Teresa ORECKA-GRABDA

Ichthyopatolgy

**HEMATOLOGICAL, CLINICAL AND ANATOMICAL PATHOLOGY
OF THE EUROPEAN EEL (*ANGUILLA ANGUILLA* (L.))
FROM POLLUTED WATERS OF NORTHWESTERN POLAND**

**BADANIA HEMATOLOGICZNE, KLINICZNE I ANATOMO-PATOLOGICZNE
EUROPEJSKIEGO WĘGORZA (*ANGUILLA ANGUILLA* (L.))
Z ZANIECZYSZCZONYCH WÓD POLSKI PÓŁNOCNO-ZACHODNIEJ**

University of Szczecin

Within the years 1970–1973 a total of 820 eel individuals were checked for their health state. The eels were caught in water bodies (Szczecin Lagoon and lakes: Dąbie, Siccino, Czaplinek, and Lipiany) of a different level of pollution. Based on clinical, anatomopathologic, hematologic, and cytologic analyses, the range of exogenous intoxication was determined. The internal organs revealed symptoms of hemocytopathy with acute and chronic damaging inflammations, degenerative and necrobiotic processes prevailing.

INTRODUCTION

The health of fish and safety of fishery products from Szczecin Lagoon and adjacent lakes is a serious problem because of pollution and eutrophication caused by industrial, domestic and agricultural wastes. This has resulted in restriction or curtailment of fishing seasons in these waters. The eel fishery has declined and landings of fish in general from Szczecin Lagoon and the Baltic declined at an average annual rate of 3.5% between 1962 and 1972, and have not recovered.

During this period of decline a survey of the health of eels in these waters revealed a

sharp increase in disease, including papillomas, septicemia and skin necrosis (Grabda et al. 1973; Dzidziul 1973; Einszporn-Orecka 1974, 1976; Pilarczyk 1973).

This paper describes the anatomic, cytologic, clinical pathology and hematologic criteria observed in eels from these polluted waters.

MATERIAL AND METHODS

The materials consisted of 820 eels caught within 1970–1973 from Szczecin Lagoon and Dąbie Lake (moderately and highly polluted water bodies) and, additionally, from lakes: Siecino and Czaplinek (controls), and Lipiany (owing to some specific pathological signs shown by the fishes in that lake).

The length and weight of the eels examined ranged within 32–89 cm (total body length) and 50–1,190 g, respectively; the age ranged from 1+ to 11+ (larval stages not considered).

The quantitative assays made on blood collected from the caudal vein included; erythro-, leuko-, and thrombocyte counts (number of cells/mm³ of blood) in the Bürker chamber; photocolometric determination of hemoglobin (cyanomethemoglobin method) and hematocrit; MCH (mean corpuscular hemoglobin), MCHC (mean corpuscular hemoglobin concentration), MCV (mean corpuscular volume); and relative and absolute differential leukocyte counts.

The incidence and intensity of invasion by *Trypanosoma granulosum* Laveran et Mesnil, 1909 were determined by counting both live flagellates in a drop of blood in the Bürker chamber and those in stained blood smears; heavily infested fishes were excluded from the study.

Additionally, from smears stained with the Pappenheim (May-Grünwald and Giemsa stain) and Wright techniques, the condition of the peripheral blood and hemopoietic organs; kidney (pro- and mesonephros), spleen, and liver was assessed. Furthermore, the health of the fishes was evaluated from clinical, anatomic, and cytopathologic changes and hematologic indices; the eels examined were assigned either to 1) a group showing physiologically normal parameters (occasionally with moderate clinical deviations), 2) a group showing abnormally low values of the indices and marked pathologic changes of the internal organs.

RESULTS

Pathological examination revealed a steady deterioration of the health of the eels during the period of 1970–1973. Acute and chronic changes were present in 27% (Siecino Lake), 47% (Szczecin Lagoon), and 65% (Dąbie Lake) of the eels examined. Eels sampled from Dąbie Lake were representative of all years classes, while samples from Siecino i Szczecin Lagoon were often composed of age 7 and older eels.

CLINICAL AND ANATOMICAL PATHOLOGY

External signs manifest as hyperemia as well as petechial and ecchymotic hemorrhages on the skin (the belly in particular) were recorded, on the average, in 14% of the eels examined, with a maximum of 70% being affected. At the same time, some fishes (7% on the average, and exceptinally 98%) displayed depigmentation, focal necrosis, and skin lesions. Individual eels from every water body sampled and most fishes from Lipiany Lake showed a different, brown skin pigmentation accompanied by a lack of mucus.

Gross signs of disease often involved the circulatory system. Some of the fishes (7–19% on the average) had hyperextended mesenteric vascular system of the intestine. Exudative hyperemia of the air bladder was recorded in an average of 12% of the fishes, 67% being affected at the most. Peritoneal exudate was present in 5% of the eels, most often in those from polluted water. Exceptionally, the edema assumed the form of ascites.

Chronic inflammation and degeneration of liver parenchyma were recorded in 95% of the eels, 40% of them showing localized congestion or general congestion with edema and infiltrations as well as petechial and ecchymotic hemorrhages and thrombi. On several occasions the pollution gradient was found to be associated with cases of severe hemorrhagic liver inflammation with necrosis of the parenchyma and hemorrhagic into the peritoneal and pericardial cavities.

Additionally, among the eels affected by complex clinical changes, 16% showed fatty degeneration, 24% infarction of a varying intensity, and another 13% parenchymatous hemosyderosis. Acute clinical changes involving chromatic degeneration and liver atrophy were observed in 85% of the emaciated rachitic eels from Lipiany Lake.

In 60% of the fishes, the spleen as evaluated in terms of its morphotic aspects revealed hyperfuntion, degeneration, and necrosis. Swelling, deformation of the organ, and hyperplasia of the red pulp were found to be fairly common (17% of the fishes). On the other hand, the spleen in 27% of the eels was specifically shrunk and nodular (raspberry-like in appearance). At the stage of its atrophy (60% of the Lipiany Lake fishes) the spleen was affected by hyperpigmentation and saturation with chromatic deposits.

Functional disorders in kidneys with variously damaged nephrons were detected in 70% of the eels. Most frequent (22–50% of the fishes) were exudative and inflammatory lesions expressed as hyperemia, and a reduced compactness occurring most often in the peripheral necrotic area or in the pronephros. In some samples, 40–90% of the eels contained atrophied kidneys with chromatic degeneration and abundant pigment deposits.

The clinical changes were accompanied by chronic or acute colitis or hemorrhagic inflammation of the intestinal mucosa, near the anus in particular.

HEMATOLOGY

Erythrocytes of the peripheral blood. The mean erythrocyte count was $1.558.000/\text{mm}^3$ ranging from $1,448,000 \pm 47,000$ to $1,695,000 \pm 148,000/\text{mm}^3$. These value was comparable with definitions of Kreutmann (1973), Schliecher (1927), Zajceva (1967), taking into account pathological incidents with the results of Poluhowich and Park (1972), too. They differed, however, from the physiological standard set for *Anguilla japonica* (Kawamoto, 1929).

Most eels showing acute and chronic clinical signs (in certain periods 60–100% of the fishes) had a lower (by $350,000/\text{mm}^3$ on the average) erythrocyte count ranging around $1,100,000 \pm 173,000/\text{mm}^3$, $t = 5.7$.

Some of the eels with pathological signs (up to 40% in several samples from polluted lakes) showed a moderate polycythemia with a higher (by $380,000/\text{mm}^3$ on the average) erythrocyte count reaching $1,888,000/\text{mm}^3$, $t = 5.83$.

The physiological hemoglobin content averaged from 350 assays was found to vary from 9.34 g% to 10.08 g% (a mean of $9.76 \pm 0.86\text{g\%}$). At an increased erythrocyte count typical of a moderate polycythemia, the hemoglobin content increased to 12 and 13%. On the other hand, the hemoglobin level in those eels with clinical changes dropped (by 1.74% on the average) down to $8.02 \pm 1.03\text{g\%}$, $t = 4.65$, depending on the intensity of pathological changes and proportionally to the erythrocyte count. The lowest hemoglobin content (3.5 g% and sometimes 2.45 g%) was determined in association with acute lesions of parenchymatous organs.

The relative volume of erythrocytes (hematocrit) in eels from lakes ranged within 33–39% with a mean of $35\% \pm 2.44\%$, whereas the Szczecin Lagoon fishes showed slightly higher range and mean, 34–42% and $36 \pm 2.85\%$, respectively. The hematocrit of the eels affected by clinical changes either decreased (by 6.5% on the average) down to $27.7 \pm 3.0\%$, $t = 4.85$ or increased to $41\% \pm 4.37\%$, $t = 3.73$, the fluctuations being proportional to erythrocyte count and size.

The erythrocyte indices (MCH, MCHC) show the mean hemoglobin content in a cell, as determined for 60% of the control eels, to be 65 μg . The group of diseased eels contained a higher number of individuals with the highest (75–86 μg) hemoglobin content indicative of poly- and hyperchromasia.

The mean erythrocyte volume (MCV) of the peripheral blood in 82% of the control eels was 232 μm^3 , the pathologically affected fishes showing wide variations in cell size; 276–388 μm long macrocytes and 154–210 μm long microcytes prevailed.

Leukocytes of the peripheral blood. The mean leukocyte count as determined from 300 control eels was $16,000 \pm 5,480/\text{mm}^3$. At the same time, a decreasing trend in the absolute leukocyte count in the circulatory blood was detected; the drop occurring over the 4-yr period of study amounted to over 10,000 cells/ mm^3 . Leukopenia was more clearly marked in eels showing pathological changes, their leukocyte count varying from 28,000 to 40,000/ mm^3 . Comparatively infrequent, especially in 1973, was a moderate

or high leukocytosis recorded at a normal or low erythrocyte count. In those instances the leukocyte count increased at a mean of $40,000/\text{mm}^3$ ($t = 2.35-6.39$), with maxima at $86,000$ and $180,000/\text{mm}^3$.

Assuming, after Sano (1957) and on the basis of our own data, a numerical predomination of lymphocytes, the control ranges of heterophils and lymphocytes are set at $4,000-6,000/\text{mm}^3$ and $9,000-18,000/\text{mm}^3$, respectively. The optimal leukogram was defined in 7–39% of the fishes, no similar values being found in the Lipiany Lake eels. However, 17–30% of the eels showed approximately regular values, accompanied by a moderate relative granulocytosis (heterophils making up 31–58%) and a low total leukocyte count. In a few cases (6–12% of the fishes on the average), fairly high granulocytosis and lymphocytosis were recorded, reflected in the relative leukogram and less often associated with peripheral blood leukocytosis.

Leukopenia and moderate granulocytosis or else a slight or acute granulo- and lymphopenia associated with a low total leukocyte count ($2,000-10,000$ cells/ mm^3) were found to have occurred in most eels from various habitats, particularly in 1973, in some samples lymphopenia affecting up to 90% of the fishes examined.

The qualitative composition of the circulatory (peripheral) blood is supplemented by thrombocytes occurring, on the average, in concentrations of $45,000$ cells/ $\text{mm}^3 \pm 9,843$. The deviations from the mean were usually statistically nonsignificant, except for a periodic decline down to $17,000-30,000$ cells/ mm^3 recorded in eels collected from a highly polluted lake. In a few cases the thrombocyte count exceeded $120,000$ cells/ mm^3 .

CYTOLOGY OF CIRCULATORY BLOOD CELLS

Erythrogram. The blood of those eels assigned with a high probability to the hematologic control contained erythrocytes which were usually mature, orthochromatic, with signs of moderate aniso- and microcytosis. In most fishes, the erythrocytes deviated from the regular form, poikilo-, ovalo-, ellypso-, and drapenocytes occurring along with micro- and macrocytes (Pl. 1). Mature irregular erythrocytes were usually poly- and orthochromatic; some of them showed spotty cytoplasm with basophil dots, the cytoplasm being finely vacuolized and easily subject to lysis (Pl. 1, 2). Many erythrocytes contained variously displaced and deformed nuclei displaying heteropyknosis (Pl. 1, 2, 3).

A compensatory reaction of juvenile cells (polychromatic and basophil erythroblasts, hyperchromatic micro- and macroblasts or single paraerythroblasts and hematogonia) was recorded relatively rarely, only exceptionally in as many as 15% eels from the control lakes. The acute pathologic condition was characterized by swollen cells subjected to caryolysis or hyperpyknosis and caryorrhexis.

Leukogram. The composition of peripheral (circulatory) blood leukocyte group (following the classification and nomenclature of Einszporn-Orecka (1973) and Kreutzmann (1976) showed various degrees of alteration along some granulocyte developmental lines as well as an increase in the number of immature cells, displaying transitory

Plate 1. Irregular blood cells in acute toxic anemia of eel circulatory blood; polychromatic poikilocytes, including juvenile erythroblasts and polychromatic leptocytes

Plate 2. Acute toxic anemia: polychromatic basophil-spotted, finely vacuolised erythrocytes at the pre-disintegration stage in eel circulatory blood

Plate 3. Hypo- and hyperchromatic leukocyte system cells: pro-(†), meta-, and granulocytes as well as macrophages with phagocytosed nuclear fragments in eel circulatory blood.

Plate 4. Kidney cytopoenia with moderate parenchyma disintegration: progranuloblasts (†) and a gigantic phagocyte with an erythrocyte in its plasma; erythrocytes and cellular detritus also visible

characters and functionally stimulated. Such developmental irregularities were observed in pro-, meta-, and granulocytes (Pl. 3). The blood of a selected group of fish with acute clinical changes showed a well-marked domination of juvenile forms (pro- and metagranulocytes), indicative of regenerative dislocation (Pl. 3). The increased (on occasions up to 21% and 80%) amount of primordial blood cells or poorly differentiated ones of the reticular-endothelial origin reflected progranulocytosis and a reaction similar to monocytosis with an intensified tissue disintegration.

Furthermore, the cellular reactions in the peripheral blood included leukopenia with degenerative displacement, atypical parablasts, and irregular micro- and macroblasts (Pl. 3). The cell characteristics varied from hyperchromasia with simultaneous nuclear pyknosis to oligochromasia with a progressing swelling, vacuolar and fatty degeneration, pathologic granulation, and cyto- and caryolysis.

CYTOLOGY OF HEMOPOIETIC ORGANS

Kidney Various parts of the kidney were equally hemopoietic, producing cells of the erythro-, granulo-, lympho-, and thrombocyte lines. In 70% of the eels, toxic glomerulitis with a varying distribution of necrotic centres and irregular cell proliferation was revealed. A few kidneys contained low numbers of primordial and juvenile erythrocytes, indicative of erythroblastopenia and oligocytemia as well as hypo- and aplasia of the erythrocyte system. The erythroblast differentiation showed features of macro- and normoblastic erythropoiesis or megaloblastic erythropoiesis with parablasts and hematogonia (corresponding to cells of the lymphocytal origin).

The leukocyte system cells differentiation was usually characterized by pattern of poorly and variously differentiated cells and leukocytopenia, except for some cases of an intensified proliferation associated with peripheral leukocytosis (Pl. 4). Basically, a unidirectional proliferation of primordial hemocyto- and granuloblasts occurred (Pl. 4,5). Under a constant influence of a damaging factor, the blastosis disappeared, which resulted in hypo- and aplasia of the leukocyte system. At an intensified granulopoiesis, the numerical domination of granuloblasts, pro- and granulocytes was observed; less frequently mature rod and segmented heterophils were predominant (Pl. 5,6). In association with progressing necrosis alterations the cells changed, affected by vacuolar and fatty degeneration, cyto- and caryomegalia, aniso- and hyperpyknosis (Pl. 6,7,8).

Clinical changes in the kidney corresponded to cytologic changes expressed as disintegration occurring with a varying intensity, from individual necrosis centers to extensive necrotic areas (Pl. 5,7). The changes taking place in cells were generally related to pathocytosis. Cellular degeneration proceeded through anisocytosis, anisochromy, to liquefaction necrosis. A mass erythrolysis was observed in the reduction zones. Generally, very important was proliferation and differentiation of the reticular-endothelial system cells (Pl. 8). Parallel to proliferation, the number of macrophages, schizocytes, and pigmentophages was observed to increase (Pl. 4).

Plate 5. Hemopoietic centre in excessively hydrated kidney tissue: a group of heterophilous precursors with hypochromasia and caryolysis

Plate 6. Vacuolar and fatty degeneration in granulocytes; regular and pathologic mitotic figures

Plate 7. Necrosis of intratubular kidney tissue with single hyperchromatic hemocytoblasts (↑), granulocytes, numerous nuclei, and cellular detritus

Plate 8. Reticular cells, altered by fatty and vacuolar degeneration, in kidney parenchyma

Spleen. The morphotic composition of the spleen shows varying amounts of mature and senile erythrocytes filling the tissue as well as varying distribution and degradation of these cells in anisochromy and heteropyknosis or caryo- and cytolysis (Pl. 9,10). Only exceptionally were the primordial pro- and erythroblasts found in the spleen tissue. The erythrocyte system cells showed characteristics of hyperchromatic aniso- and microcytes and parablasts, mostly at the pre-disintegration stage.

Keeping in line with spleen properties, proliferation of lympho- and histiocytes (non-differentiated cells of the USS system) was taking place (Pl. 9,10). On the other hand, the granulocyte line cells differentiation was observed in a few spleens only, particularly in those anatomically changed ones, dissected from eels affected by acute clinical alterations. In these few cases, fibroblast proliferation and granulocyte differentiation into hemocytoblasts, pro- and granulocytes were observed (Pl. 11).

Additionally, the pathologically changed (enlarged, deformed, raspberry-like in appearance) spleens showed a varying growth of the connective tissue capable of differentiating mesenchymocytes into non-differentiated histiocytes. The proper splenocytes were subjected to fatty and vacuolar degeneration and hyper- and hypochromasia, or plasmolysis (Pl. 12,13,14). Occasionally, atypical bi- and polynuclear cells showing features of neoplastic stimulation were prevailing (Pl. 13,14). Moreover, proliferation of phagocytes attacking degenerated and senile erythrocytes was observed to occur with varying intensity.

Liver. Cytology of the liver showed marked polymorphic changes indicative of degeneration. A uniform hyperemia of the parenchyma with necrolysis was associated with hepatocyte changes proceeding through fatty and vacuolar degeneration or chromatic degeneration (Pl. 15,16). The parenchymal hyperemia was accompanied by abundant infiltrations of varying composition, small hemocytoblasts, lympho- and thrombocytes, or lympho- and granulocytes prevailing, with a domination of blastic cells. Additionally, numerous histiocytes functioning as phagocytes (pigmentophages and hemosyderocytes) occurred. Most cells in the necrobiotic centers tended to disintegrate, showing signs of hyperchromasia and caryolysis or heteropyknosis. Frequently 75% of the cells were subjected to erythrolysis.

The amount of destruction and the nature of morphotic changes in the tissue indicated focal scattered or extensive necrolysis. The liver showed blood deficiency with a strikingly extensive necrosis. Moreover, micro- and macroguttate lipid degeneration was frequently damaging the organ (Pl. 17,18).

Macroscopically, the liver atrophy with chromatic changes was accompanied by variations in the appearance of hepatocytes which stained poorly and contained granulated cytoplasm with excess of lipids (Pl. 16,17,18). On the other hand, excessive amounts of intra- and extracellular pigment deposits and grains of pigment (hemosyderin and bilirubin) were observed in the lipid-rich cellular detritus (Pl. 17).

Plate 9. Degradation centre in spleen with swollen, hypochromatic erythrocytes at the pre-disintegration stage, hypochromatic thrombocytes (†), and a granulocyte.

Plate 10. Differentiation centre in spleen: lymphocytes, single hemocytoblasts (†), and a few non-differentiated cells showing symptoms of hypochromasia

Plate 11. A group of cells in spleen: three reticular cells (fibroblasts (†), hemocytoblasts (††), progranulocytes and granulocytes (†††)

Plate 12. Degeneration of reticular cells in spleen tissue: vacuolar and fatty degeneration, hyperchromasia, and plasmolysis

Plate 13. A non-typical, binuclear, gigantic reticular cell from spleen parenchyma

Plate 14. A swollen, degenerated, polynuclear cell from spleen parenchyma

Plate 15. Homogenous hyperemia of liver: swollen hepatocytes with obliterated contours and damaged cell walls as well as hyperchromasia and caryolysis

Plate 16. Hepatitis: retrogressive and degenerative vacuolar-fatty changes in hepatocyte cytoplasm; moderate density of hemosiderosis granules

Plate 17. Liver parenchymal hemosiderosis: disappearance of hepatocytes and granules; inter- and extracellular deposits of hemosiderin and bilirubin in excessively fatty parenchyma

Plate 18. Liver atrophy at the hemosiderosis stage: damaging hepatocyte degeneration with clear coarse granulations (hemosiderin) of cytoplasm, caryoliposis and heteropyknosis

DISCUSSION

Based on hematologic criteria, non-specific characters of normo- and hypochromatic anemia with polychromasia, anisopoikilo- and microcytosis were identified for the symptomatologically non-uniform condition. At the same time, hyperchromatic anemia and microcytal anemia with a moderate renewal of macro- and normoblastic, or megaloblastic erythropoiesis of a non-regenerative nature were developed to a lesser extent. The hemopoietic organs malfunction resulted from a poor, rare, and morphologically irregular reaction of the erythrocyte system cells.

With respect to the leukocyte system, remarkably common was leukopenia (often panleukopenia) with moderate relative granulocytosis and slight or acute granulo- and lymphopenia. Moreover, asynchrony in the granulocyte system cells maturation with degenerative dislocation of these cells, and a reaction of poorly differentiated cells of the reticular-endothelial system were recorded as well.

Pathogenetically, the condition corresponds to hemolytic anemia caused by infections and toxic factors. Following an intensified erythrolysis, the proliferation and differentiation of the erythroblastic cells become impaired and manifest as their hypo- and aplasia. Hypochromatic anemia with anisopoikilocytosis and lowered erythrocyte parameters (the hemoglobin content in particular) proceeds accompanied by iron metabolism disorders, parenchymal hemosiderosis. In extremal cases, histochemical assays indicate chromatic cachexis bronzea.

The excretory and hemopoietic functional insufficiency of the kidneys resulted from inflammational and degenerative changes (glomerulonephritis) similar to nephritis accompanying intoxications. The intertubular tissue degeneration caused hypo- and aplasia, erythropenia included, of hemopoietic systems. The remaining cell systems show additionally a permanent or transient panleukopenia as well as blastosis and lymphopenia. Simultaneously, a moderate compensatory hyperplasia of the reticular-endothelial system with proliferation of poorly differentiated monoid-type cells and phagocytes (erythro- and pigmentophages) was observed to proceed.

Hemopoietic disorders, tissue hypo- and aplasia in the kidney brought about a compensatory reaction in the spleen and – less frequently – in the liver (extranephrotic metaplasia). Pathophysiological changes in the spleen were manifest as hypersplenism and hyperplasia of the reticular-endothelial system. The erythrocyte retention and destruction greatly exceeded the normal physiological level. Erythropoietic processes were extremely rare. The most common reaction was differentiation of the mesenchyma into mature granulocytes and erythro-, pigmento-, and lipophages as well as non-differentiated monoid-types cells. The reticuloendotheliosis in various organs is indicative of a chronic pathological condition associated with necrotic disintegration of the tissue and regenerative processes with proliferation of cells of a poorly differentiated mesenchyma (corresponding to reticular mononucleosis and hemoblastosis).

Diagnostically, the peripheral blood leukopenia with granulo- and lymphopenia does not allow any optimistic prognosis. A permanent influence of various concentrations of

toxins resulting from environmental pollution brings about acute and chronic inflammatory and necrobiotic processes in the internal organs, which are indicative of a possibly lethal disease.

CONCLUSIONS

1. Under a long term influence of various concentrations of environmental toxins, exogenous intoxication in waters of different level of pollution results in hemocytopathy of eels, appearing as acute or chronic destructive inflammations with degenerative and necrobiotic processes prevailing in the internal organs.
2. A non-specific diagnosis involves poly- and oligochromatic anemia with anisopoikilo- and microcytosis as well as hypo- and aplasia of the erythrocyte system.
3. Erythrocyte degeneration and intensifield hemolysis lead to disorders in and retardation of hemopoiesis and — indirectly — to hemosyderosis, emaciation, and cachexis bronze of the eels.
4. Limited or absent defense reactions in the peripheral blood (granulo- and lymphopenia, at a low leukocyte level) as well as blastosis and reticuloendotheliosis in the hemopoietic centres constitute a specific set of signs.

REFERENCES

- Dzidziul A., 1973: Histopathological changes in liver and kidney of the eel, *Anguilla anguilla* L., affected by Papillomatosis anguillarum. *Acta Ichth. et Pisc.* III, 3: 109–118.
- Einszporn-Orecka T., 1973: Change in the picture peripheral blood of tench *Tinca tinca* (L.) under the influence of *Ergasilus sieboldi* Nordm. I. Composition of morphotic blood constituents of uninfected fish in annual cycle. *Acta parasit. pol.* XXI, 29: 393–411.
- Einszporn-Orecka T., 1974: Differences in the eel peripheral blood hematological parameters associated with papilloma (Papillomatosis anguillarum). *Acta Ichth. et Pisc.* IV, 2: 73–82.
- Einszporn-Orecka T., 1976: Cytological evaluation of the peripheral blood cells and hemopoietic organs in Pestis anguillarum of eels. *Acta Ichth. et Pisc.* VI, 1: 67–81.
- Grabda E., Einszporn-Orecka T., Dzidziul A., 1973: Results of studies on the health conditions of eel from the Szczecin Bay and Dąbie Lake in years 1971–72. C.M. 1973/M: 12. ICES.
- Kawamoto N., 1929: Physiology studies on the eel. I. The seasonal variation of the blood constituents. *Sci. Rep. Tohoku Imp. Univ., Biol.* IV, 4: 635–641.
- Kreutzmann H.L., 1973: Veränderungen des Hämoglobingehaltes, des Hematokrit und der Erythrozytenzahl von *Anguilla anguilla* nach Erkrankung an Salzwasseraalseuche. *Wiss. Z. Univ. Rostock.* 22, 6–7: 721–725.
- Kreutzmann H.L., 1976: Untersuchungen zur Morphologie des Blutes vom europäischen Aal (*Anguilla anguilla*). III. Untersuchungen zur Granulopoese. *Folia Haematol.* 103, 5: 686–700.
- Pilarczyk A., 1973: The morphological and histological structure of tumours in the "Cauliflower disease" (papilloma) of eels. *Acta Ichth. et Pisc.* III, 1: 91–106.

- Poluhowich J.J., Parks H., 1972: A comparative study of blood chemistry and respiration in marine and fresh-water eels. *Prog. Fish. Cult.*, **34**, 1: 33–37.
- Sano T., 1957: Haematological studies of the culture fishes in Japan. I. On the blood of eel. *J. Tokyo Univ. Fish.* **43**, 1: 75–79.
- Schliecher J., 1927: Vergleichend-physiologische Untersuchungen der Blutkörperchenzahlen bei Knochenfischen. *Zool. Jahrb. Abt. Allgem. Zool. Physiol. d. Tiere.* **43**, 2: 121–200.
- Zajceva N.D., 1967: Sezonnye i vozrastnye osobennosti krovi evropejskogo ugr'ja. Obmen veščestv i biochimija ryb. Izdat. „Nauka” Moskva: 168–171. (in Russian).

Translated: dr Teresa Radziejewska

Teresa Orecka-Grabda

BADANIA HEMATOLOGICZNE, KLINICZNE I ANATOMO-PATOLOGICZNE
EUROPEJSKIEGO WĘGORZA *ANGUILLA ANGUILLA* (L.)
Z ZANIECZYSZCZONYCH WÓD POLSKI PÓŁNOCNO-ZACHODNIEJ

STRESZCZENIE

Ocena kliniczna, anatomopatologiczna i hematologiczna zdrowotności węgorzy z wód różnie zanieczyszczonych związkami antropogennymi (z Zalewu Szczecińskiego, jezior Dąbie, Siecino, Czaplinek, Lipiany) wskazuje na wielokierunkowe oddziaływanie toksyn egzogennych.

W obrazie hematologicznym ogólnie przeważały cechy niedokrwistości (oligocytemii) normo- i niedobarwliwej (normo- i hypochromicznej) z polichromazją i anizopoikilocytozą oraz mikrocytozą. W zakresie układu białokrwinkowego odczynem jednoznacznym jest leukopenia z mierną, względną granulocytozą oraz nieznaczną lub wysoką granulo- i limfopenią. Zaznacza się również niezgodność dojrzwania szeregu granulocytów z przesunięciem degeneracyjnym oraz odczyn niskozróżnicowanych komórek układu siateczkowo-śródbłonkowego.

Pod względem patogenetycznym schorzenie odpowiada niedokrwistości hemolitycznej z upośledzonym rozplemieniem i różnicowaniem komórek szeregu erytroblastycznego (formy paraerytroblastów i hematogonii) i zjawiskiem hypo- i aplazji tego układu (niedokrwistość hypo- i aplastyczna).

Obraz morfologiczny pierwotnych i wtórnych narządów krwiotwórczych (nerka, śledziona, wątroba) wskazuje na obecność ostrych lub przewlekłych stanów zapalnych typu uszkadzającego z przewagą procesów zwyrodnieniowych i martwiczych.

Т. Ореца - Грабда

ГЕМАТОЛОГИЧЕСКИЕ, КЛИНИЧЕСКИЕ
И АНАТОМОПАТОЛОГИЧЕСКИЕ ИССЛЕДОВАНИЯ ЕВРОПЕЙСКОГО
УГРЯ *ANGUILLA ANGUILLA* (L.) ВЫЛОВЛЕННОГО
В ЗАГРЯЗНЁННЫХ ВОДАХ СЕВЕРО-ЗАПАДНОЙ ПОЛЬШИ

Р е з ю м е

Клиническая, гематологическая и анатомопатологическая оценка угрей из вод с разной степенью загрязнённости (антропогенными соединениями) Щецинского залива, озёр Домбе, Сетино, Чаплинек и Липяны, показывает на действия во многих направлениях экзогенных токсинов.

В гематологической картине в основном преобладали черты малокровия (олигоцитемии), нормо- и недоокращенного (нормо- и гипохромической) с полихромазией и анизопоикилоцитозой, а также микроцитозой. В системе белых кровяных телец однозначной реакцией является лейкопения с относительно средней гранулоцитозой, а также незначительной или высокой грануло- и лимфопенией. Выявляется также несогласие созревания ряда гранулоцитов с дегенеративным перемещением, а также реакция низкодифференцированных клеток сетчато-эндотельной системы.

С точки зрения патогенетики, заболевание соответствует гемолитическому малокровию с дефективным развитием и различием клеток эритробластического ряда (формы паразитирующих и гематогоний)

и эффектом гипо- и анализии этой системы (малокровие гипо- и апластичное).

Морфологическая картина первичных и вторичных кроветворных органов (почка, селезёнка, печень) показывает на присутствие острых или хронических воспалительных процессов повреждающего типа, с преобладанием дегенеративных и некротических процессов.

Author's address:

Received: 1986.01.02

Doc. Dr hab. Teresa ORECKA-GRABDA

Uniwersytet Szczeciński

Zakład Parazytologii i Ochr. Środ.

ul. Felczaka 3a

71-412 Szczecin

Polska (Poland)