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The spawning of Lake Sevan khramulya  
(Varicorhinus capoeta sevangi)  
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by E. M. Malkin

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O razmnozhenii sevanskoi khramuli.

By: E. M. Malkin

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The spawning of the lake Sevan khramulya

(Varicorhinus capoeta sevangi).

By: E. M. Malkin

The quantities of the lake Sevan khramulya (Varicorhinus capoeta sevangi, Filippi) are shrinking and the study of its natural reproduction process is of primary importance. The main object of our work is the study of the periodicity of the spawning and the estimation (however tentative) of the ratio of khramulya which breeds in lake and river spawning grounds. No light has been thrown on this subject in any previous literature.

This article analyses the data collected by us during the years 1963 - 1967 and also the findings of V. M. Chikova (3) on the age composition of the catches of khramulya for the past years, beginning in 1956.

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I. T. Negonovskaya, a scientific worker of the Sevan hydrobiological station, studied the Sevan khramulya in 1964 and has kindly permitted us to use her findings.

The data were collected during the mass fishing period (May - July) as well as during the post-spawning period in September. More than 4,000 fish from foraging, as well as spawning stocks, were submitted to a biological analysis. During the study of the various stages of sexual products of the females we used a scale similar to that suggested by I.T. Negonovskaya. (The only difference is in the grade markings on the scale characterizing the same stages of the sexual cycle.

A short explanation of the different stages of maturity together with the appropriate markings is outlined below. The markings of the same stages used by I. T. Negonovskaya are shown in brackets.

There are no juvenile fish (I) among those which have reached commercial size. At stage II (II) the ovaries look like grey or light grey semi-transparent strands. The ovicells are not visible to the naked eye. At stages II-III (III) the ovaries are grey and semi-transparent as before, but they are larger in size and their granular structure is visible to the naked eye. At stage III (III-IVa) the ovaries are grey and yellow-grey, non-transparent and still larger in size. The ovicells are clearly visible. At stage III-IV (III-IVb) the ovaries are light-yellow or yellow and matt. The ovicells are large but have not yet reached their ultimate size. At stage IV - V (not identified by Negonovskaya) the ovicells did not yet ovulate. When the abdomen of the female is squeezed a few eggs drip from the anal opening. At stage V (V) the ovicells have ovulated; a slight pressure on the abdomen of the female forces out the eggs. Stage VI - egg laying.

Some males become sexually mature when they are three years old (some even during their third year), whereas the females will not mature before they are six years old. There is little difference in the growth rate of both sexes (1,2).

Khramulya which has reached 17 to 18 centimeters is fished with seine nets. In spring, sometimes even in very early summer, during the foraging period sexually mature and immature khramulya of various sizes are caught in the same seine-nets. As their gonads mature the sexually mature specimens move towards the spawning grounds. The spawning period of khramulya is extended: it starts at the beginning of June (and sometimes even at the end of May) and lasts until the end of July. While the sexually mature khramulya moves towards the spawning grounds and begins spawning, the specimens with gonads at the stages of maturity III, III - IV and IV stay in the foraging areas and feed intensively.

In 1965 the spawning of khramulya began during the first days of June: all females caught in two days with seine-nets near the Tsakkar<sup>x/</sup> river had reached stage IV of sexual development, 11% of the males were milters. Hardly any sexually immature fish were caught. In the river itself both ripe and laying females were caught. At the same time at the near-by feeding grounds (avlakhi Kuru-Kharaba near Eranos, etc.) together with sexually immature fish some large females with gonads at the 149 maturity stages III, III-IV and at early stage IV were caught in the seine-nets.

In order to examine the foraging stock from May 10th until June 5th, 1965 the condition of the sexual products of 1,331 females were analyzed. The specimens were taken partly from nets set in the open lake, but primarily from seine-nets used for fishing in the khramulya feeding grounds.

x/ The spawning runs into the Tsakkar river occur, as a rule, 10 - 15 days earlier than into other rivers.

Table No.1 shows the size range of females of foraging khramulya according to their stages of maturity during the period when the mature females move towards the spawning grounds.

Knowing the composition of the spawning stock during its passing into the principal spawning rivers, Argichi and Vardenis (Table 2), we can assume from Table No.1 that the females in the foraging stock in May and early June which have reached stages III, III-IV and IV of maturity, will become fully mature during the same year. The smallest size of these females (27 cm) corresponds to the minimal size of the spawning khramulya. The difference in the average sizes in the identified stages of maturity is probably due to the fact that large fish mature faster. This assumption is confirmed by the observations on the size range of the khramulya which enters the rivers for spawning. Thus, in 1965, at the beginning of the spawning run (June 18th) the average size of the female khramulya in the Argichi river was 36.3 cm, whereas towards the end of the run (July 15th) it was 33.7 cm. Their size range is shown in Fig.1.

Further examination of table No.1 shows that there are practically no specimens of the older age-group among the fish whose sexual products indicate that they will not spawn that same year. Out of 1,100 females only one (less than 0.1%) was 43 cm long (not shown in the table). With the exception of the above specimen, the maximum size of the females at stage II of maturity did not exceed 34.5 cm and at stage II-III their size did not exceed 37 cm.

We studied females of a similar size range at stages II and II-III of maturity in the foraging stock early in the summer of 1966. 622 specimens were examined and in this case there were no exceptions.

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Table I.

Size composition of female khramulya from the foraging areas, classified according to the stages of maturity of their sex products (in %).

Stages of maturity	S i z e G r o u p s																								Average Size, cm						
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40		41	42	43	44		
II	0,2	-	I,1	2,4	5,9	10,6	13,8	14,9	13,8	12,5	9,7	4,6	2,9	2,7	2,1	1,2	0,7	0,6	0,1											24,4	991
II-III						2,8	0,9	1,8	5,5	8,3	7,3	11,0	9,2	3,7	17,4	11,0	7,3	3,7	4,6	3,7	1,8								28,4	109	
III												1,4	2,8	8,5	5,6	15,5	15,5	12,7	14,1	12,7	7,0	1,4	2,8					33,2	71		
III-IV												1,0	-	-	1,1	3,2	5,3	12,6	16,8	18,9	14,7	11,6	6,3	3,2	1,1	2,1	1,1	1,0	35,7	95	
IV															1,5	3,1	1,5	1,6	1,6	9,4	20,3	15,6	17,2	14,1	9,4	4,7		36,4	64		
IV-V																													100,0		

Table 2.

Size composition of female khramulya in the main spawning rivers in 1965.

River	S i z e G r o u p s																	Average size, cm
	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	
Argichi	$\frac{1}{0,1}$	$\frac{5}{0,4}$	$\frac{4}{0,3}$	$\frac{12}{1,1}$	$\frac{33}{3,3}$	$\frac{75}{6,9}$	$\frac{128}{11,8}$	$\frac{125}{11,5}$	$\frac{169}{15,5}$	$\frac{206}{18,9}$	$\frac{155}{14,2}$	$\frac{72}{6,6}$	$\frac{43}{3,9}$	$\frac{42}{3,8}$	$\frac{11}{1,0}$	$\frac{8}{0,7}$	$\frac{1089}{100}$	35,9
Vardenis	$\frac{1}{0,2}$	$\frac{11}{2,0}$	$\frac{9}{1,6}$	$\frac{12}{2,2}$	$\frac{46}{8,4}$	$\frac{90}{16,5}$	$\frac{82}{15,0}$	$\frac{60}{11,0}$	$\frac{49}{9,0}$	$\frac{84}{15,4}$	$\frac{60}{11,0}$	$\frac{22}{4,0}$	$\frac{8}{1,5}$	$\frac{7}{1,3}$	$\frac{3}{0,5}$	$\frac{2}{0,4}$	$\frac{546}{100}$	34,6

Note: In the fractions the numerator represents number of specimens, the denominator - %.



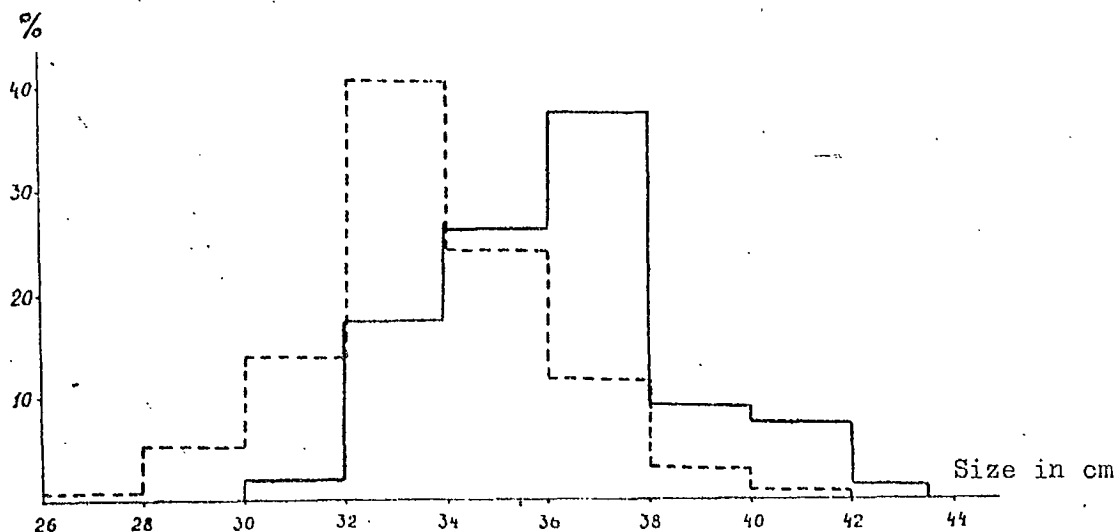


Fig.1 Size composition of female khramulya at the beginning and at the end of the spawning run into the Argichi river (1965).

June 18

July 15

It should be noted that at the beginning of September after the end of that spawning period, we found many large females with gonads which we classified as being at stages II and II-III of maturity. It eventually became evident, however, that the sexual products of these khramulya were at the post-spawning stages VI (II) and VI (II-III).

According to I. T. Negonovskaya, who studied the September con-  
 dition of gonads in histological sections, the resorption process of the  
 gonads of spawned-out females is already so advanced in the month of  
 September, that the external signs of spawning are undiscernible.

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The above findings permit us to assume that missed spawnings are extremely rare among the lake Sevan khramulya that have already spawned once.

In the spring of 1964 I. T. Neronovskaya has found in a pre-spawning stock of khramulya some females at stage II-III of maturity who bore traces of previous spawning. These specimens were from 32 to 35.5 cm long. I. T. Neronovskaya assumes that these specimens will not spawn during the current year. We believe, however, that the relatively young females (presumably nine or ten year old, according to their size) found by I. T. Neronovskaya do not skip any spawning: they merely mature slowly and manage to spawn at the end of the season.

The existence of this type of khramulya is confirmed by the data as shown in the supplementary maxima in the right hand part of the size range of females at stage II-III of maturity. A considerable number of these females do not reach sexual maturity, as is evident from Table 1.

Nevertheless, although a certain number of females with gonads at stages II-III of maturity will indeed reach maturity that same year, we shall consider them as immature, for the sake of simplicity. This kind of reasoning is unlikely to cause any significant error, since these females, even among the foraging fish, represent only 8% of the total. The relative number of these specimens in the entire stock is very small and the percentage of those who might become sexually mature is all the more negligible. If, on the other hand, we include fish at stage II-III of maturity with the size-range of immature females, we can end up with an overstated maximum size estimate of first maturity.

If we compare the size ranges of immature females (stages II and II-III) and those of the mature females (spawning)(Fig.2), we can see that when they have reached 27 cm in length some of the females become mature while all become mature after they reach 37 cm. In other

words, females reach their first maturity between 27 and 37 cm in length. On the other hand, if the first maturity occurred, say, at 39 cm, specimens of 37.5, 38.0 or 38.5 cm. would be found in the immature stock. (Measurements were taken with a 0.5 cm accuracy).

In the spawning rivers the number of specimens larger than 37 cm., i. e. that mature for the first time, is quite large (18.7% in the Vardenis river and 30.2% in Argichi river). See Table 2. If we consider that the maximum size of females maturing for the first time can be less than 37 cm., these percentages would be still higher.

Our data show that the females larger than 37 cm. belong to three ages: ten, eleven and twelve years. We have practically never found females who have missed spawnings after having once spawned. The females of the khramulya spawn annually and many times but the fishing in the spawning rivers by blasting near the estuary prevents their penetration (at least that of the females) into the river spawning grounds and their post-spawning return to the lake. The conservation of repeatedly spawning specimens is possible under these conditions only in the absence of stocks which spawn exclusively in the rivers.

The lake spawning grounds of khramulya are situated near the spawning rivers, in the pre-estuarine areas. Obviously, each river and its pre-estuarine area is used as a spawning ground by one stock: one part of this stock moves into the river and the other part stays in the adjoining lake area. The khramulya which has already spawned in the lake (where the fishing is not as intensive as in the river proper), can enter the river in the following year. This explains why, notwithstanding the

fishery which practically eliminates the possibility of a second spawning in the rivers, such a spawning does take place and to quite a large extent.

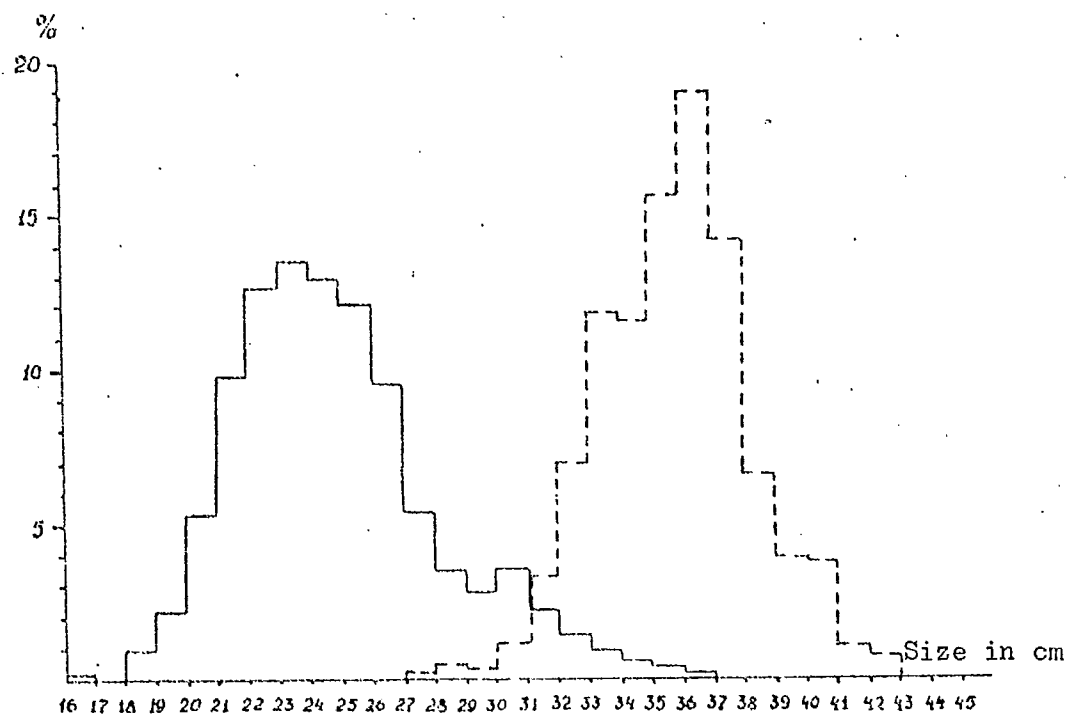


Fig. 2 Size composition of sexually mature and immature khramulya in Argichi river (stages II and II-III of maturity in the foraging stock) in 1965.

----- sexually mature      \_\_\_\_\_ sexually immature

If we superimpose the diagrams (Fig.2) of the immature and the mature (spawning) females of the khramulya, we immediately notice the small amount of overlapping. A similar distribution of the sizes of the females was found in the general catches (rated by area and fishing tools) (Fig.3).

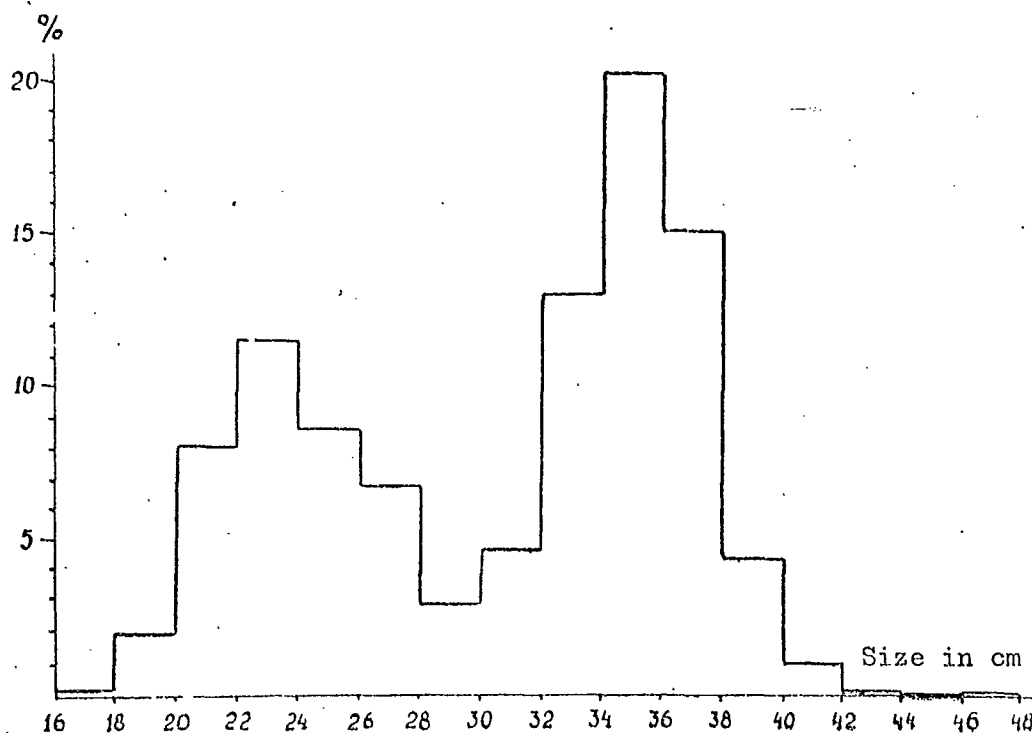


Fig.3 Size composition of female khramulya in general catches (1965).

It can be seen in Fig.3, that there are two apexes in the size range of the females that were caught, one represents the immature fish, the other those fish that were caught when breeding. We believe that these two peaks are explained by the fact that the khramulya females which were earlier fished during their annual foraging expeditions, now form commercial stocks after they mature and move into the spawning grounds. Either way the presence of a very pronounced valley between the two apexes in the size range of the khramulya females in the general annual catches, permits us to estimate the ratio between the mature and the immature members of a commercial stock. If we assume that all females longer than

30 cm are sexually mature, we can obtain their overall proportion in the commercial stock. Thus, during 1963-1965 it was an average of 63% (59.5 - 68%).

According to the data of the histological analysis made by I. T. Neronovskaya in April 1964, the proportion of females preparing for spawning that same year was about 60% of the fished khramulya population (according to our figures - 61.4%). Thus, our method of obtaining approximate data on the ratio between the mature and the immature khramulya in a commercial stock, is quite adequate and convenient, since it does not require any special labour-consuming research. 155

The presence of mixed lake and river spawning stocks and several other reasons make it difficult to explain the ratio between the lake and the river reproduction of the khramulya. Nevertheless, some approximate data on this subject can be obtained. As previously, the analysis is carried out using females.

Using data, accumulated over several years, on the age-composition of catches from the lake and its rivers, we study a given year-class beginning with its entrance into commercial fishery and until it has been completely fished out. Having thus established the abundance of a particular year-class through annual large-scale surveys, we determine the average ratio of the sexes of khramulya during the period under study. The abundance of females in that year-class is established using the average ratio of the sexes. Since, according to our data, the mature females make up every year 63% of the total number of fish caught, we determine the number of sexually mature females in this particular year-class.

With our multi-annual data on the age composition of catches from the main spawning rivers, we determine, using the same process, the number of females of a given year-class caught in these rivers.

The resulting data enable us to determine the ratio of sexually mature females caught in lake and river spawning grounds.

During the present study we have analyzed the catches of 1956 - 1967. During these years four year-classes of khramulya born during (1952 - 1955) went into commercial fishery and were entirely (or almost entirely) fished out. The abundance of these year-classes was 893, 946, 986 and 843 thousand individuals respectively. The number of sexually mature females caught in the lake with its tributaries was 281, 298, 299 and 255 thousand respectively. In the main spawning tributaries 65, 54, 62 and 56 thousand individuals, i.e. 23.1%, 8.1%, 20.7% and 22% (an average of 21%) of the total catch.

It should be noted that the number of females spawning in the rivers is understated here because the number of specimens caught in secondary river spawning grounds and in the approaches to these small rivers was not taken into account.

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On the basis of her histological analysis of pre-spawning and post-spawning khramulya stocks I. T. Neronovskaya established that the number of females preparing for repeated spawning represents 43% - 45% of the total number of mature females. Considering the fishing methods in the spawning rivers, which practically exclude the post-spawning return, we must assume that the khramulya, which survives for a repeated spawning, belongs to the lake-spawning group. If we consider that the remaining

khramulya which reproduces in the lake represents more than 40% of the whole sexually mature stock, we can conclude that the total amount of lake spawnings is quite substantial. In our opinion, three quarters of all the lake Sevan khramulya spawns in the lake spawning grounds.

In summation, we can draw the following conclusions.

1. The females of the Sevan khramulya reach their first maturity when they are about 30 cm long. Sexually mature khramulya smaller than 27 cm were not found in the lake.

2. Females, whose sexual products before spawning (late May - early June) have reached stage III of maturity, can be considered sexually mature, since no specimens smaller than 27 cm are found among them.

3. Among the females preparing for spawning the larger specimens mature faster.

4. According to our data, there were no missed spawnings in the female khramulyas, they occur only in exceptional cases.

5. Strictly speaking there are no river-spawning stocks of khramulya, but it appears that there are stocks of which one part enters the rivers to spawn, while the other part spawns in the pre-estuarine areas of the lake. The females, that have spawned in the pre-estuarine area of the lake, may enter the river for their next spawning.

6. Approximate estimates show that the number of mature females in a commercial stock varies from 60% to 68% (according to the 1963 - 1965 data).

7. The proportion of khramulya which spawns in the main river spawning grounds is around 20% of the total number of spawners (not including those caught in the lake at the small rivers approaches). Concurrently, the khramulya which spawned in the lake and survived for a repeated spawning, represents more than 40% of the total mature stock. 157



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