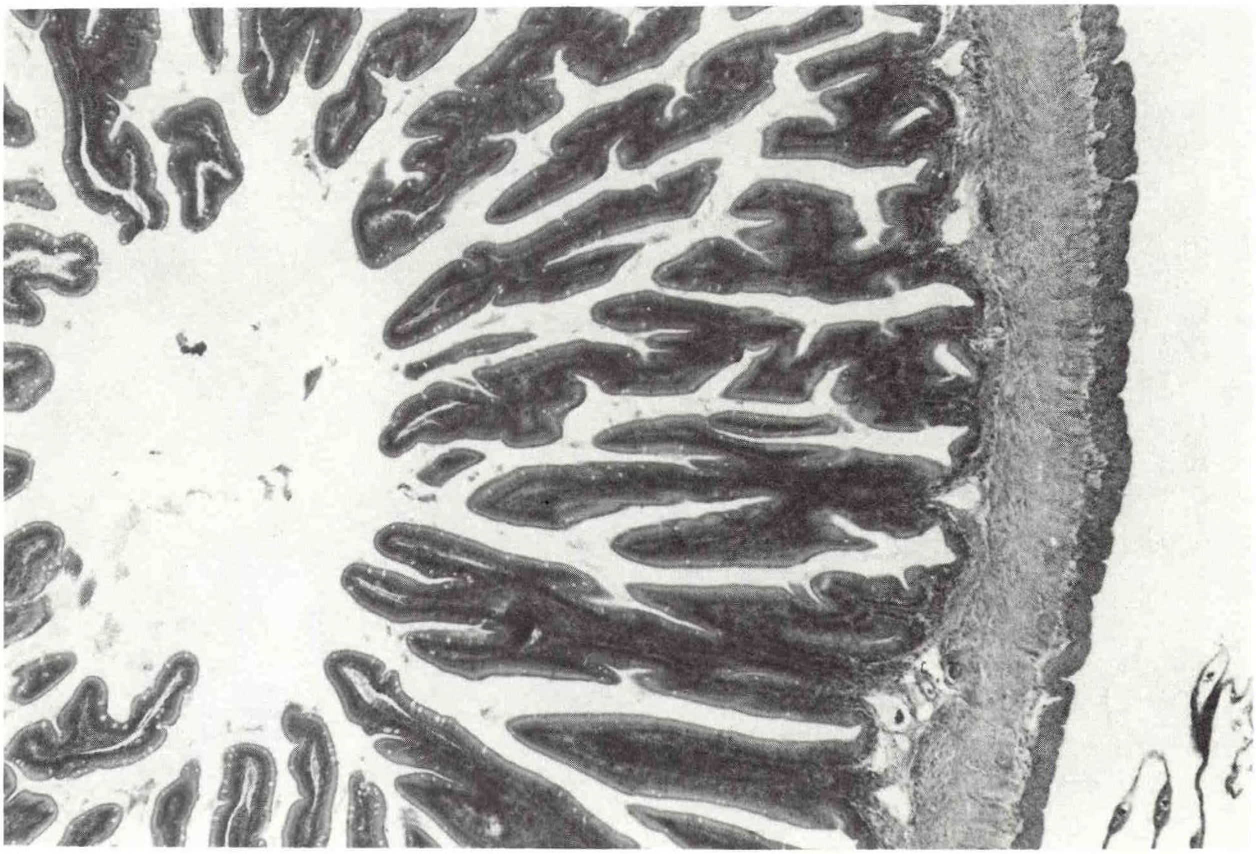

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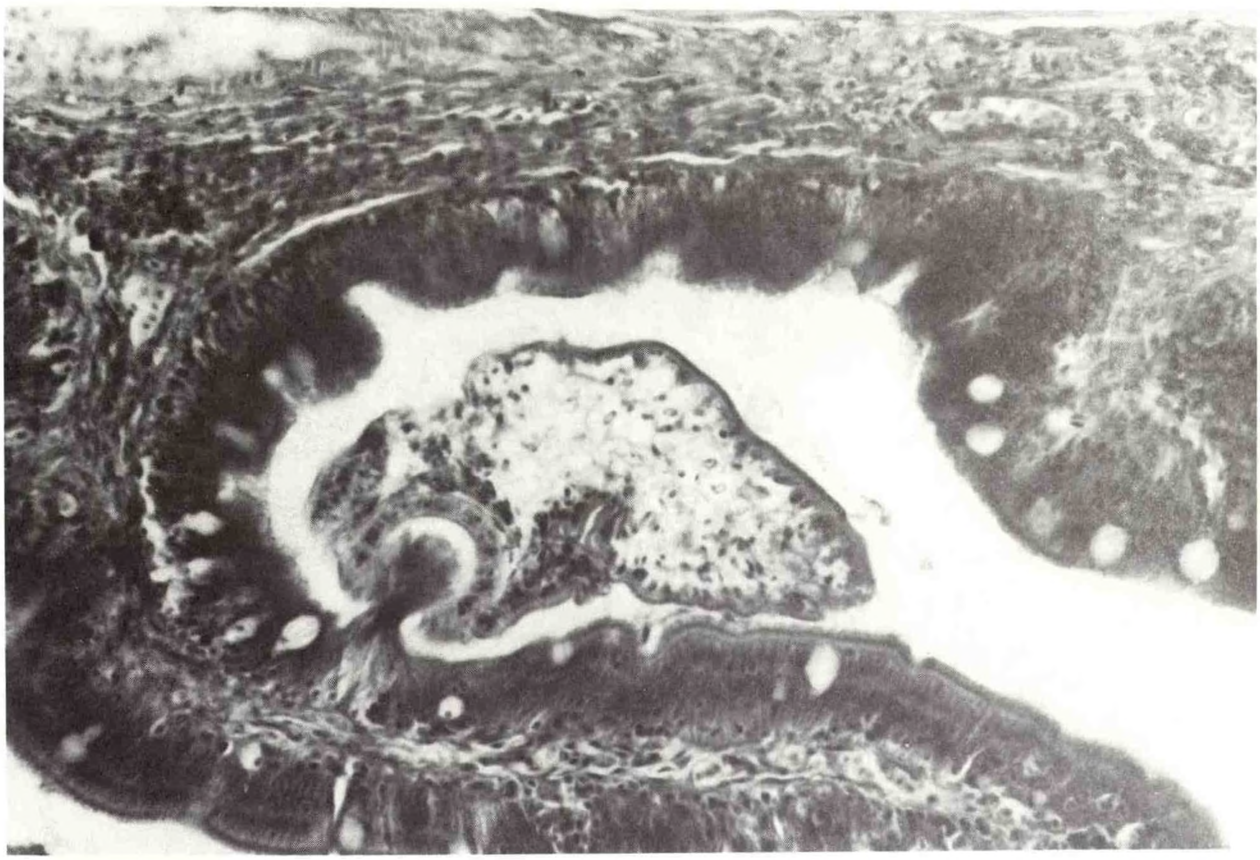

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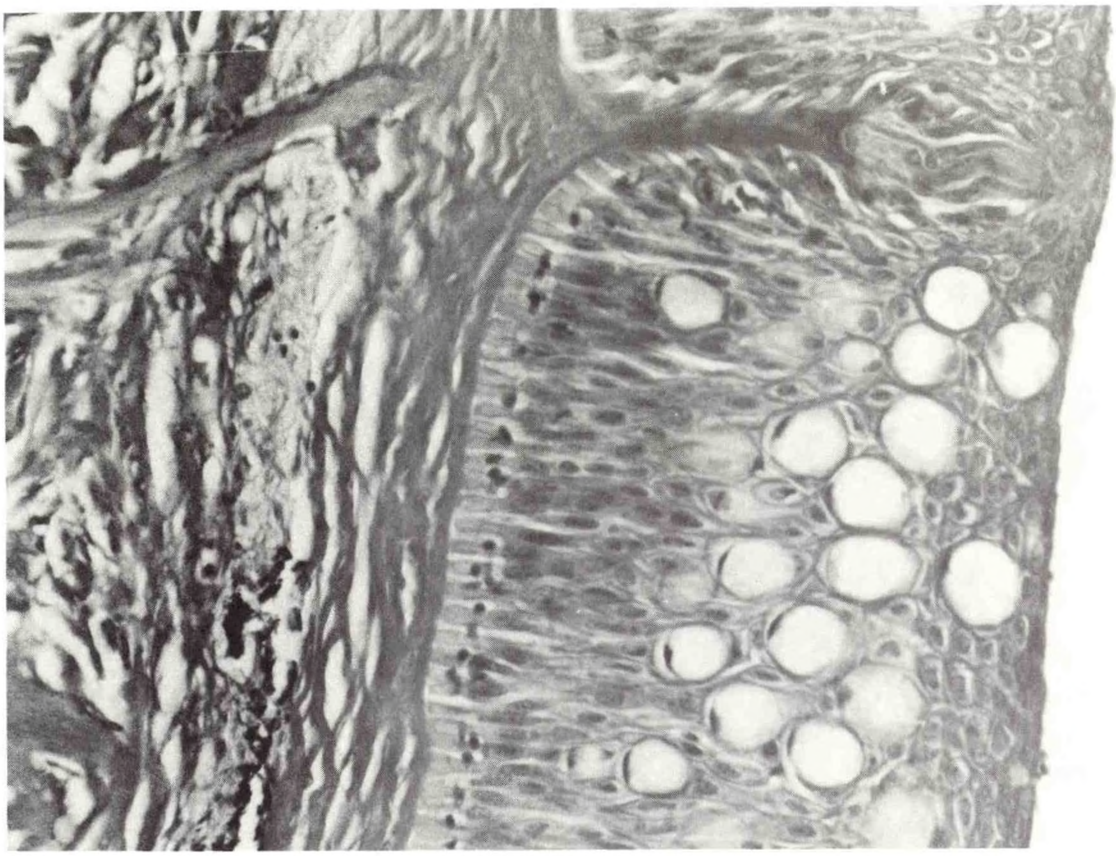

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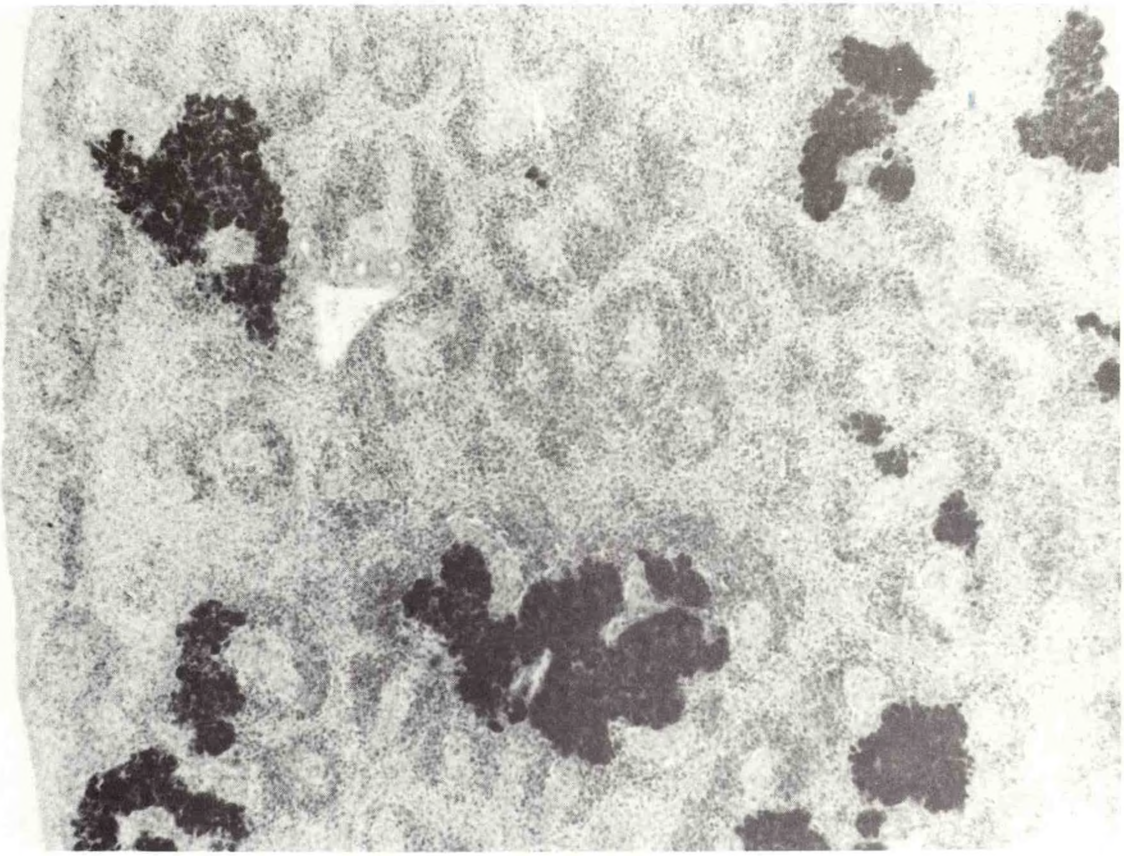

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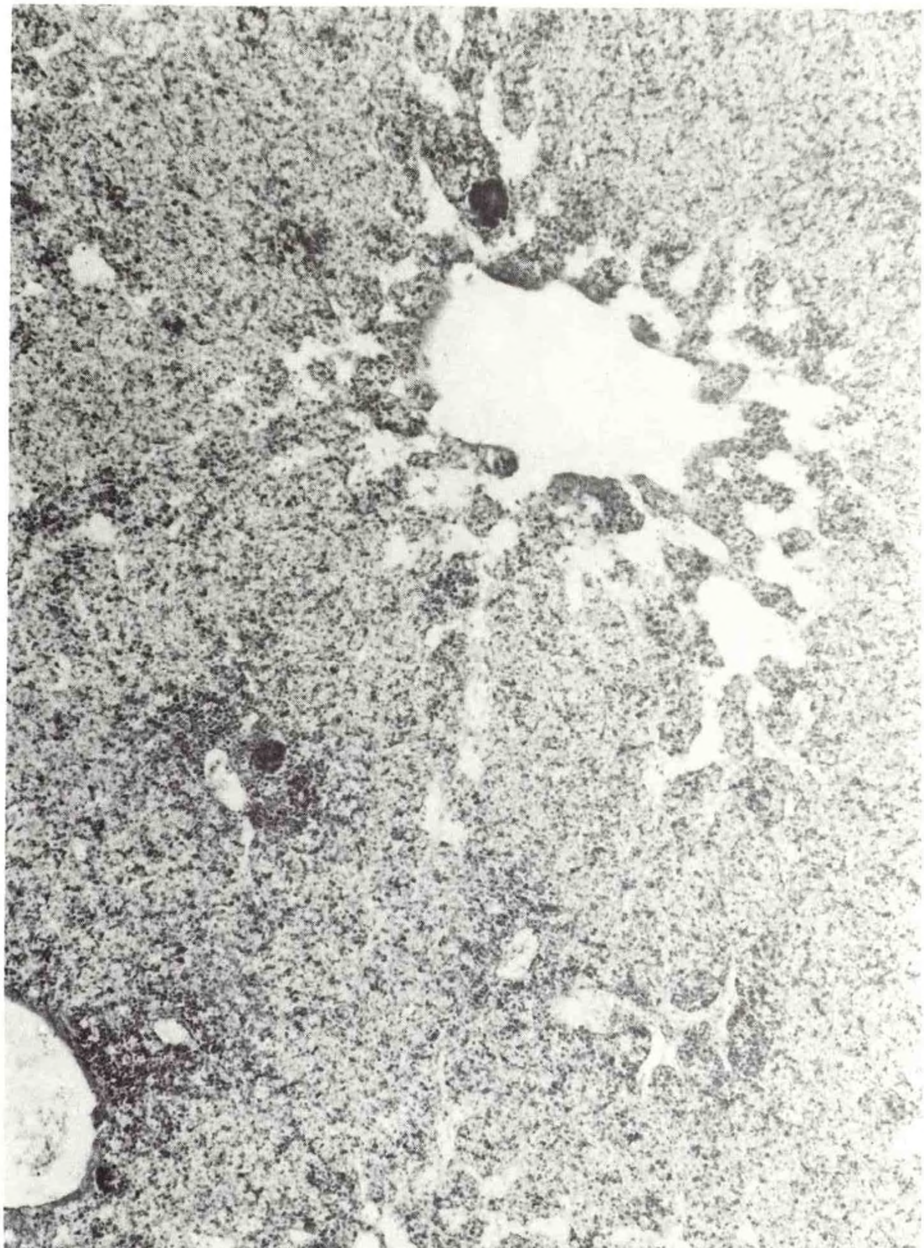

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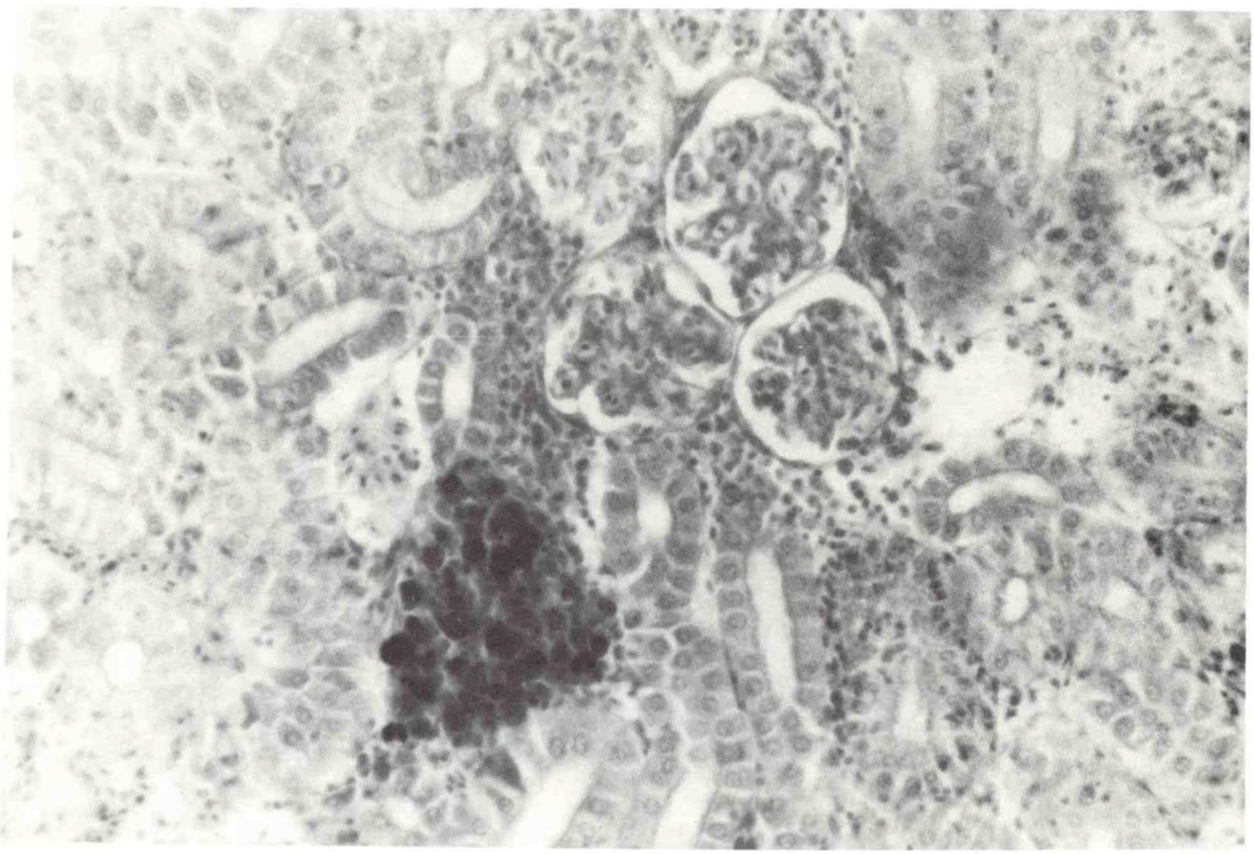

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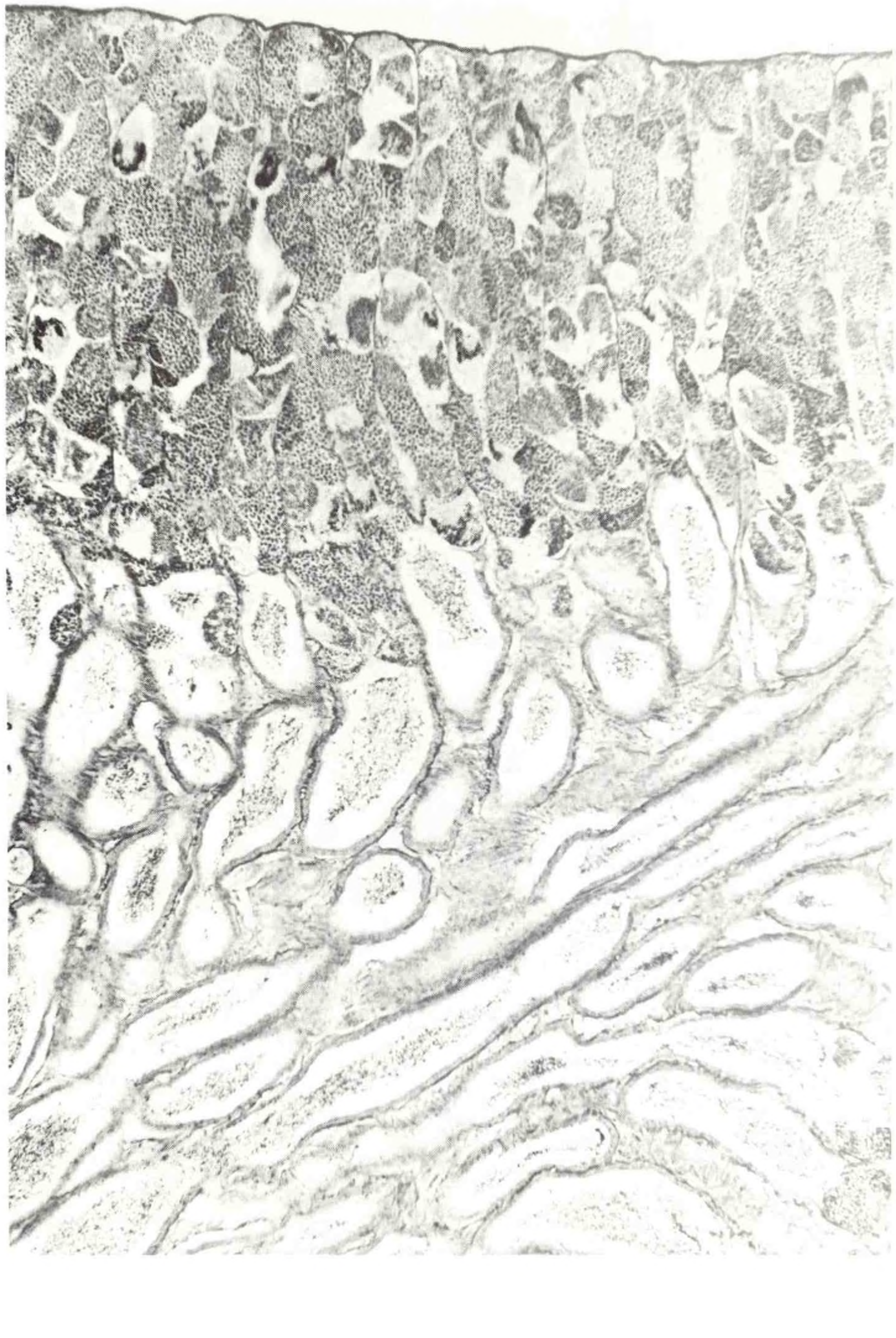

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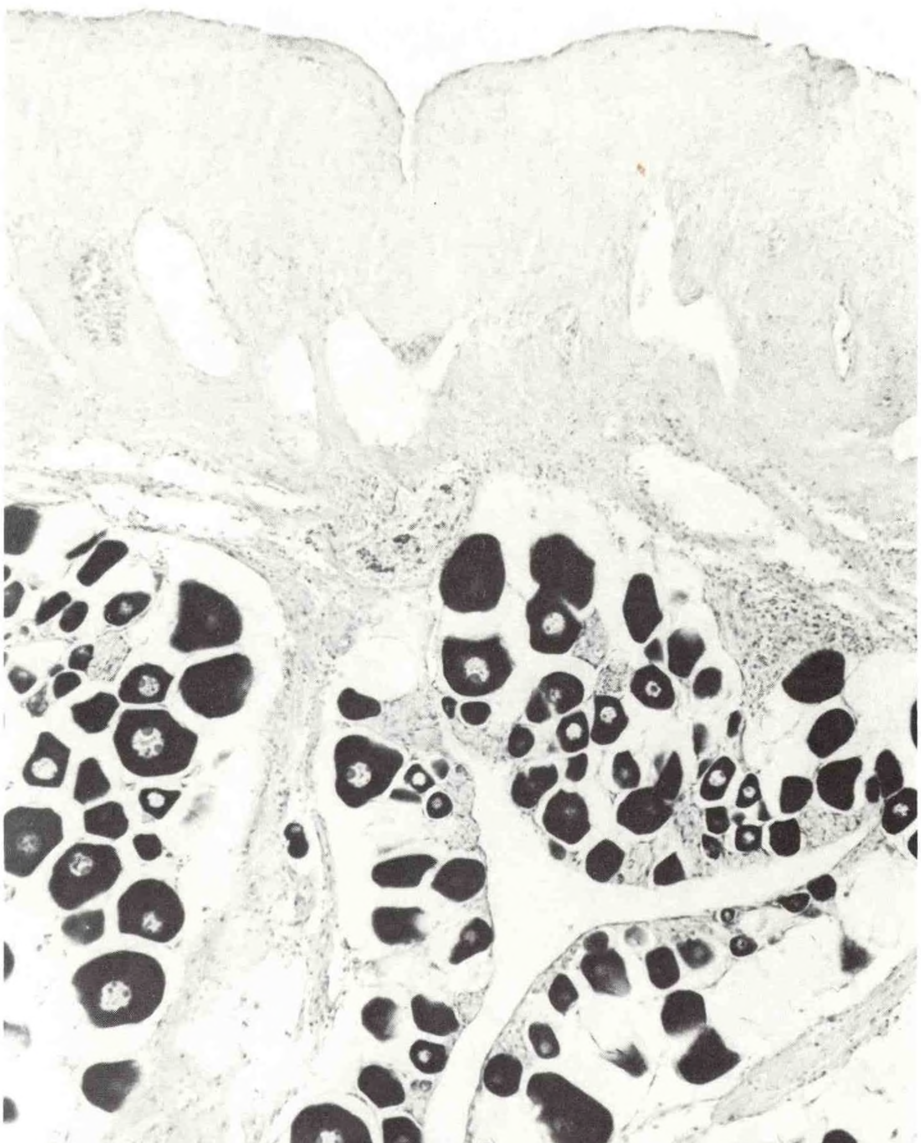

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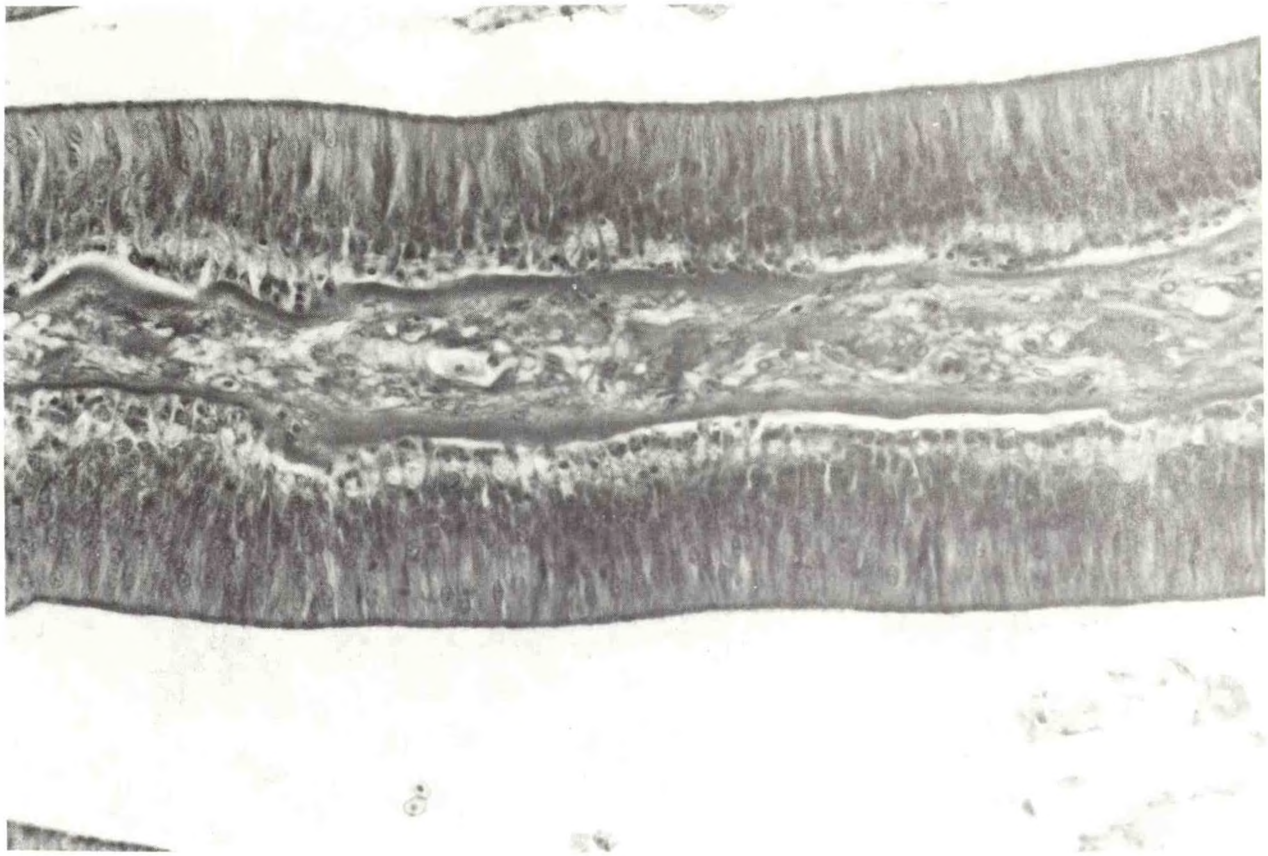

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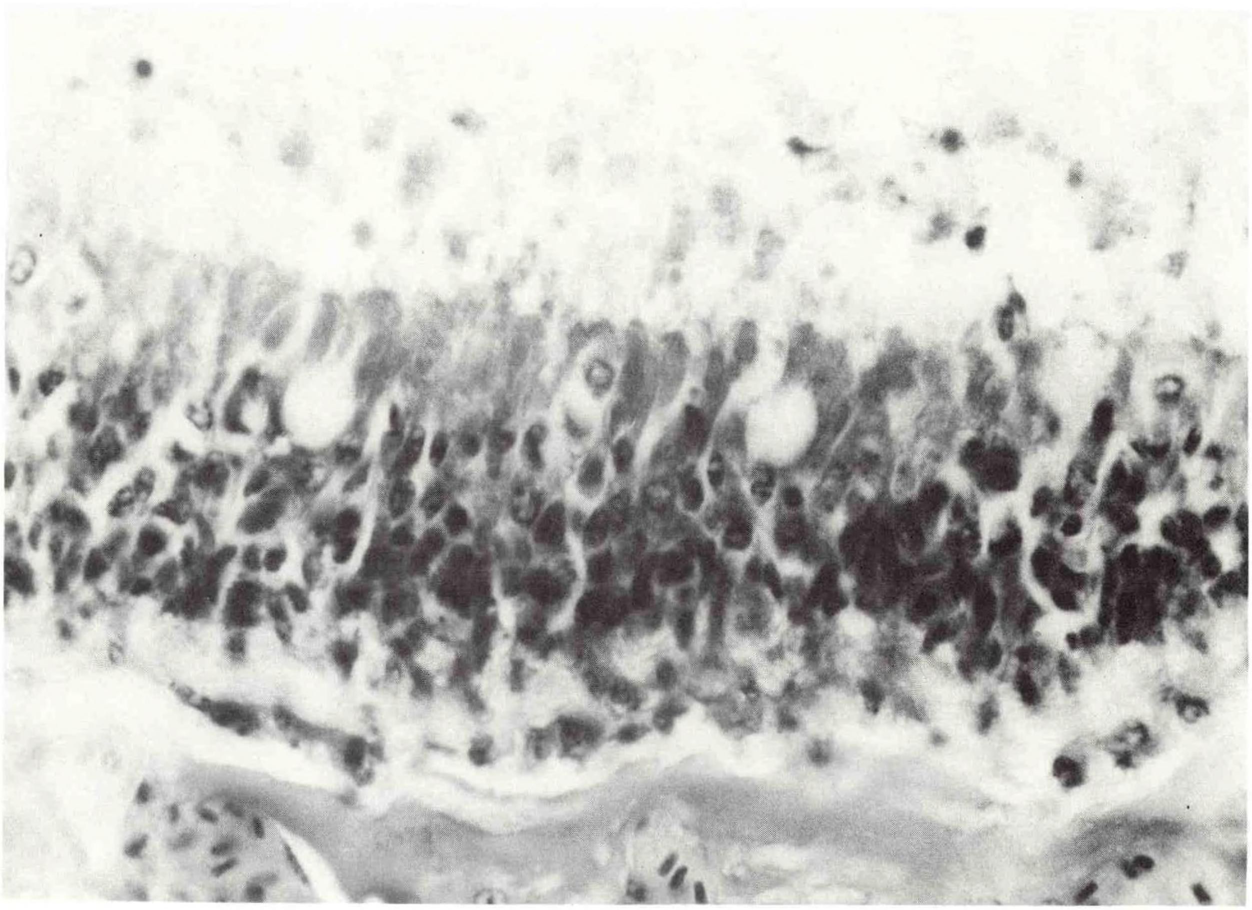

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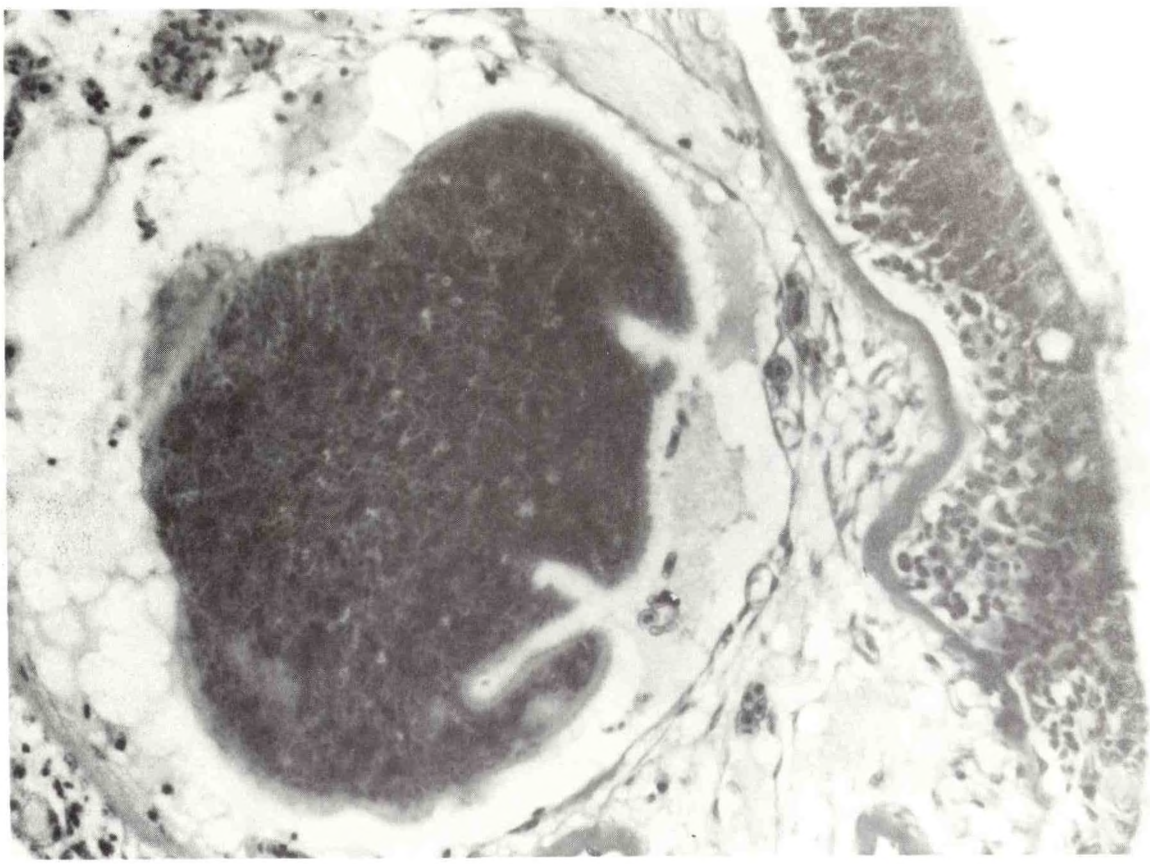

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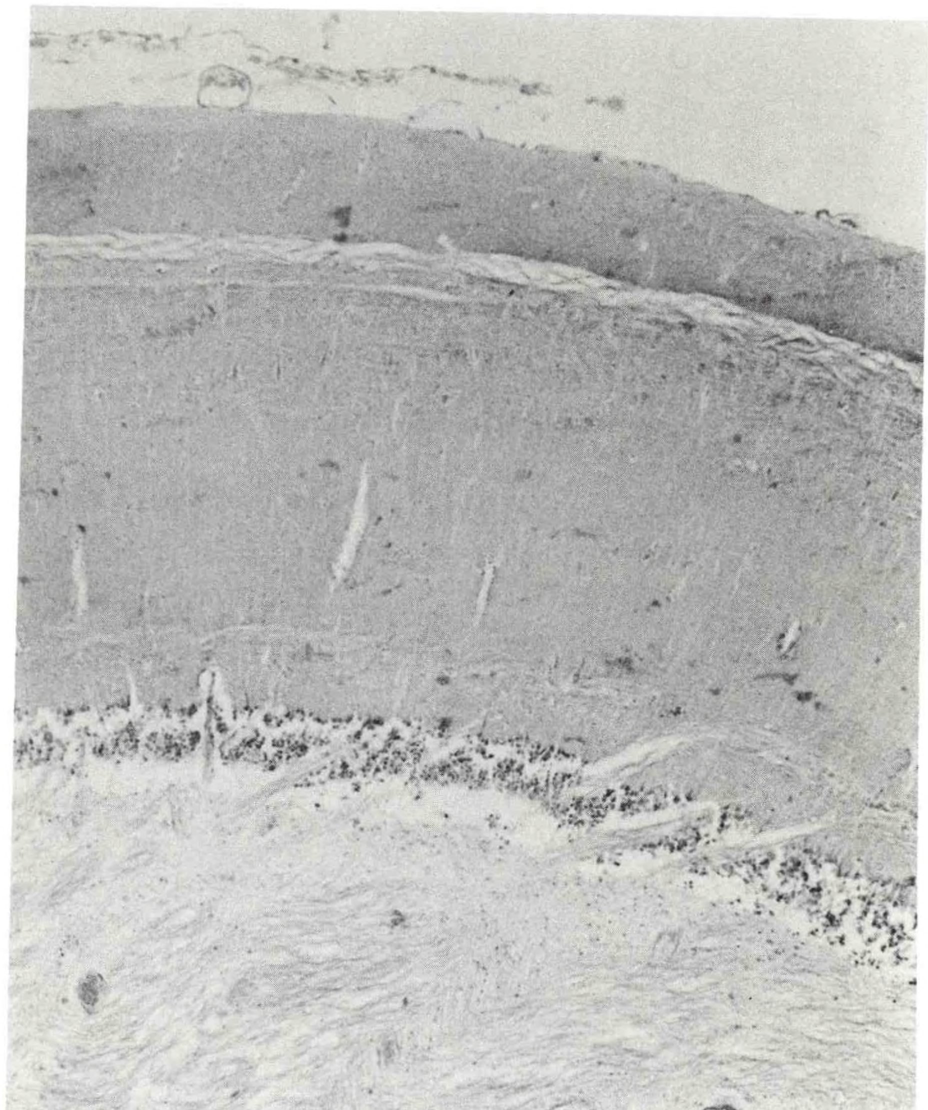

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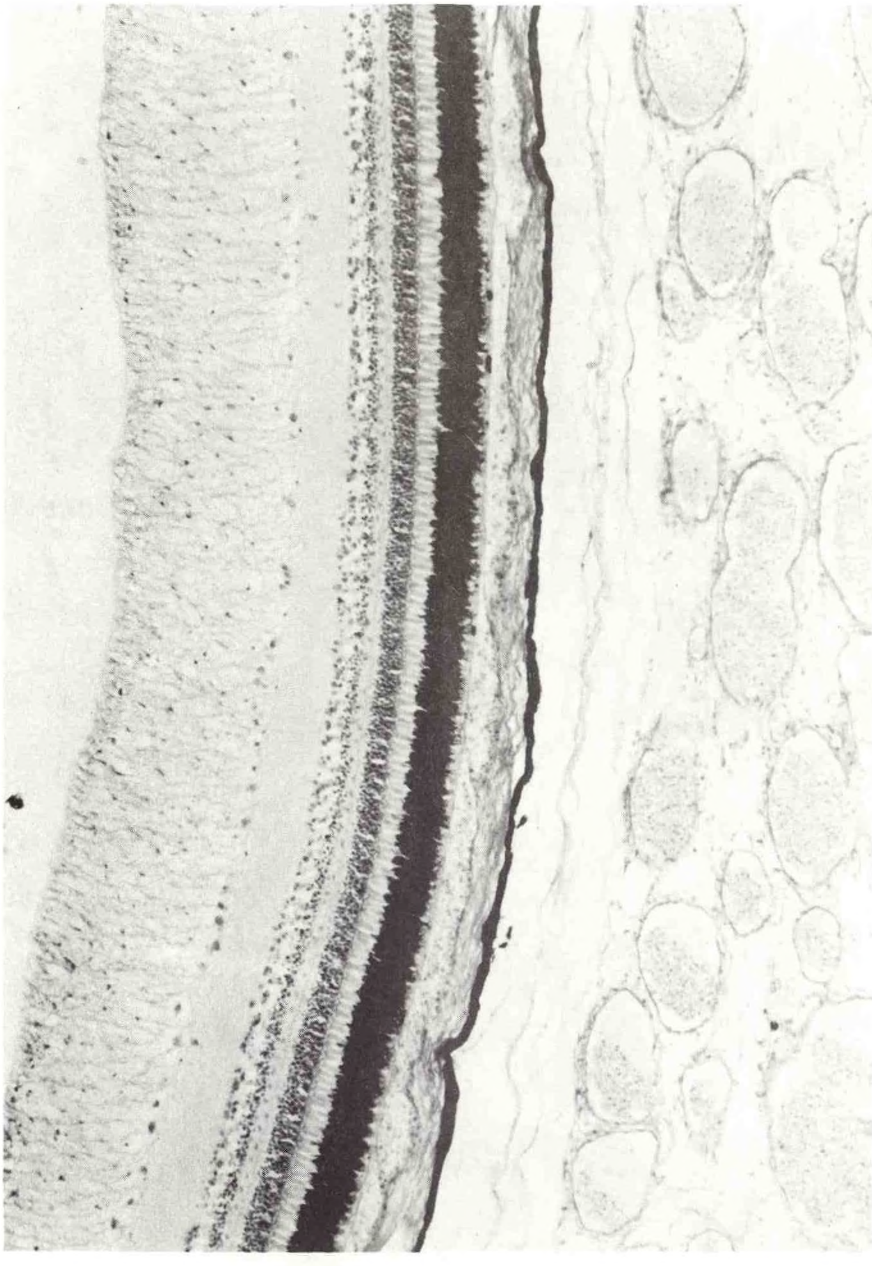

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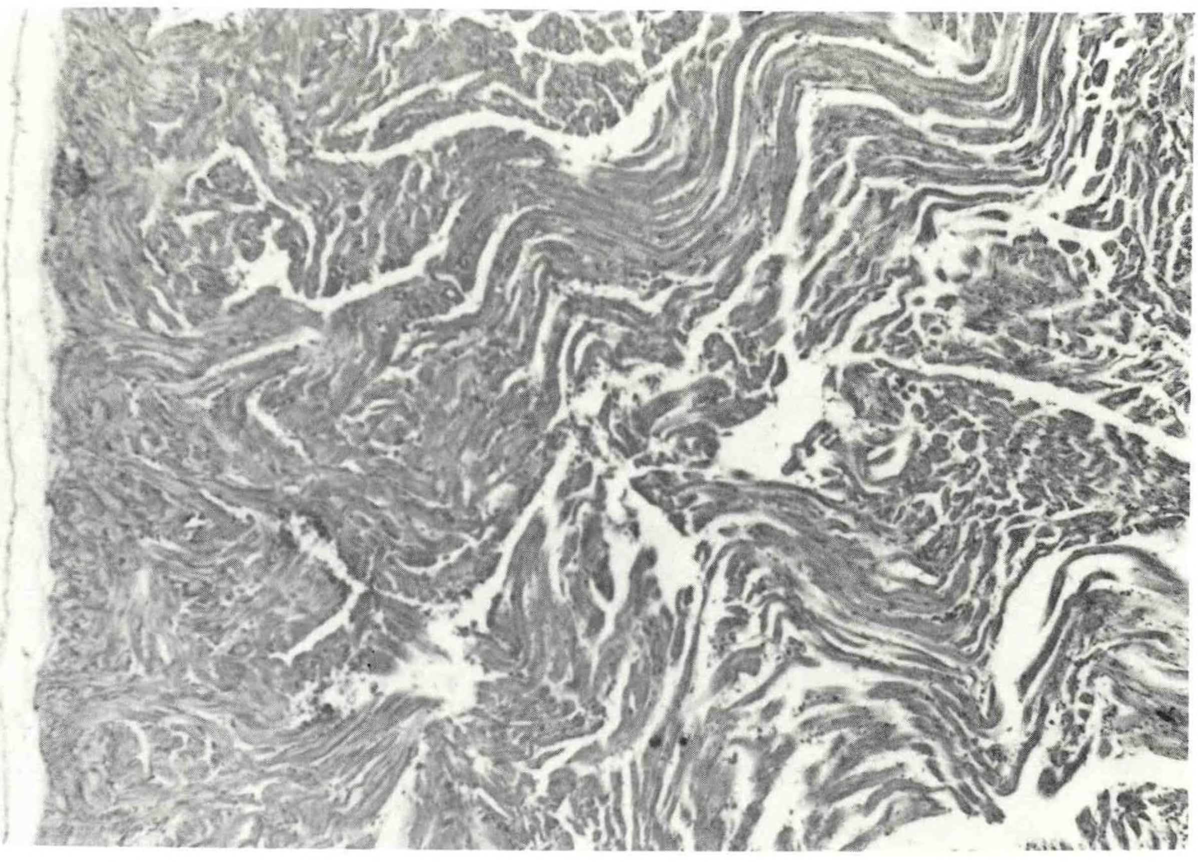

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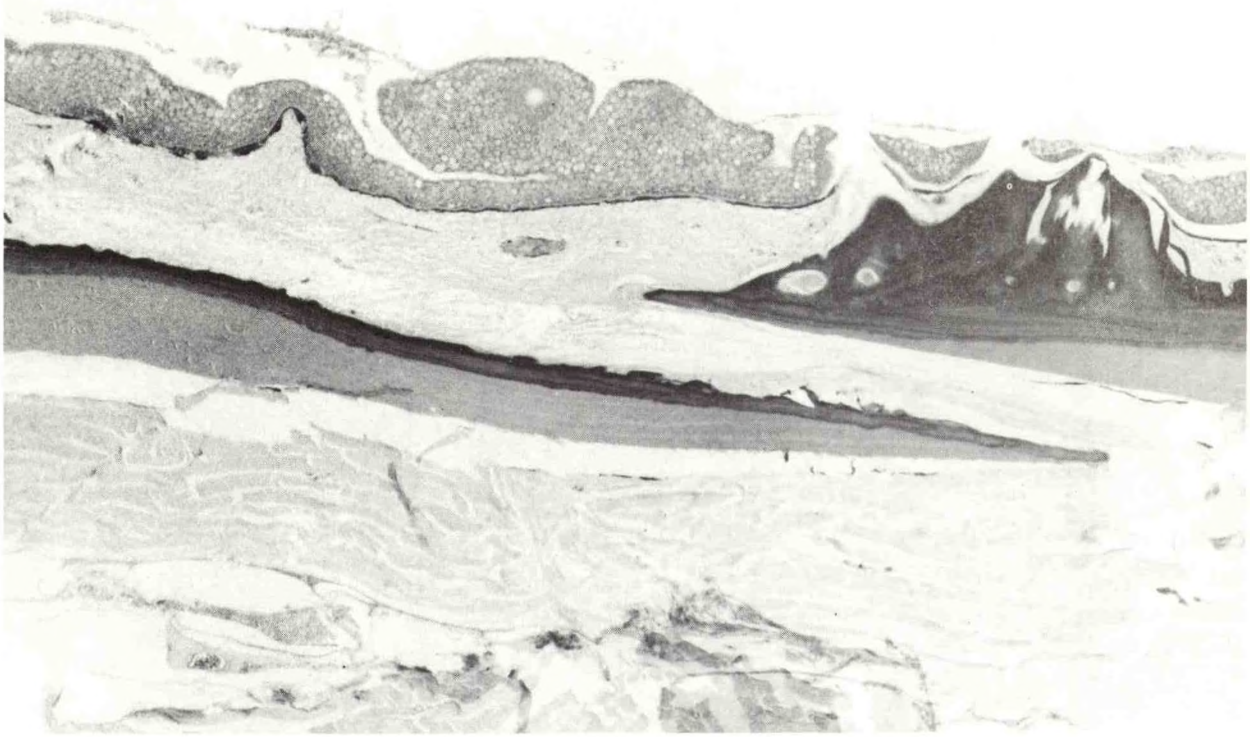

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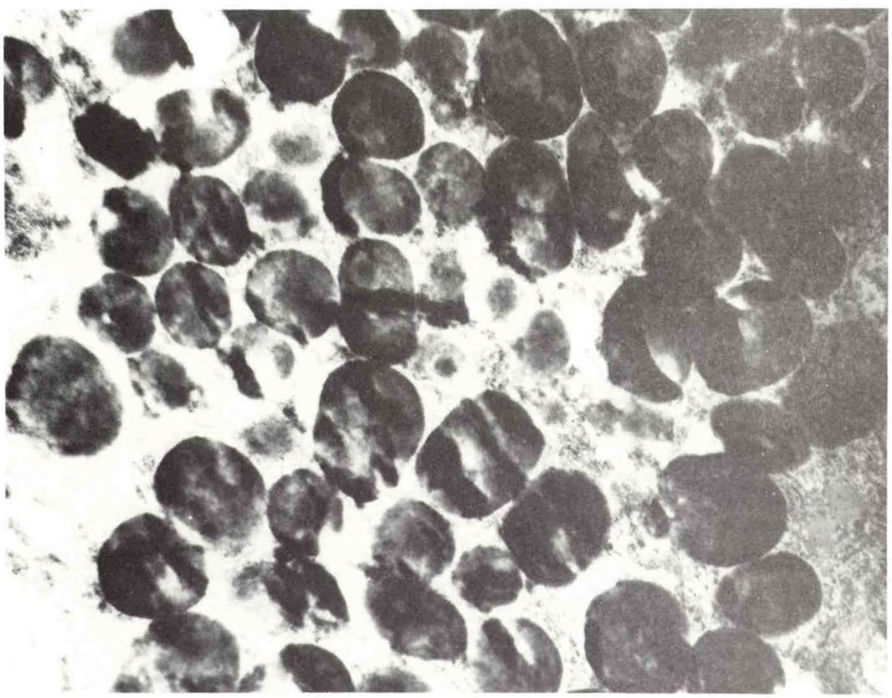

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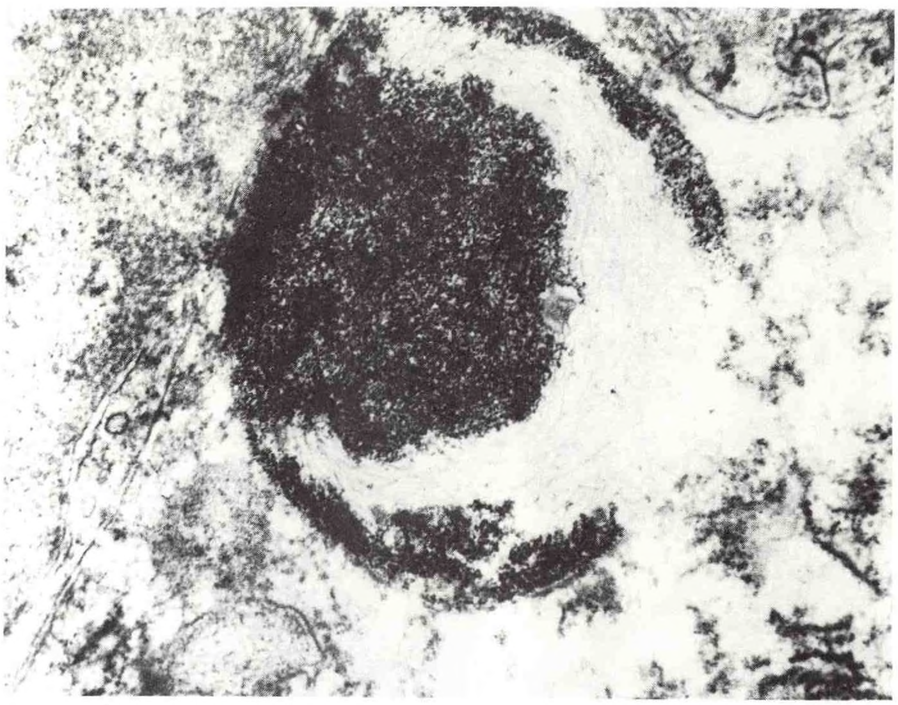

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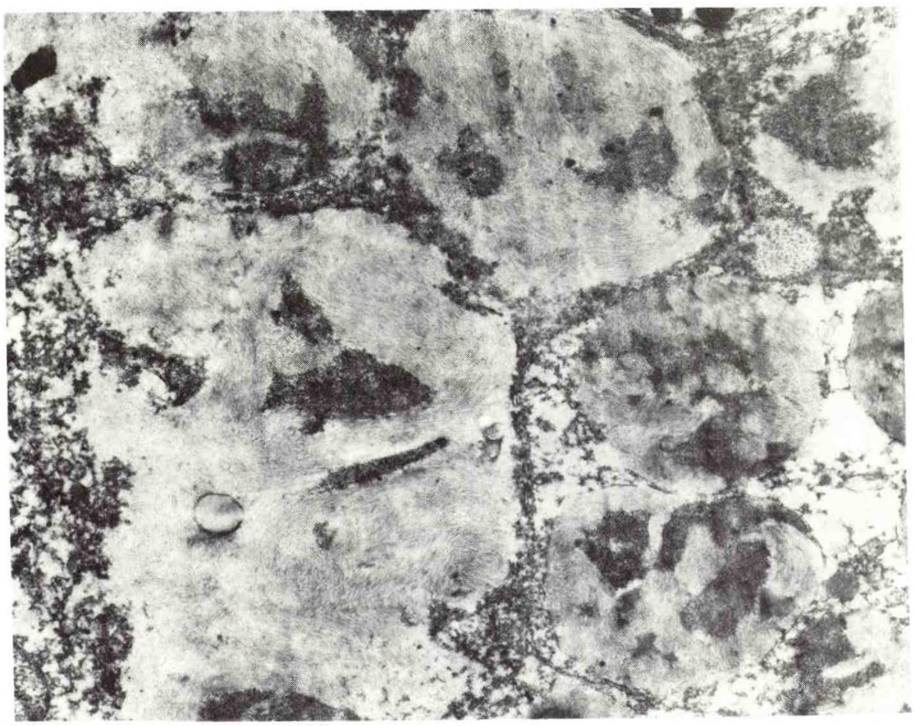

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