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Tõnu NOORITS

SEASONAL CHANGES IN THE OVARIES OF COMMON BREAM *Abramis brama* L. IN LAKE VÕRTSJÄRV

In Estonian inland waters the common bream is the main subject of investigations at the Laboratory of Fish Production Biology, Institute of Zoology and Botany, Academy of Sciences of the Estonian SSR. Along with studies in the sphere of morphometrics and systematics (Хаберман, 1964, 1974), physiology of blood (Кирсипуу et al., 1974; Кирсипуу, 1978) and liver (Лаугасте 1970, 1978; Лаугасте et al., 1974), genetics (Таммерт, 1974), the problems of reproduction, developing and function of bream reproductive system are completely untouched or poorly dealt with. In the present study, attention is concentrated on the investigation of seasonal changes in the ovaries of bream.

Material and methods

On the basis of 521 analyzed adult specimens from L. Võrtsjärv (Estonian SSR) the seasonal changes in the gonosomatic index were studied as well as the histological structure of ovaries and the dynamics of energetic reserves (lipids, glycogen) in the oocytes. Material was collected during a period of six consecutive years 1975—1980. The standard length and body weight were measured. Both the ovaries were removed, cleared from connective tissue and weighed with precision up to 0.1 g. The size of ovaries was expressed by the gonosomatic index (GSI), which was calculated for each fish by taking the body weight as the denominator. For histological study the pieces were cut from the cranial end of left ovary, fixed in Bouin's and Baker's fluids and processed by the conventional celloidin-paraffin technique. The survey preparations were stained with haematoxylin-eosin according to Mayer, and toluidin-blue. The content of glycogen was stated by PAS reaction. Frozen sections were stained for lipids by Sudan black B and Sudan red. The amount of glycogen and lipids in the oocytes was estimated visually on the histological preparations according to a 4-degree (0, 1, 2, 3) scale (Pl. I). Maturation stages of ovaries were determined according to the widely used 6-degree scale (Сакун, Буцкая, 1963).

Results and discussion

The bream belongs to the fishes with an asynchronous growth of oocytes. Both the simultaneous and portional spawning are proper to it. The spawning type and the whole reproduction biology of bream are closely connected with the nature of oogenesis, which in turn depends on the existence conditions (Кошелев, 1966, 1974). In Estonian inland waters breams become mature at the age of 5—9 years (Хаберман, 1964). At that time their length reaches 28—31 cm on the average in L. Võrtsjärv.

There is no remarkable change in the GSI of immature breams throughout the annual cycle (Ноорнтс, 1978). The average is 1.34 in the

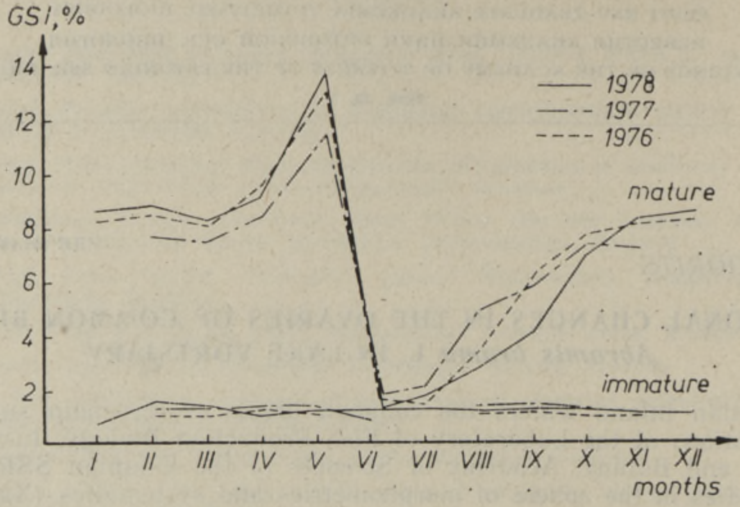


Fig. 1. Seasonal dynamics in the GSI of female breams.

females of a length of 26—30 cm. The GSI of mature fishes undergoes great seasonal changes (Fig. 1). It steeply increases at the beginning of August in connection with oocytes entering the period of trophoplasmic growth. With the oocytes increasing due to the processes of vacuolization and vitellogenesis, the GSI of the fish increases as well (Ноорытс, 1978). From November to March the changes in the GSI are negligible. Beginning with the end of March the GSI increases again.

Before spawning the GSI of female fishes may vary on a large scale — up to 3.9 times (Ноорытс, 1978). During the whole sexual cycle the GSI of the females increases on the average 10 times (extreme indices 1.15 and 22.70). Remarkable inter-year differences occur in the seasonal dynamics of the GSI (Fig. 1), induced mainly by the influence of various ecological factors. The GSI of the females increases with the length and weight of fishes, i. e. the bigger and more heavy specimens have relatively bigger gonads. As the data characterizing the connection of the GSI with the length of the fishes were published previously (Ноорытс, 1978), here we present only the data on the dependence of GSI upon the weight of fishes throughout the annual cycle (Table 1).

From June to July the ovaries of the females maturing for the first time or repeatedly, are in the II and VI—II stage of maturity, respectively. If the histological structure of the former consists mainly of oocytes in the period of cytoplasmic growth (Pl. II, *a*), then the latter reveal, besides, also traces of earlier spawning in the form of different resorption stages of empty follicles and remaining oocytes. In the oocytes of the older generation, a protein deposition takes place, as revealed by intensive staining of cytoplasm with toluidin-blue. Data on the dynamics in the α_2-globulin fraction of the blood serum proteins of the females prove it as well (Кирсипуу, Пиху, 1965).

In the oocytes of the older generations, vacuolization starts in early August (Pl. II, *b*). During that month the gonads enter the III stage of maturity. Usually, in repeatedly maturing specimens this occurs at a more rapid rate than in those maturing for the first time. Within the ovary, the vacuolization of the cytoplasm proceeds unsynchronously. As a rule, the vacuolization comes to an end in the second half of September, and then the vitellogenesis starts. The start of vitellogenesis coincides with the decreasing of water temperature in the lake below 10 °C. As shown in some papers (Лаугасте et al., 1974; Лаугасте, 1978) the

Table 1

The dependence of the GSI on the weight of fishes throughout the annual cycle

Weight groups, g	Months											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
<300					8.56	1.24	1.32					
n					7	7	3					
300—500	6.92	7.94	8.14	7.49	12.21	1,81	1.78	3.68	5.00	6.13	6.84	
n	3	6	2	4	53	17	14	2	15	1	6	
500—700	8.27	8.19	8.35	7.06	13.48	1.86	1.59	4.11	5.69	6.59	6.79	8.03
n	8	7	4	2	41	10	11	18	24	5	14	3
700—900	7.89	8.05	6.55	9.16	14.29	1.40	1.63	4.62	6.86	9.20	9.63	9.30
n	2	1	3	1	29	4	4	5	11	2	11	3
900—1100			9.85		13.84	1.85	1.73	4.51	8.62	9.80	11.68	9.62
n			1		12	3	2	3	10	1	8	1
1100—1300					21.10	1.96			9.11		12.18	11.72
n					2	2			1		1	1
average	7.90	8.47	7.92	7.61	13.07	1.70	1.66	4.21	6.27	7.48	8.69	9.17
n	13	14	10	7	144	43	34	28	61	9	40	8

Table 2

Changes in the morphological indices of oocytes throughout the annual cycle*

Index, μm	Months											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
oocyte diameter	756	772	782	804	840		156	504	650		772	769
n	12	70	52	22	75		32	50	54		60	40
nucleus diameter		131	155	126	125		69	91			122	
n		12	4	12	15		13	20			18	
thickness of *zona radiata*	11.1	11.3	10.3	12.1	11.3			7.9	8.8	8.6	10.7	11.2
n	8	35	6	6	30			20	30		42	18
thickness of follicular epithelium		5.3		5.4	5.9		1.9		4.3		5.3	
n		12		5	9		12		22		16	

* Measurings were made on the preparations stained with haematoxylin-eosin.

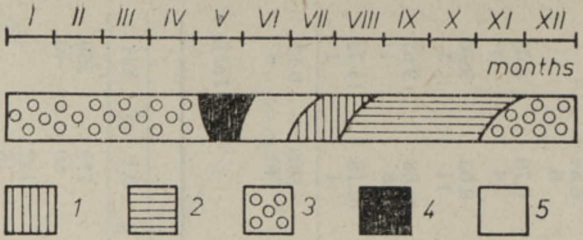


Fig. 2. The annual reproductive cycle of bream ovaries in L. Võrtsjärv: *1* — II, *2* — III, *3* — IV, *4* — V, *5* — VI—II stages of maturity.

temperature level of 10—12° determines the transition from the summer (carbohydrate) type of metabolism to the winter (fat) one. The processes of generative metabolism are apparently connected with that temperature threshold as well. The intensity of vitellogenesis in the oocytes rises with further decreasing of the water temperature. This phenomenon has also been observed by other scientists (Лукшене, 1978).

Passing to the IV stage of maturity is gradual. Usually it occurs at the beginning of November (Pl. II, *c*). During hibernation (from December up to March) the development of the oocytes is blocked — no remarkable changes are found either in the main morphological indices of the oocytes (Table 2) or in the GSI (Fig. 1). The metabolic processes in the gonads are restrained. This conception correlates well with the results of investigations into the connections between the sexual cycle and the protein system of blood serum (Кирсипуу, Пиху, 1965; Kirsipuu, 1977). The development of gonads continues again with the arrival of spring. It is indicated by a gradual increase in the GSI from early March onwards.

As histological observation demonstrated, the nucleus in the bream oocytes displaces towards the animal pole already at the end of IV maturation stage (Pl. II, *d*). We have not succeeded in following the yolk fusion in the maturing oocytes — probably this occurs immediately before

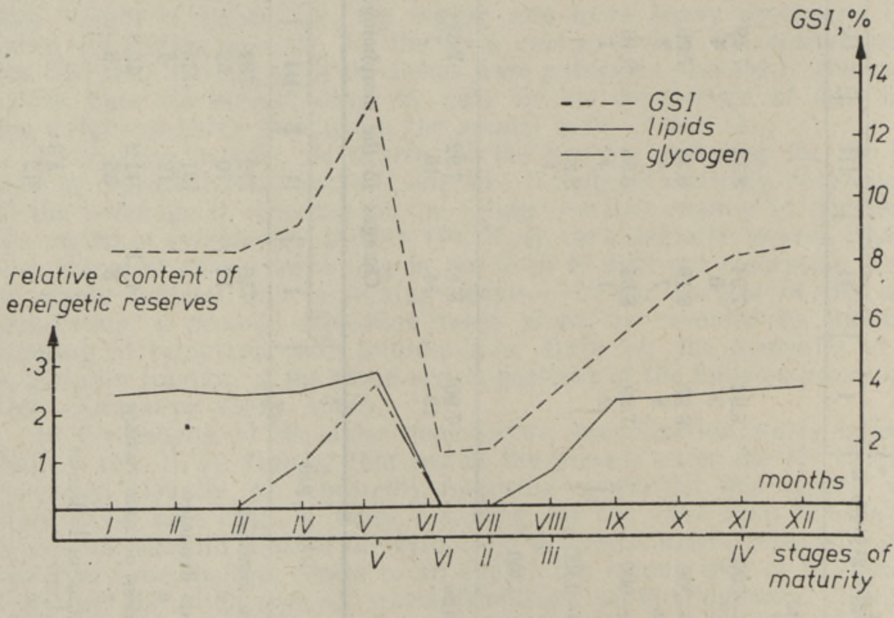
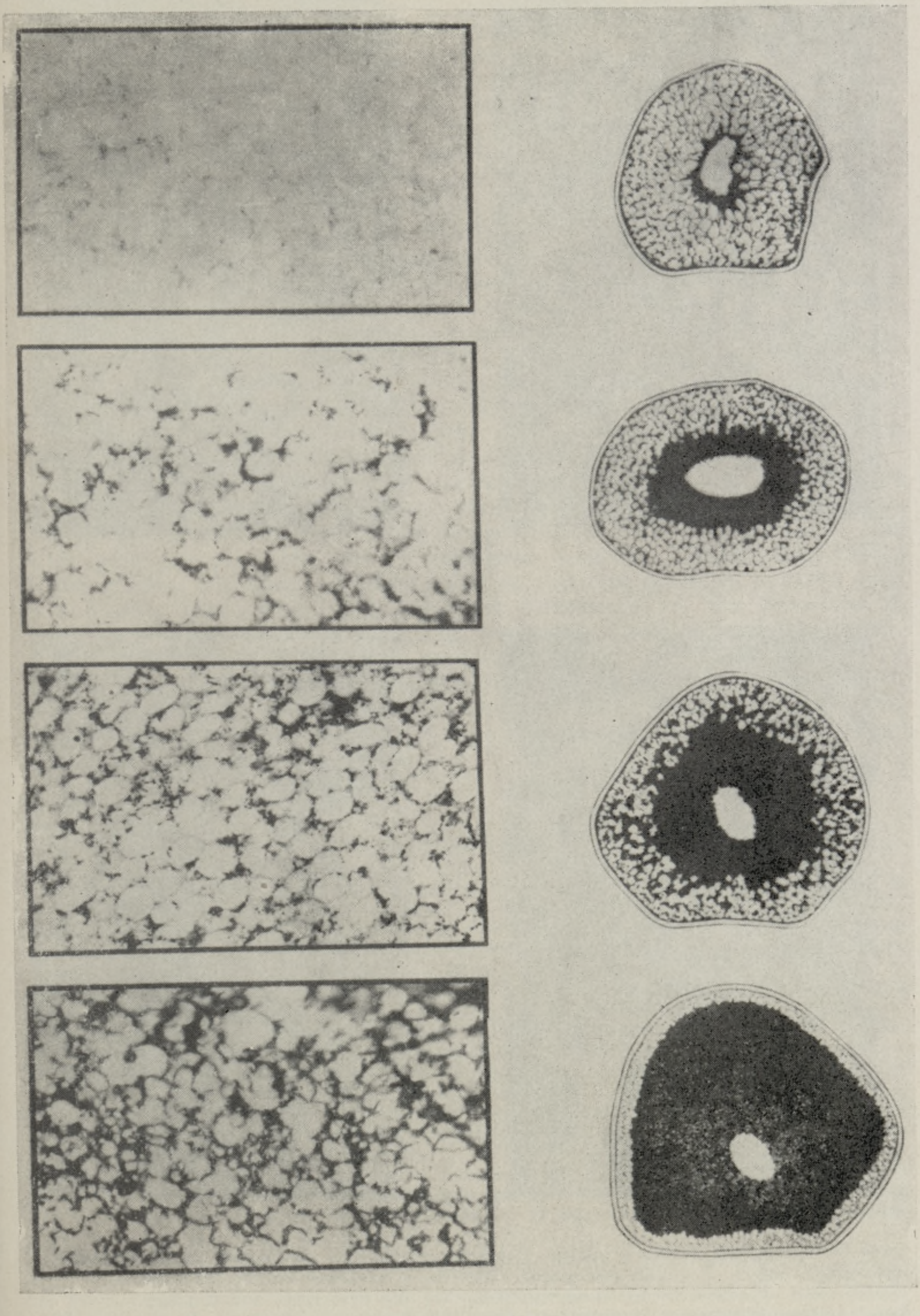


Fig. 3. Seasonal changes in the relative content of lipids and glycogen in the bream oocytes.

I II



0
1
2
3

Plate I. Scales for visual estimation of the relative content of glycogen (I) and lipids (II) in oocytes; I — PAS reaction, ×280; II — Sudan black B, ×70.

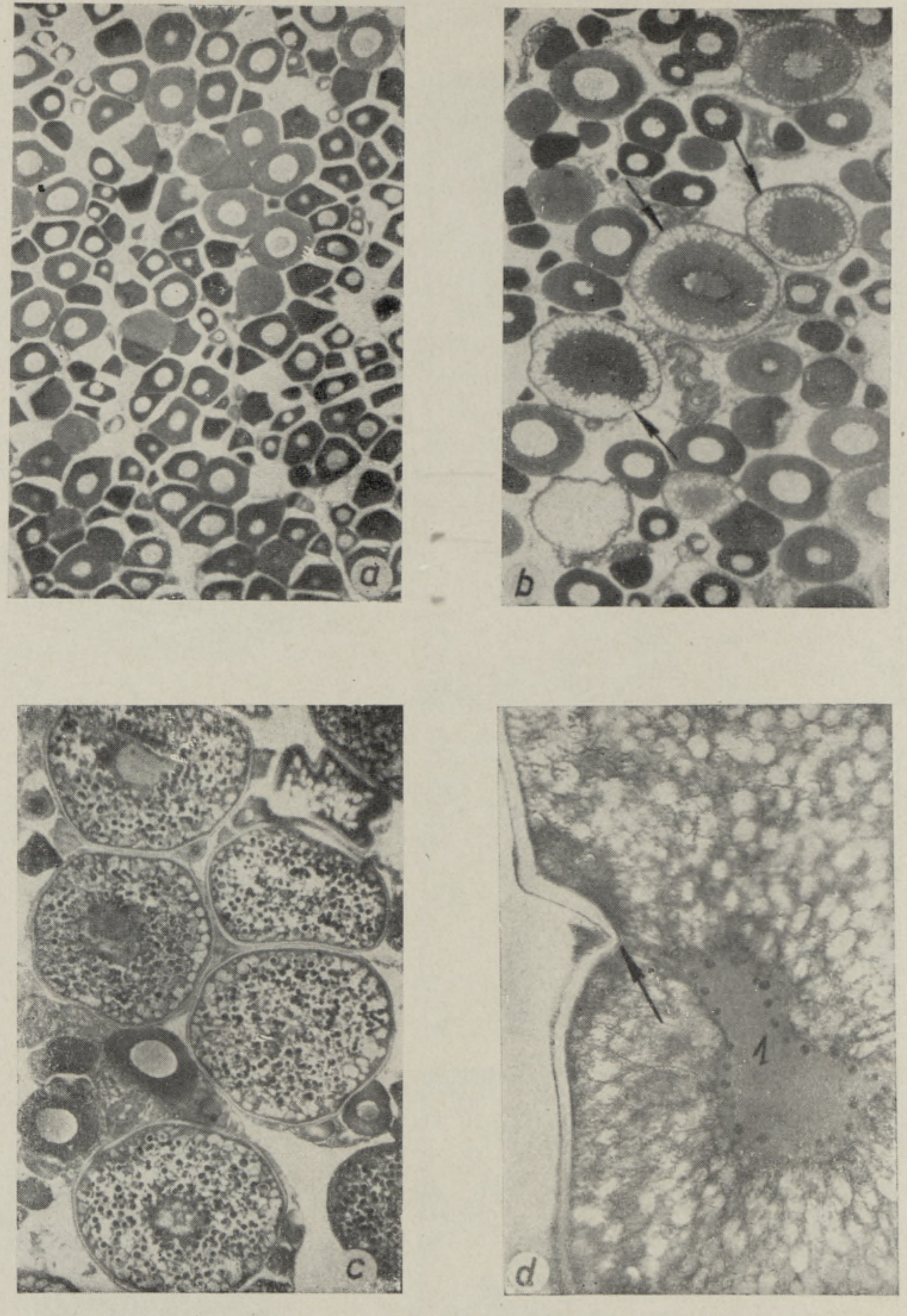


Plate II. *a* — ovary of the female maturing for the first time; one can see oocytes in the period of cytoplasmic growth (June); toluidin-blue; ×70. *b* — oocytes of older generations (↑) at the beginning of vacuolization (late July); haematoxylin-eosin; ×70. *c* — oocytes at the beginning of the IV stage of maturity (November); haematoxylin-eosin; ×70. *d* — nucleus (*1*) in the animal pole of an oocyte near the micropyle (↑) (early May); haematoxylin-eosin; ×280.

spawning. Depending on the location in the ovary, the maturing oocytes or the mature ones are of a different quality — their dimensions and the yolk content vary. This is mainly motivated by anatomic causes — the oocytes lying near the large blood-vessels have better feeding and growth conditions (Мейен, 1940; Лебедев, 1967).

In L. Võrtsjärv, the breams have prolonged simultaneous spawning, which occurs in several spawning groups. The breeding period extends from the first decade of May to the first decade of June, usually. The prolongation of spawning is probably caused by the difference in the maturity of age groups. The number of spawning groups (up to 3) depends on meteorological conditions (temperature regime, water level) during the reproduction period, mainly. The resorption processes (VI—II maturation stage) in ovaries last for 1.5—2 months. The duration of the resorption of the remaining oocytes and the development of the following oocytes generations depends greatly on feeding conditions and the water temperature in that period (Володин et al., 1974; Лукшене, 1978; Фалеева, 1975). In the enfeebled and exhausted specimens at extremely poor physiological state resorption may pass throughout the whole vegetation period and finish by winter or next spring, blocking the development of the next oocytes generation (Володин, 1979). The annual cycle of development of ovaries is presented in Fig. 2.

During the annual cycle of ovaries development, one may observe certain dynamics in the glycogen and lipids deposition in the oocytes (Fig. 3). It is known that in the biodynamics of cells both the lipids and the glycogen play the role of energetic reserves (Даниленко, 1967). The gradual deposition of lipids starts in July, but glycogen appears only in March. There may occur inter-year differences in the dynamics of glycogen and lipids as well, but they are statistically insignificant. Visual estimation of energetic reserves dynamics has been successfully used in the investigations into the liver of cyprinids (Лаугасте, 1970, 1978). The results of the visual estimation of energetic reserves in gonads may be used as complementary indices in the ecomorphological investigations of sexual cycles of fishes.

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SESOONSED MUUTUSED VÕRTSJÄRVE LATIKA *ABRAMIS BRAMA* L. MUNASARJADES

Uurimistulemustele toetudes on konstateeritud, et Võrtsjärve latika munasarjade küpsuskoefitsiendi, samuti energeetiliste reservide (glükogeen, lipiidid) suhtelise sisalduse sesoonsed muutused on märkimisväärsed. Nende üldine käik kordub aastast aastasse, täheldatud hälbed johtuvad muutuvaist ökoloogilistest tingimustest. Gonaadide histoloogilise analüüsi alusel on kirjeldatud emaslatikate sugutsüklit ja määratud kindlaks üksikute suguküpsusastmete kestus.

Тыну НООРИТС

СЕЗОННЫЕ ИЗМЕНЕНИЯ В ЯИЧНИКАХ ЛЕЩА *ABRAMIS BRAMA* L. ОЗЕРА ВЫРТСЪЯРВ

Исследованы сезонные изменения коэффициента зрелости яичников, а также относительного содержания энергетических резервов (гликоген, липиды) в ооцитах леща. Общий ход этих изменений повторяется из года в год, имеющиеся межгодовые различия обусловлены различными экологическими условиями. В результате гистологического изучения гонад описан половой цикл самок леща, выявлена продолжительность отдельных стадий зрелости.