

## Changes in selected blood parameters in carp with signs of spring viremia, gill necrosis, and tapeworm invasion\*

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**Abstract** — The level of fourteen haematological and biochemical parameters and the activity of serum enzymes in the blood of healthy carp and of specimens with signs of spring viremia of carp, gill necrosis, and tapeworm invasion were compared. In most indices distinct deviations from the norm were associated with spring viremia.

**Key words:** carp, pond production, diseases, physiological indices.

### 1. Introduction

Haematological indices, components of serum, and the activity of serum enzymes in fish have been investigated for many years. The investigations concentrate on processes occurring in the organisms of fish under the influence of such environmental factors as changes in parameters of habitat conditions, applied feed, or farming operations, and also on processes associated with the pathological condition. Apart from its cognitive character the investigation of diseased fish aims at checking the possibility of applying the analysed indices in diagnostics.

In the study of physiological indices of carp from ponds with an intensive production level in the Gołysz Experimental Station of the Polish

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Academy of Sciences, attention was also paid to specimens with signs of disease. The purpose of the work was to determine the level of some haematological indices and the activity of excretive enzymes in serum from infected fishes, to compare these values with those obtained in healthy carp, and to evaluate the examined parameters as possible indices for use in ichthyopathological diagnostics.

## 2. Material and method

Infected carp were taken from fish production ponds where distinct signs of the given pathological unit were noted. Three diseases of great importance in pond fish culture were chiefly taken into consideration: spring viremia of carp (SVC), gill necrosis (GN), and tapeworm invasion (IC).

In 1978 40 two-year-old carp with signs of SVC were sampled from two ponds. In the next year the investigation on fishes with signs of spring viremia was carried out in one pond, 70 specimen being examined. Physiological indices were also determined in 20 second year carp, with signs of gill necrosis. Also, in the same period, i.e. in autumn 1977, the investigation included 40 carp from 2 different ponds where invasion of *Caryophyllaeus* sp. and *Bothriocephalus* sp. tapeworms was observed.

Specimens with distinct signs of the given pathological unit were selected for the investigation. Directly after catching blood samples were taken with a syringe from the caudal vein. The basic ichthyopathological examinations then being carried out. They included observation of morphological and anatomopathological changes and appearance of parasites.

14 parameters were determined in the blood: concentration of haemoglobin, haematocrit, serum total protein, lipids, cholesterol, glucose, creatinine, and urea, the level of calcium, and inorganic phosphorus, and the activity of acid and alkaline phosphatase, and of asparagine and alanine transaminase. The applied methods were described in an earlier paper (Pilarczyk 1986). The activity of enzymes was expressed in units (I.U.) denoting the number of micromoles of the substance (substrate) converted in the final yield of the reaction by 1 l of serum during 1 min at 37°C.

## 3. Results

In 1978 in the two ponds the ichthyopathological investigation showed changes characteristic for SVC in 50—70% of examined fishes. The survival of the fish stock was 42% and 65%. In the following year the survival rate was higher, reaching about 88%. In 1979 the greatest in-

tensity of signs of disease was observed on May 17. The last examination was carried out on June 26 (SVC') when the signs of spring viremia had disappeared.

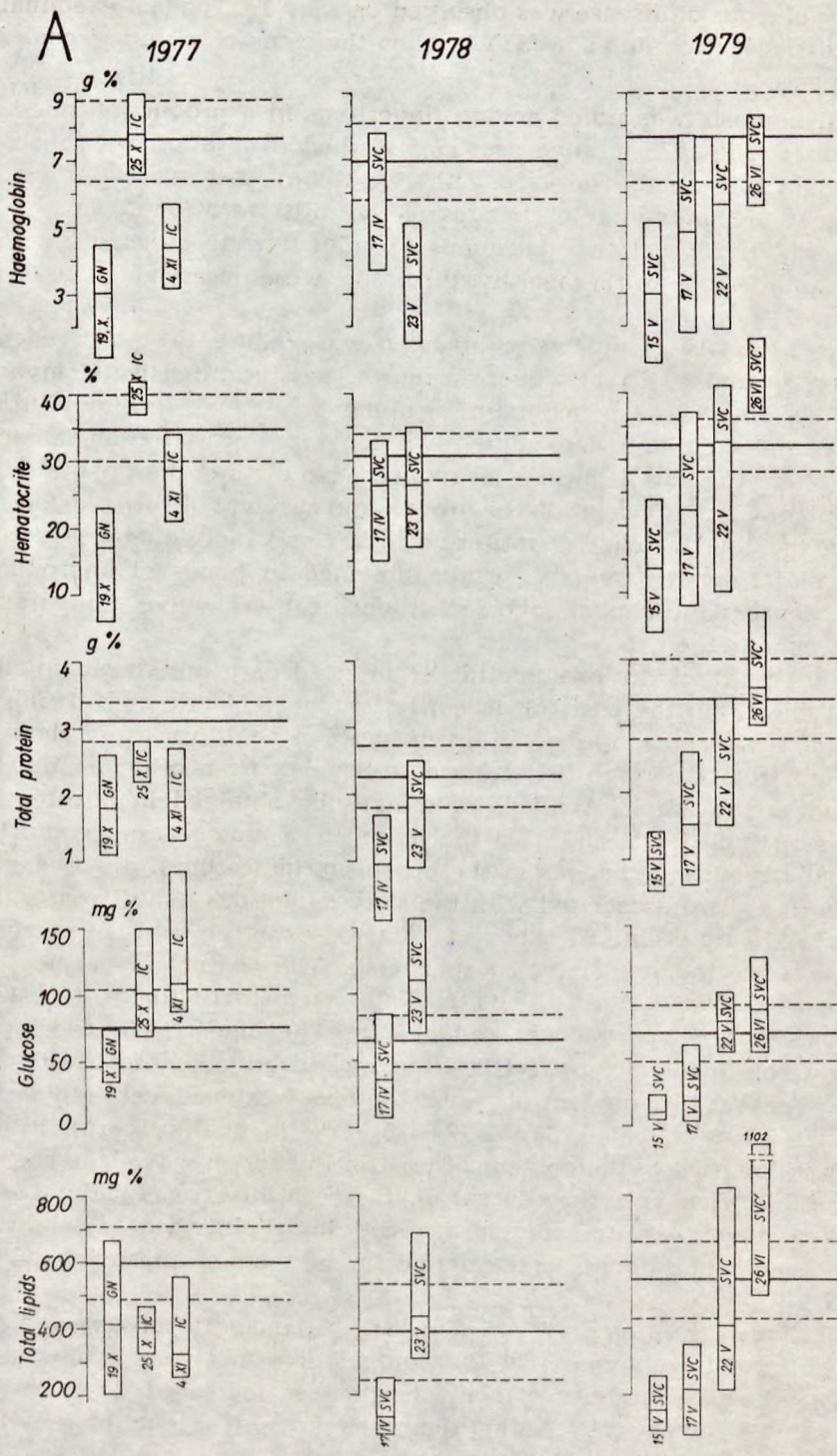
Gill necrosis was noted among fingerlings in a production pond. By the end of the 1977 farming season disturbed respiration was observed in fish in this pond. The carp gathered at the fresh water inflow. On examination, unfavourable changes of the gills were found. In extreme cases (about 25% of the specimens examined) wide areas of necrosis, reaching 40—50% of the healthy gill tissue, were observed: some deaths occurred.

The extensity of tapeworm invasion was relatively high, reaching about 80% and 100%. However, in most cases the intensity of invasion was low, about 2—4 parasites in an alimentary canal. In about 10% of carp examined there were more than ten tapeworms in the intestine, its patency thereby being partial reduced. No distinct detrimental effect of the tapeworm invasion on the growth and survival of carp was observed. In the final catches quantitative losses and individual weights did not differ from the average results obtained in ponds of approximate stock density and similar level of intensification, where no parasites were found in the fish.

The results of the examination of infected carp are shown in fig. 1 and Table I. On the basis of an earlier study (Pilarczyk 1986), the average level and range of the given index in healthy carp of the same age and from the same fish culture season but from other ponds were plotted in the graph. Analysis of the results obtained in infected fish shows distinct deviations from the norm in a number of parameters. Particularly strong changes in the organism, indicating a disturbance of homeostasis, are associated with the very dangerous fish disease spring viremia of carp (Table II). Above all, decreases in the value of numerous indices were found in infected specimens. The content of haemoglobin fell to 2—4 g% (7—9 g% in healthy fish), haematocrit to 10—15% (30—36% in healthy specimens), lipids to 150—200 mg% (400—540 mg%), cholesterol to 30—80 mg% (120—150 mg%), and glucose to 10 mg% (60—70 mg%). The content of serum proteins was decisively reduced, in extreme cases to below 1 g% (2.5—3.5 g% in healthy carp). In 1978 a slight decrease in the content of urea in the serum was also observed. In the following year the content of this constituent was maintained at a normal level. Also the content of creatinine slightly varied, while that of inorganic phosphorus and calcium in the serum approximated the norm.

Changes occurring in the organism and damage to organs and cells brought about an increase in the content of excretive enzymes in the serum. The total activity of acid phosphatase increased to a marked degree, in some cases exceeding ten times the normal level of activity in



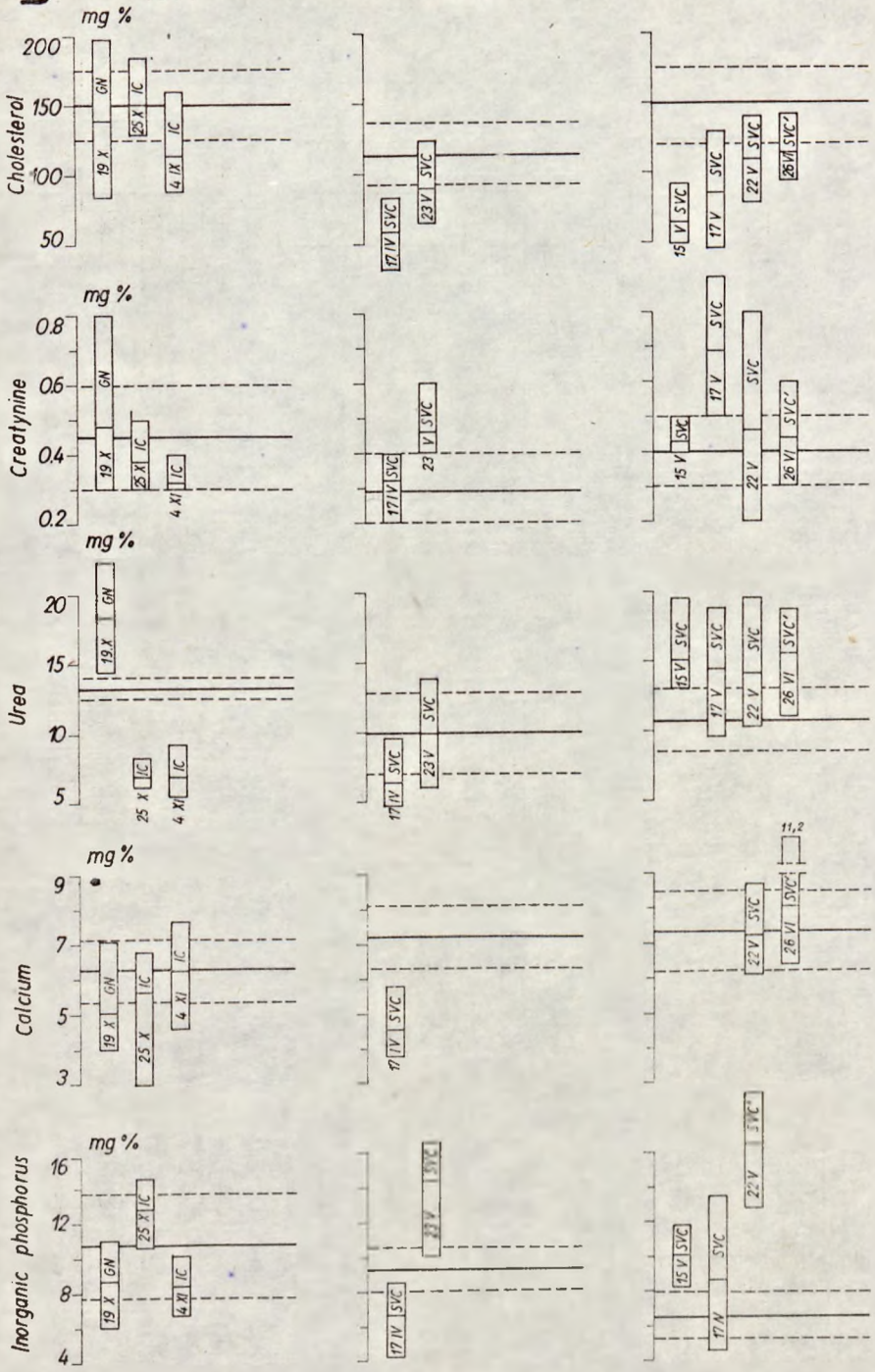


**B**

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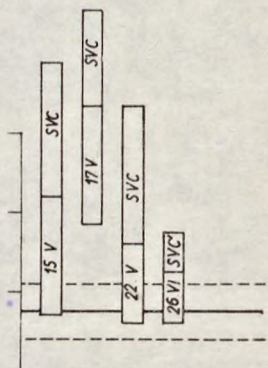
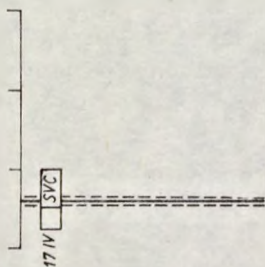
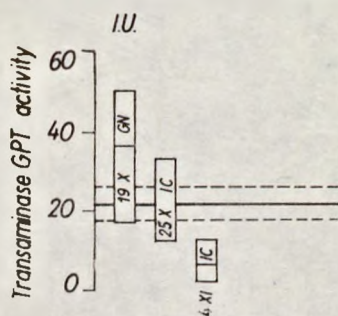
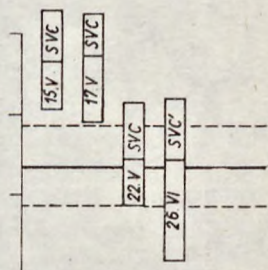
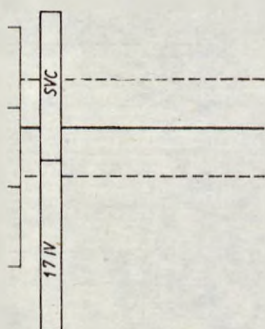
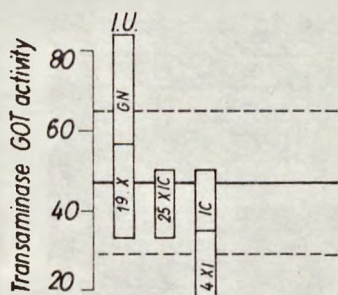
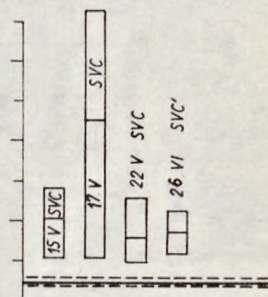
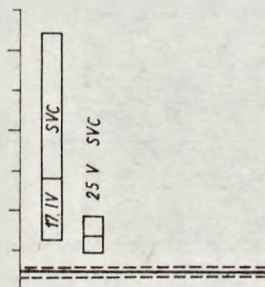
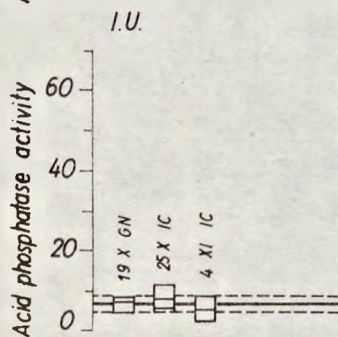
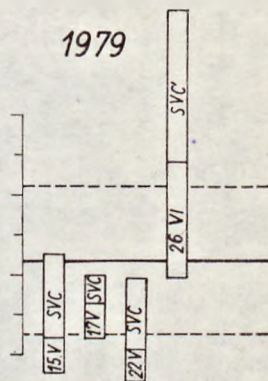
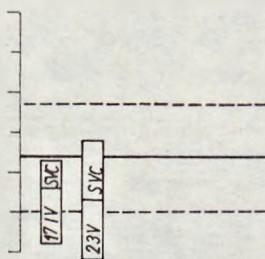
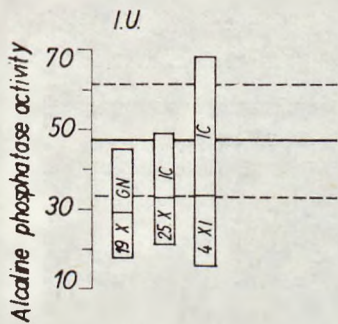


C

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1978

1979



the serum (fig. 1). The highest activity of acid phosphatase was noted in fish with advanced pathological changes. Changes in the composition of isoenzymes of acid phosphatase were found in carp with signs of SVC. The activity of the isoenzyme sensitive to the inhibitory effect of L(+) tartar increased (Table II).

In the case of this pathological unit the level of other enzymes determined in the serum did not show such definite changes. The activity of asparaginian transaminase increased by 20—75%. Similar variation was found in alanine transaminase. The activity of alkaline phosphatase decreased and then gradually increased as the disease receded.

The examination of carp with signs of gill necrosis showed distinct decreases in the value of the red blood indices (Table I). In these fishes the average concentration of haemoglobin was 3.1 g<sup>0</sup>/<sub>0</sub> and haematocrit 17.1<sup>0</sup>/<sub>0</sub>. The average content of total protein in the serum fell to 1.8 g<sup>0</sup>/<sub>0</sub>. Also the level of glucose and lipids was lower than that in healthy fish. The content of serum urea exceeded the norm. Other indices (fig. 1) did not decisively differ from the values found in healthy fish, though there was a considerable dispersion of results.

Also the results obtained in carp with signs of tapeworm invasion did not decisively differ from determinations made in healthy fish (fig. 1). The infected carp were sampled from two ponds. During the first examination normal red blood indices were found while the second examination showed a low level of haemoglobin in the peripheral blood (4.4 h<sup>0</sup>/<sub>0</sub> on the average) and a fall in the haematocrit value. Tapeworm invasion was accompanied by a 25—45% decrease in the serum total protein content. A slightly smaller decrease was noted in total lipids. The level of urea was low, while the content of glucose increased. The activity of alanine transaminase was lower.

#### 4. Discussion

Striking deviations from the norm in the determined indices were associated with spring viremia of carp (SVC). The results obtained under the conditions of high production ponds at the Fish Culture Experimental Station Gołysz confirmed earlier observations, e.g., some authors reported that the disease was accompanied by a distinct decrease in the value of the red blood indices (Dombrowski 1954, Amlacher

Fig. 1. A—C. Comparison of the level on the investigated parameters in infected fish (bars — extreme values and the mean for the group) and in healthy fish (continuous line — average level of results; broken line — the calculated range). SVC — spring viremia of carp; SVC' — investigation after disappearing of SVC signs; GN — gill necrosis; IC — tapeworm invasion



Table I. Arithmetic means and ranges of haematological, biochemical indices and activity of blood serum enzymes of carp showing signs of spring viraemia (SVC), Gill necrosis (GN), and tapeworm invasion (IC)

Disease	Data of Investigation	Haemoglobin g %	Haematocrit %	Serum total protein g %	Total lipids mg %	Glucose mg %	Cholesterol mg %	Urea mg %	Creatinine mg %	Calcium mg %	Inorganic phosphorus mg %	Alkaline phosphatase activity I.U.	Acid phosphatase activity I.U.	Transaminase GOT activity I.U.	Transaminase GPT activity I.U.		
SVC	17 April 1978	6.40 3.7-7.8	26.2 15-33	0.95 0.1-1.7	137.6 82-253	36.5 7-85	58.8 31-83	6.44 4.7-9.6	0.32 0.2-0.4	4.56 3.8-5.8	6.68 4.3-8.6	26.0 12-33	27.5 12-64	46.8 4-84	10.7 5-20		
	23 May 1978	3.50 1.5-5.1	26.3 17-35	1.95 0.9-2.5	438.3 310-690	11.8 70-157	89.2 65-124	9.98 6.0-13.8	0.46 0.4-0.6		14.16 10.9-16.7	23.0 8-38	13.1 9-18				
	15 May 1979	2.98 0.9-5.1	13.6 4-24	1.00 0.5-1.4	152.0 93-256	11.1 5-23	64.7 49-92	15.09 12.9-19.4	0.43 0.4-0.5		10.00 8.2-11.8	14.2 5-35	19.9 10-27	73.0 61-86	43.9 14-78		
	17 May 1979	4.81 1.8-7.7	22.4 8-37	1.52 0.6-2.6	215.1 79-351	18.5 3-60	86.7 46-131	14.24 9.6-18.8	0.68 0.5-0.9		8.75 4.6-13.5	20.3 14-30	44.9 10-72	74.5 58-85	67.1 37-91		
	22 May 1979	5.61 1.9-7.6	32.5 10-41	2.23 1.5-3.4	407.1 214-821	77.45 55-99	109.0 78-141	14.10 10.2-19.6	0.46 0.2-0.8		7.25 6.1-8.7	16.45 12.8-19.4	10.1 3-29	15.2 9-25	48.8 37-63	32.1 12.67	
	26 June 1979	7.22 5.6-8.3	41.9 37-48	3.56 3.0-4.7	868.6 488-1102	87.0 53-126	114.2 93-142	15.51 11.1-18.7	0.44 0.3-0.6		8.07 6.4-11.2	58.0 29-96	16.6 11-22	48.8 23-64	25.0 12-35		
	19 October 1977	3.04 1.1-4.5	17.1 6-23	1.80 1.1-2.6	411.7 205-667	49.4 34-74	139.1 84-197	18.42 14.4-22.3	0.48 0.3-0.8		5.05 4.0-7.1	8.69 6.0-11.0	29.1 18-45	6.4 4-8	56.8 33-84	36.7 17-50	
	25 October 1977	7.78 6.6-9.0	38.5 37-42	2.44 2.2-2.8	400.6 346-470	116.6 68-149	151.6 128-183	6.92 6.2-8.2	0.38 0.3-0.5		5.66 3.0-6.8	12.85 10.7-14.6	33.0 21-49	7.8 5-11	36.7 33-50	21.7 12-33	
IC	4 November 1977	4.41 3.2-5.7	28.6 21-34	1.90 1.32-2.7	326.0 254-556	118.6 87-193	114.2 88-160	6.93 5.6-9.2	0.32 0.3-0.4	6.28 4.6-7.7	8.46 6.7-10.2	34.7 16-68	4.7 2-8	35.1 17-50	6.7 2-13		



Table I. Comparison of arithmetic means and ranges of serum acid phosphatase activity of healthy and SVC - infected fish

State of carp	Date of investigation	Total activity	Activity of isoenzyme inhibited by tartar
Diseased fish	15 May 1979	19.93 10.30-26.71	8.27 5.04-14.16
	16 May 1979	30.91 22.23-39.20	7.45 2.99-12.97
	17 May 1979	44.86 10.25-71.92	10.51 1.33-20.51
	18 My 19799	51.85 20.50-73.34	16.85 5.60-35.82
	21 May 1979	21.14 15.48-26.44	3.55 1.15-6.81
	22 May 1979	15.21 9.05-25.04	1.69 0.74-2.99
	26 June 1979	16.60 10.92-22.24	1.34 0.26-3.13
Healthy fish	18 April 1979	4.87 3.36-7.84	1.65 0.78-2.52
	18 May 1979	11.51 7.85-14.11	2.57 0.60-5.06
	24 May 1979	10.27 7.05-12.98	2.39 0.70-3.86
	19 June 1979	12.48 9.19-15.51	1.41 0.46-3.33

1972, Jancik, Vasil 1973, Svobodová, Tesarčik 1973) and in the level of glucose (Amlacher 1957), and a decrease in the concentration of serum protein and a change in their proportions (Flemming 1958, Riedmüller 1965, Kulov 1966, Stefan 1970). Also the content of lipids was found to be altered (Schäperclaus 1979). The present results widen the range of information about changes occurring in the organism of carp with signs of SVC.

Comparison of the analysed indices in fish with spring viremia with results obtained in healthy carp from other ponds in the same farming season shows decisive differences. A number of indices in infected fish were outside the range calculated for the healthy population (fig. 1).

Interesting observations were made in connection with changes in the activity of excretive enzymes in the serum, especially acid phosphatase. A marked increase in the content of acid phosphatase in the serum (up to 20—50 I.U.) was characteristic for SVC. It seems that the determination of the activity of this enzyme in the serum can be used as an important complementary element in diagnosing the disease. The scanty information concerning acid phosphatase in fish is insufficient for elucidating the mechanism which brings about the evolution of considerable amounts of acid phosphatase and for determining the organ from which the enzyme infiltrates the blood in the case of spring viremia.

Changes in the investigated indices were less pronounced in carp with gill necrosis. Above all, a decrease in the red blood indices and

in the concentration of protein and total lipids was observed (fig. 1), this confirming earlier reports (Svobodová, Tesarčík 1974, Kreuzmann 1976, Pilarczyk 1977). The level of glucose was lower, this finding being in conflict with the results of Svobodová et al. (1976). The latter authors reported a tendency to an increasing content of sugar in the blood of carp with gill injuries in consequence of disturbances in the assimilation of oxygen from the water. Such disturbances bring about the activation of an additional source of energy by anaerobic glycolysis. Since the remaining indices varied around the values of the norm, gill necrosis seems to affect the function of this organ. However, there occur no such distinct disturbances in the whole organism as is the case in spring viremia of carp.

Similarly, tapeworm invasion was found not to affect the investigated indices, apart from a decrease in the value of the red blood indices and in the concentration of the serum total protein, which were observed on the second date of investigation. The last remark corresponds with the results of Par (1978) and Svobodová (1978) which showed that invasion of more than 15—19 specimens of *Bothriocephalus gowkongensis* per 1 two-year-old carp brought about measurable changes in the leucocyte composition and in the content of protein and lipids in the fish body. In the carp examined at Gołysz tapeworms appeared in small numbers and only sporadically exceeded 10 parasites in one alimentary canal (in 10% of the examined specimens). Tapeworm invasion of this intensity did not markedly affect the level of the indices under study.

## 5. Polish summary

### Zmiany wybranych parametrów krwi karpi z objawami wiosennej wirerii, nekrozy skrzelii oraz inwazji tasiemców

W krwi karpi z objawami wiosennej wirerii, nekrozy skrzelii oraz inwazji tasiemców oznaczono poziom hemoglobiny, hematokryt, stężenie białka całkowitego surowicy, lipidów, cholesterolu, glukozy, kreatyniny, mocznika, ilość wapnia, fosforu nieorganicznego, aktywność w surowicy fosfatazy kwaśnej i fosfatazy zasadowej, transaminazy alaninowej i asparaginianowej (tabela I). Uzyskane wyniki porównano z rezultatami badań karpi zdrowych wykonanymi w tym samym okresie sezonu hodowlanego (ryc. 1). Szczególnie silne zmiany badanych wskaźników, wskazujące na naruszenie homeostazy, towarzyszyły wiosennej wirerii karpi. Stwierdzono zdecydowany wzrost w surowicy (tabela II) aktywności fosfatazy kwaśnej, do wartości 20—50 I.U. (wobec 5—10 I.U. u karpi zdrowych). Wydaje się, że oznaczanie aktywności tego enzymu może być ważnym elementem pomocniczym w diagnozowaniu wiosennej wirerii karpi.



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