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Physiology

SEASONAL AND DAILY VARIATIONS
OF RESPIRATORY METABOLISM OF LIVER AND KIDNEY OF BREAM
ABRAMIS BRAMA (L.)

SEZONOWE I DOBOWE ZMIANY INTENSYWNOŚCI
POBIERANIA TLENU PRZEZ WĄTROBĘ I NERKĘ LESZCZA
ABRAMIS BRAMA (L.)

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The investigations related to seasonal and daily variations of oxygen consumption by liver and kidney of bream with consideration of sex. The results obtained indicate to more intensive respiratory metabolism in autumn in comparison to summer season. Highest metabolic intensity ascertained at males during autumn season. Daily variations became also very distinct. Increased respiratory metabolism in liver and in kidney was apparent during the evening; highest respiratory metabolism noted at males during evening.

The variations of activity in physiological processes are characteristic for their rhythmic course. Rhythm represents the correct form of systems activity capable of stimulation. It relates to complete organisms, organs, tissues, cells and cell organs (Reinberg, Ghata, 1964).

Rhythm is still maintained after separation of organ from organism. The variety of biologic rhythms is characteristic for particular functions. Frequency of rhythms possesses very wide range, from seconds, through days, months, seasons and years.

Most interesting from practical point of view are the daily, seasonal and annual rhythms of fish. Daily rhythmic changes of fish are recognized empirically and are exploited in fishery. Recognized and also exploited are the seasonal variations of fish activity, particularly connected with migration (Fontaine, 1967).

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Various investigations indicate to variable rhythms in fish feeding (I o n o v a, 1969; K o g a n, 1963) and to interrelation of respiratory metabolism dynamics from seasonal cycles and from daily rhythms (D r i a g i n, 1968; S k a z k i n a, 1969; V e s e l o v, 1966).

Quantity of oxygen consumed by particular internal organs contribute towards total respiratory metabolism which varies under different conditions. (H a n s o n and S t a n l e y, 1969; W e l l s, 1935).

There is no doubt that the spontaneous endogenous of period may be subject to transformations under influence of daily and seasonal changes in period of environment. Thus, the rhythmic changes of organs respiratory metabolism may present the expression of adapting ability to variation of environment.

This work is first part of studies on adapting ability to changes of environment and comprises the results of oxygen consumption by organs which show high metabolic activity, i.e. liver and kidney of bream, in aspect of daily and seasonal rhythms with due consideration to differences appearing at males and females.

METHOD

Investigations had been carried out on breams of both sexes of age 5-8 years caught in Zalew Szczeciński. The investigations had been carried out during summer season (July-August) and autumn season (October-November). For experiments, the fishes were kept in experimental aquarium. Temperature of water amounted to $18 \pm 1^\circ\text{C}$ in summer and $11 \pm 1^\circ\text{C}$ in autumn. For each season investigated, selected two experimental groups of fish. Investigations of one group were carried-out during morning hours 8³⁰-10³⁰ and of second - during evening hours 17³⁰-19³⁰. Measurements of tissular respiration were made by direct method of Warburg (U m b r e i t et al., 1957; W ę g r z y n o w i c z, Z b a n y s z e k 1971). Consumption of oxygen denoted in $\mu\text{l O}_2/\text{g}$ of wet tissue/hour. Obtained results presented statistically.

RESULTS AND DISCUSSION

An analysis of seasonal metabolic changes in investigated organs, expressed by quantity of oxygen consumed, indicates essential differences (Tab.1).

In autumn season, kidney respiration of all fishes was more intensive by about 50% in relation to summer season, while respiration of liver - only by 7%. The kidney shows higher requirement for oxygen in both seasons when compared with liver. During summer season, the metabolism of kidney is higher by 18% in comparison with liver and in autumn season - by 64%.

Daily changes of oxygen consumptions

In autumn evening, the intensity of kidney respiration was by 13% higher and of liver - by 9% in relation to values obtained before noon. In summer evening, the consumption of oxygen by kidney is higher by 22% and by liver by 6% in comparison to values obtained before noon. The analyses of daily

Table 1

Values of oxygen consumed by liver and kidney of bream *Abramis brama* (L.) ($\mu\text{l O}_2/\text{g}/\text{hour}$)
with consideration to weight of body

Weight group	Control group					Weight group	Experimental group						
	Weight (g) from - to	n	\bar{x}	Liver δ	Kidney δ		Weight (g) from - to	n	\bar{x}	Liver δ	Kidney δ		
I	330-350	10	372	± 72	587	± 80	I	330-350	10	419	± 65	610	± 75
II	380-425	11	345	± 75	449	± 65	II	380-425	11	386	± 57	591	± 82
III	550-620	11	259	± 55	392	± 74	III	550-650	11	372	± 75	508	± 53
IV	810-835	12	237	± 74	372	± 84	IV	850-870	11	317	± 67	498	± 69
V	835-900	12	234	± 85	371	± 72	V	900-930	11	276	± 85	400	± 83

n = number of specimen examined

\bar{x} = arithmetic mean

δ = standard deviation

variations indicate that intensity of metabolism in kidney and in liver during evening of both seasons is higher; variations are smaller in autumn season and higher in summer season.

Seasonal variations of oxygen consumption of males and females

In summer season, the respiration of males kidney is higher by 39% and of liver by 5% in comparison to females. In autumn season, kidney of males shows higher metabolism by 3% in comparison to females, while the liver of females shows higher metabolism by 14% in comparison to males. Seasonal variations for the same sex show more intensive metabolism in kidney by 55% in autumn and 35% in liver in comparison to summer season. The kidney of males respirates more intensively by 15% in autumn and the liver by 11% in comparison to summer season (Tab.2).

Table 2

Values of oxygen consumption by kidney and liver of bream *Abramis brama* (L.) ($\mu\text{l O}_2/\text{g}/\text{hour}$) with consideration to seasonal and daily changes at males and females

Sex	Summer						Autumn					
	Time of day	n	Liver		Kidney		n	Liver		Kidney		
			\bar{x}	δ	\bar{x}	δ		\bar{x}	δ	\bar{x}	δ	
♀♀	P	11	255	+45	321	+50	11	365	+45	521	+63	
	W	11	285	+55	363	+35	12	368	+50	542	+75	
♂♂	P	12	278	+48	401	+64	12	303	+40	541	+65	
	W	12	293	+55	553	+38	12	336	+45	557	+58	

P - before noon; W - evening; n - number of specimen examined;

\bar{x} - arithmetic mean;

δ - standard deviation

Daily variations of oxygen consumption by males and females

Before noon in summer, the kidney of males shows more intensive respiration by 19% and in evening by 52% in comparison to females. Before noon in autumn, the kidney of males shows increase of intensity by 3% and by 2% in evening, in comparison to females.

In summer, the liver of males shows increase of intensity by 9% before noon and by 2% in evening in relation to females. In autumn, the liver of females shows higher respiratory metabolism by 20% before noon and by 9% in evening in comparison to males.

Summary of daily variations shows increased metabolism in kidney and in liver during evening for both investigated seasons at females and males. In autumn season, the liver of females shows higher metabolism before noon and

in evening in relation to males, while the kidney of males shows higher metabolism before noon and in evening during both seasons in relation to females (Fig.1,2).

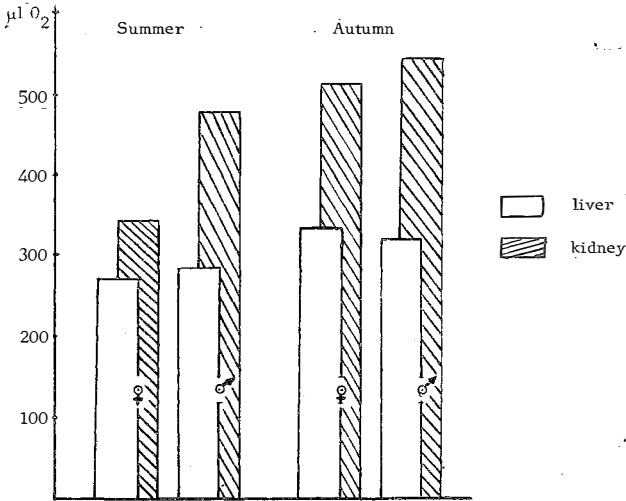


Fig. 1. Seasonal changes of oxygen consumption by liver and kidney of bream *Abramis brama* (L.) (μl O₂/g/hour)

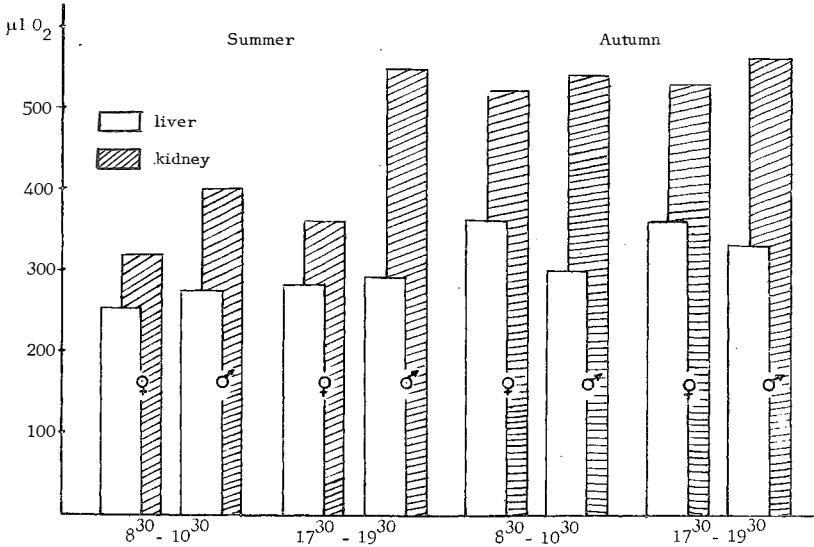


Fig. 2. Changes of oxygen consumption in μl O₂/g/hour by liver and kidney of bream *Abramis brama* (L.) in summer and autumn season

CONCLUSIONS

1. Seasonal changes influence the intensity of oxygen consumption in kidney and in liver of bream.
2. More intensive respiratory metabolism in examined organs are noted in autumn season.
3. Kidney of bream shows more intensive respiratory metabolism in comparison to liver for summer and autumn season.
4. Most intensive seasonal metabolism is noted in kidney of males during autumn season.
5. Daily rhythm is characteristic for increased respiratory metabolism in evening.

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SEZONOWE I DOBOWE ZMIANY INTENSYWNOŚCI POBIERANIA TLENU
PRZEZ WĄTROBĘ I NERKĘ LEŚCZA ABRAMIS BRAMA (L.)

S t r e s z c z e n i e

W cyklu badań zdolności adaptacyjnych do zmian środowiska przeprowadzono pomiary zużycia tlenu przez wątrobę i nerkę leścza metodą Warburga w aspekcie rytmów dobowych i sezonowych z uwzględnieniem różnic występujących u samców i samic.

W wyniku badań stwierdzono, że 1) nerka wykazuje intensywniejszą przemianę oddechową w zestawieniu z wątrobą w sezonie letnim i jesiennym, 2) w sezonie jesiennym występują intensywniejsze przemiany oddechowe w badanych narządach, 3) najbardziej intensywne przemiany sezonowe występują w nerce u samców i samic w okresie jesiennym, 4) rytm dobowy zaznacza się zwiększoną intensywnością przemian w badanych narządach wieczorem.

СЕЗОННЫЕ И СУТОЧНЫЕ ИЗМЕНЕНИЯ ИНТЕНСИВНОСТИ ПОГЛОЩЕНИЯ КИСЛОРОДА
ПЕЧЕНЬЮ И ПОЧКОЙ ЛЕЩА АБРАМИС БРАМА (L.)

Р е з ю м е

В цикле исследований адаптивных способностей по отношению к изменениям среды проведены измерения потребления кислорода печенью и почкой леща по методу Варбурга в аспекте суточных и сезонных ритмов, принимая во внимание различия, наблюдаемые у самцов и самок.

В результате исследований установлено, что: 1) почка проявляет более интенсивный дыхательный обмен в сопоставлении с печенью в летний и осенний периоды; 2) в осеннем сезоне наблюдаются более интенсивные дыхательные превращения в исследуемых органах; 3) наиболее интенсивные сезонные изменения наблюдаются в почке у самцов и самок в осенний период; 4) суточный ритм характеризуется усиленной интенсивностью превращений в исследуемых органах в вечернее время.

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