

## THE GROWTH AND CONDITION OF COMMON CARPS (*Cyprinus carpio*) INTRODUCED INTO CROATIAN VRANSKO LAKE

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### Summary

In the late forties the freshwater Mediterranean Vransko lake was stocked with common carps (97,5% mirror ones of farm origin and 2,5% scaled onse of river origin). The 122 carps (52 females and 70 males) from that lake were collected for this research in 1979 and 1982. The 120 were scaled and only two lined, all being between 2+ and 11+. The condition coefficients (K) varied between 1,15 and 1,40 and the standard length — maximum height ratio was  $3,01 \pm 0,19$ . The correlation between standard and total lengths can be expressed by the following formula:

$$SL = 8,274 + 0,845 TL \text{ (p, < 01)}$$

Length — mass relationship was determined to be:

$$\log W = -4,738 + 2,94 \log L \text{ (p, < 01)}$$

All these parameters show that common carps in Vransko lake transformed and stabilized themselves into the wild form. Compared to other wild stocks and not any more to the cultured carps, they adapt well to the lake environment, their growth and condition being fair good. However, the question of whether they should have been introduced into this lake at all remains open.

*Key words: common carp, fish introductions, Vransko lake, Croatia, length — mass relationship, condition coefficeint, length — height ratio*

### INTRODUCTION

One of the ichthyological questions where many opinions take quite opposite sides is the introduction of the new fish species. More qualitative ecological conscience prevailed upon the non-introduction, but possible economic and

some other reasons still vote for fish introduction. This procedure at higher and more organized level started in 19<sup>th</sup> century, when it was believed that fish introductions could significantly improve fisheries, i. e. in the Great Lakes (Hebert 1991). There are very few fish species whose introductions are considered beneficial, as common carp (*Cyprinus carpio*), perch-pike (*Stizostedion lucioperca*), rainbow trout (*Oncorhynchus mykiss*) as well as some coregonids and Chinese herbivorous carps in Europe (Holčík 1991). Even that depended on the region because the introduction of carps in North America was generally considered to have been unfortunate (Jhingran & Natarajan 1976). Tilapias could be mentioned as the successful example of the circumtropic introductions which led Fernando (1991) to the conclusion that severe damages could be expected when only piscivores were used. However, the diseases can also make serious threats and only an effective quarantine will ensure their exclusion.

Table 1. The stocking of common carp (*Cyprinus carpio*) into the Vransko lake. Wilde carps from river Drava were scaled, all other were cultured and mirror.

Tablica 1. Nasađivanje šarana (*Cyprinus carpio*) u Vransko jezero. Divlji šarani iz rijeke Drave bili su ljuskavi, a svi ostali ribnjačarski i maloljuskavi

Date of stocking	Number of individuals	Mean mass (g)	Age	Origin
	100 000	25	1 year	Končanica fishfarm
April 1948	30	3 000	broodstock (10 females + 20 males)	Končanica fishfarm
	93 000	20	1 year	Poljana fishfarm
November 1948	20 000	150	—	River Drava at Bijelo Brdo
	83 700	75	1 year	Končanica fishfarm
December 1949.	60 000	40	1 year	Končanica fishfarm
March 1950	460 000	50	1 year	Končanica fishfarm

Following the idea of improving the fisheries in the fresh-water Mediterranean Vransko lake in southern Croatia, just a mile from the Adriatic sea, the common carps were stocked several times in the late forties. There is a bunch of papers that take into consideration such an introduction. Its results and problems which occurred later are described in two most comprehensive papers by Morović (1964) and Treer (1989). In her paper, Habeković (1973) summarized all the carps introduced (Table 1). It is evident that 97,5% of these carps were mirror carps of the fish-farm origin and the rest were scaled ones, from the river Drava, both groups coming from north Croatia. By

these interventions the common carps were moved from their native Danube basin (Holčík 1991, Balon 1994) to the Adriatic river — drainage, or Dalmatia division, which being the most distinguished one of all the Euro-Mediterranean subregions, has five endemic genera and many endemic species (Economidis & Banarescu 1991). However, the most numerous fishes in Vransko lake prior to stocking were eels (*Anguilla anguilla*) and grey mullets (*Mugil cephalus*) (Morović 1964).

Thorough research on inhabitation of the new L-lake in South Carolina, during the first three years of impoundment Paller et al. (1992) concluded that the habitat requirements controlled the fish communities at the beginning and the interspecific interactions later on. The importance of the ecological requirements in the relation to the habitat being colonized as the biggest one for an organism's success as a colonist is also stressed by Parsons (1987). Other influences, as the position of the species on the r-K continuum or the priority effects seem to be less important, although stressed by some authors (Robinson & Dickerson 1987, Robinson & Edgemon 1988). All these have also been confirmed for Vransko lake, where common carps established a significant and stabile population. The other question is how this wild surrounding influenced the development and morphological structure of these mostly farm originated fish which in fact this paper tries to describe.

## MATERIALS AND METHODS

The 122 common carps from Vransko lake were caught by nets and electro-fishing gear in April and August 1979, as well as in May, July and December 1982. All the measures were taken immediately on spot — total and standard length, height, mass and sexes. In order to determine age, the scales from above the lateral line, below anterior part of the dorsal fin, were checked later in the laboratory. The usual parameters (i. g. Talaat & Olah 1986, Blühdorn & Arthington 1990) were dealt with — condition coefficient (K), length — mass relationship, height — length ratio and the ratio of the total and standard lengths. Age and sex structure, changes in length and mass and their annual increments, as well as length frequencies are also presented.

The Vransko lake and its ecology are thoroughly described elsewhere (Treer 1988).

## RESULTS AND DISCUSSION

Out of 122 specimens caught, 52 were females (43%) and 70 were males (57%), which is not far from an equal relationship. Part of this difference can probably be explained by the changes of behaviour regarding sexes in relation to their catchability (Blühdorn & Arthington 1990).

Table 2. Age structure, total length, mass and condition coefficient (K) of the common carps used for the study. Numerator represents mean value and denominator range

Tablica 2. Dob, totalna dužina, masa i indeks uhranjenosti (K) istraženih šarana. Brojnik označuje srednju vrijednost, a nazivnik raspon

Age	n	TL (mm)	W (g)	K
2+	1	175	70	1,31
3+	18	264	242	1,32
		240-275	182-284	
4+	39	293	332	1,32
		265-325	240-454	
5+	41	346	549	1,32
		280-380	320-750	
6+	8	384	777	1,37
		375-395	690-880	
7+	6	411	936	1,35
		400-430	867-1050	
8+	4	459	1355	1,40
		440-470	1140-1500	
9+	3	523	1823	1,27
		500-540	1665-2000	
11+	2	710	4125	1,15
		700-720	4100-4150	

Other important measures of the carps caught, including K, are presented in table 2. The condition coefficient calculated on the base of total length, differed between 1,15 in the oldest group 11+ and 1,40 in carp group 8+. In other age groups K varied between 1,27 and 1,37. These values are somewhat lower than those found by Habeković (1973) in investigation done during 1961 to 1963. More than ten years passed then from the last stocking of the carps and K was somewhat between 1,24 and 1,46. Paralelly condition coefficient of the cultured carps from the fish-farm Končanica, which was the origin of most of the carps introduced to the lake was 2,39 — 2,61. The change of habitat, lack of care and artificial feeding very soon drastically reduced K and it seems that this process has slowly been going on since. Although condition coefficients have to be used carefully (Cone 1989), these values, if compared to those for wild common carps as 1,48 — 1,51 (Steffens 1964) and 1,31 — 1,43 (Unterüberbacher 1963) show that Vransko lake is quite suitable environment for the growth of common carps. As, during the last decade Prussian carp (*Carassius auratus gibelio*) took an important role in lake ichthyofauna (Treer 1989) the values of K could become worse. Holčík (1980) stated that populations of Prussian carp along the lower and middle Danube decreased the common carp's populations, while Paller et

al. (1992) found out reductions in mean K and ascribed it to fish species competition.

Most of the carps caught belonged to the length groups from 260 — 360 mm, whose age was from 3+ to 5+ (Fig. 1). The maximum increase occurred, as usual, during the first three years, then slowed down (Fig. 2). However, that didn't happen gradually, like with carps from the Hungarian Körös waters (Talaat & Olah 1986), but varied between 7% and 18% till the ninth year of age. Hickley and Dexter (1979) constructed standard growth curves for four cyprinids using published data of the British Isles. They suggested that it was necessary to determine growth standards of fishes for each country. In that case comparing the growth in length of Vransko carps would be much easier. It is possible to make with their height — length ratio, as some other data already exist.

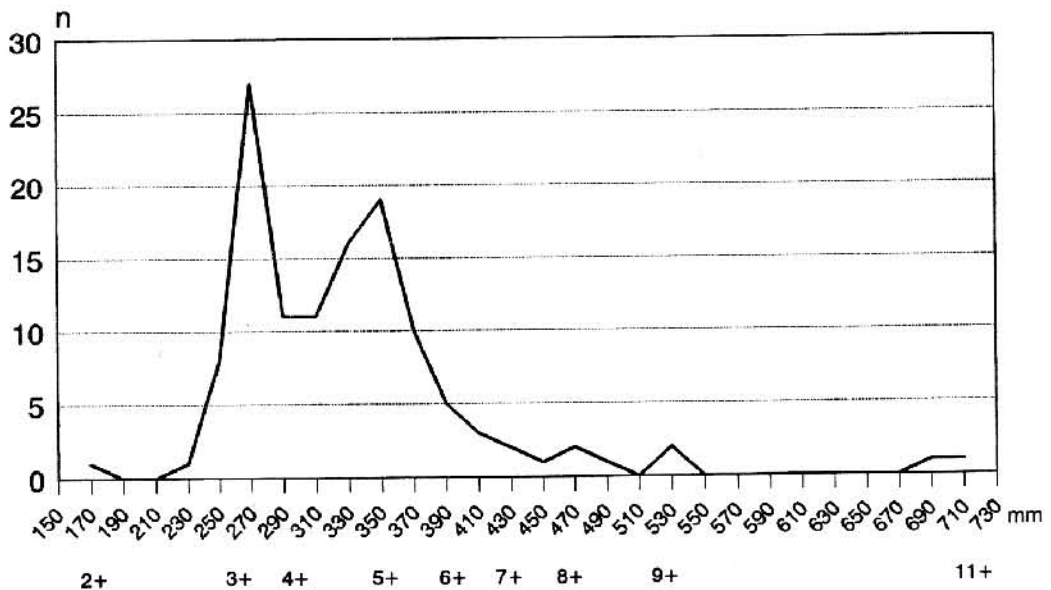


Fig. 1: Total length frequencies of investigated common carps. Each length represents mean of the 20 mm length class.

Slika 1. Frekvencija totalnih dužina istraženih šarana. Svaka dužina predstavlja sredinu 20-milimetarskoga dužinskog razreda

The ratio between standard length and maximum height of the carps investigated is  $3,01 \pm 0,19$ , or counted *vice versa* height — length ratio is  $0,332 \pm 0,021$ , both expressions of this index being used. The research of Habeković and Turk (1981) showed that this ratio on two farms from which common carps in Vransko originated, Končanica and Poljana, lays between 2,20 and 2,31. That shows how elongated carps in this lake became. That can be confirmed by Ankorion et al. (1992), who considered carps

with index lower than 0,365 very elongated. These authors also stressed how much this trait responds to environmental influences, and made quite a change for the carps of this lake. However, this length — height ratio corresponds to that of cultured Lužica carps, which is 3 (Turk 1982).

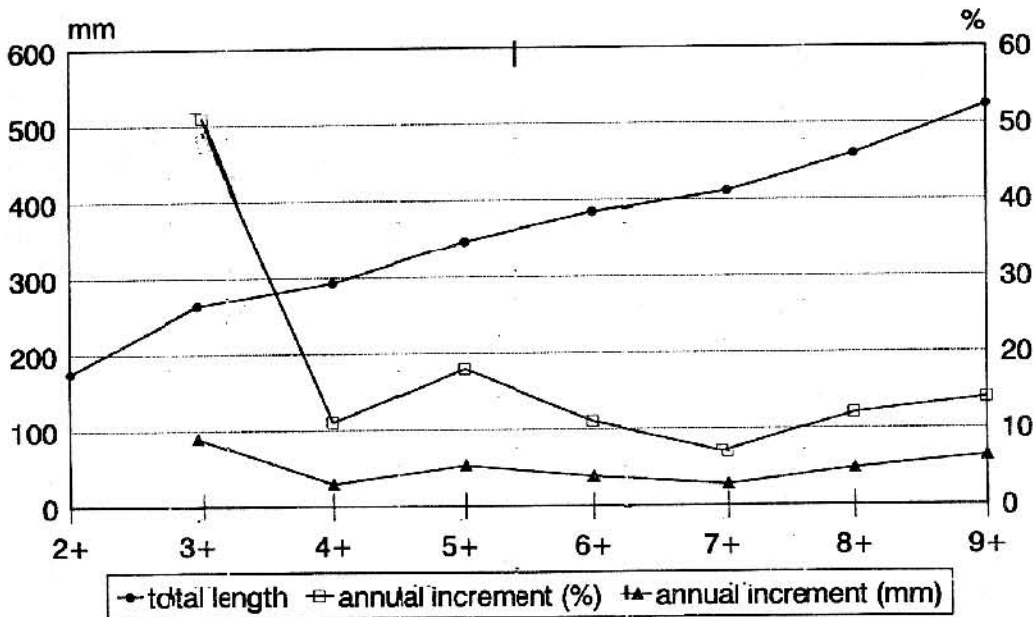


Fig. 2: Total length and annual increments in mm and %  
 Slika 2. Totalna dužina i godišnji prirast dužina u mm i %

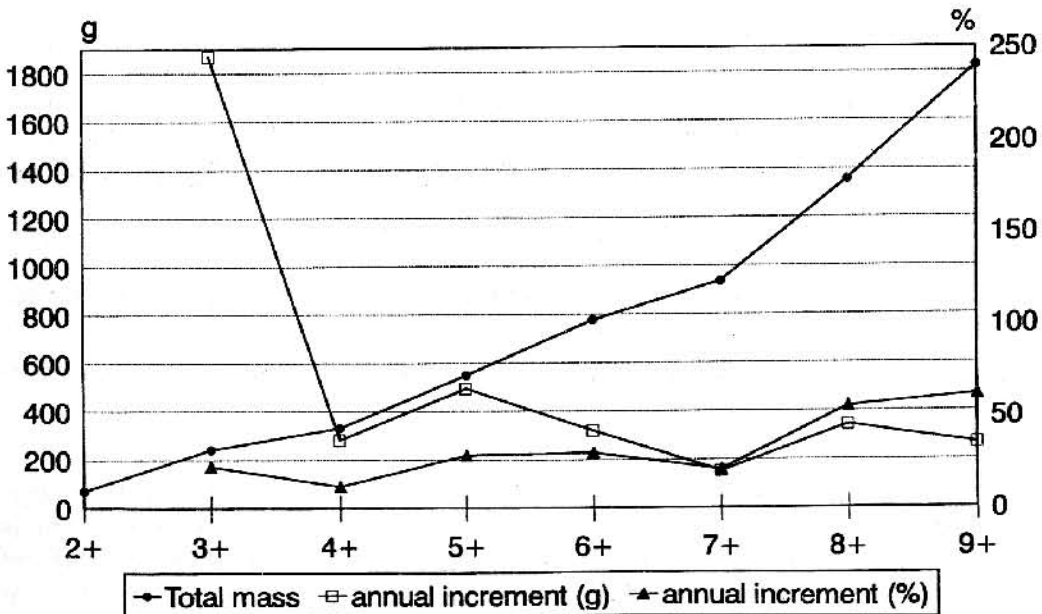


Fig. 3: Total mass and annual increment in g and %  
 Slika 3. Ukupna masa i godišnji prirast mase u g i %



As for height — length ratio, which can be presented in two different ways, the length of the fishes is mostly counted in only one way — total or standard and very rarely fork length. That sometimes causes difficulties in comparing the results. The authors of some of the papers try to overcome that by finding the correlation between these two traits, which happened to be quite high and significant (Treer et al. 1984, Blühdorn & Arthington 1990). The coefficient of correlation for investigated carpsin Vransko lake is  $r=0,989$  ( $p < 0,1$ ), and can be expressed by the following formula:  $SL = -8,274 + 0,845 TL$ .

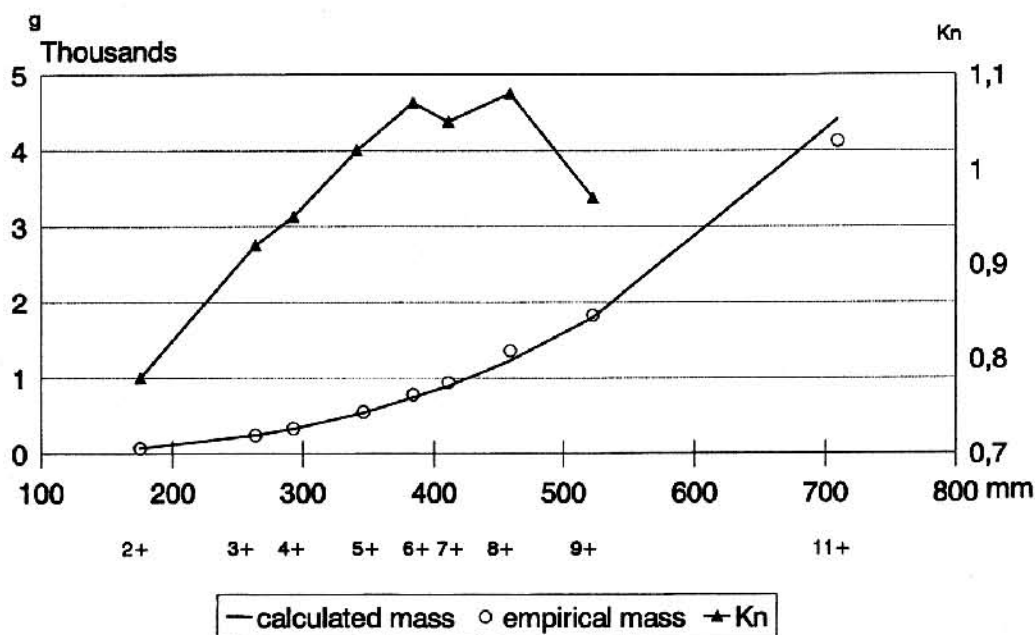


Fig. 4: Total length-mass relationship and  $Kn$  of common carp from Vransko lake.

Slika 4. Dužinsko-maseni odnos i relativna uhranjenost ( $Kn$ ) šarana iz Vranskog jezera

The relative growth in mass happened to be the highest up to the third year of age and later varied between 20% and 65% of the previous year's total mass (Fig. 3). That, to some extent corresponds to the carps from the Hungarian backwaters (Talaat & Olah 1986), although it seems that carps from Vransko lake grow more in mass. Their length — mass relationship is  $\log W = -4,738 + 2,94 \log L$  ( $r=0,999$ ;  $p < 0,01$ ), while the exponent of carps from Körös waters is only 2,82 (Fig. 4). The sample caught in Vransko lake fits all the attributes necessary for correct counting of length — mass relationship described by Blühdorn and Arthington (1990) — to be large enough, taken over the seasons and years, sexes and various life — stages are represented in known proportion. As for the lengths, the necessity

of standardized length — mass relationships for each country were stressed by Swingle and Shell (1971). They computed relative conditions (Kn) for different fresh-water fishes in Alabama. Compared to the scaled carps from rivers and impoundments in that American state, the growth of common carps from Vransko lake is very similar in mass for the same length. Their Kn is  $0,98 \pm 0,09$  for the whole population. The differences are expressed for several lengths (i. e. year) classes (Fig. 4). Up to the 4+ class (293 mm) Alabama common carps are somewhat heavier for the same length, but later on, to the 8+ class (459 mm) the situation is the opposite. At 9+ class (523 mm) both populations are almost the same (Kn = 0,97), while there are no data for Alabama carps longer then 660 mm.

Out of 122 investigated common carps, only 2 were lined and all the others scaled. It corresponds with the research of Habeković (1973) in 1961 — 1963 when 98% of the carps were scaled and 2% mirror, but shows that some N genes existed. As in the stocking process in late forties, 97,5% of the carps were mirror from the farm origin and only 2,5% were scaled and wild from the river Drava it is evident that scaled from was favoured by the nature in the process of this population's adaptation to the life in the wild. Unfortunately, it is impossible to judge how much of the existing population has traces from the farm origin. As no mirror carps were found in this research it is obvious that relatively small number of s gene can be present.

The scales, the change of length — height relationship towards the elongated form, condition coefficient, the growth in length and mass, as well as length — mass relationship show that common carps in Vransko lake transformed and stabilized themselves into wild form, like it has been happening in many other places in Europe and in the world (Ladiges & Vogt 1979). This fact lead some authors to the conclusion that common carps in Vransko lake grow very slowly and consequently are in bad condition and shape. From the farm point of view that seems to be the truth, but it shouldn't be forgotten that these carps are not farmed carps any more, although the fish-farm is the origin for the majority of stocked carps. At the moment of this research they had been living in wilderness for more than thirty years.

That is why the carps from Vransko lake should be compared with other wild stocks. These results show that they are well adapted to the lake and that their growth and condition are fairly good. The length — mass relationship is as the average one in Alabama, their related exponent is even better than of Körös carps from Hungary (whose condition is considered fairly good) and the length — height ratio even corresponds to some cultured carps. But, whether it was or was not necessary to introduce common carps to the Vransko lake, together with several other allochthonous species, is another question.



## Sažetak

# RAST I UHRANJENOST ŠARANA (*Cyprinus carpio*) UNEŠENIH U HRVATSKO VRANSKO JEZERO

Slatkovodno sredozemno Vransko jezero kraj Biograda n/m potkraj četrdesetih godina nasadeno je šaranima (97,5% maloljuskavih s ribnjaka i 2,5% ljuskavih iz rijeke Drave). Ovim su istraživanjem obuhvaćena 122 šarana (52 ženke i 70 mužjaka) ulovljena godine 1979. i 1982. Svi su u dobi od 2+ do 11+ godina, 120 među njima je ljuskavih, a dva su veleljuskava. To pokazuje veliku redukciju s gena, kao i prisutnost N gena. Indeks uhranjenosti (K) varira između 1,15 kod najstarije skupine 11+ i 1,40 kod šarana 8+, dok se kod ostalih dobnih skupina nalazi između 1,27 i 1,37. Indeks je visokoleđnosti  $3,01 \pm 0,19$ , a jaka korelacija ( $p < 0,1$ ) između standardnih i totalnih dužina tijela iznosi:  $SL = -8,274 + 0,845 TL$ .

Dužinsko-maseni odnos može se izraziti sljedećom formulom ( $p < 0,01$ ):  
 $\log W = -4,738 + 2,94 \log L$ .

Svi ovi pokazatelji upućuju na to da su se šarani u Vranskom jezeru transformirali i stabilizirali u svojem divljem obliku. U odnosu na ribnjačarske šarane koji su nasadeni u jezero, oblik i rast su im, naravno, slabiji, ali u usporedbi s drugim divljim populacijama pokazuju dobru adaptaciju na jezer-sku sredinu, te dobar rast i uhranjenost. No je li ih trebalo nasadivati u ovo jezero, drugo je pitanje.

*Ključne riječi:* šaran, poribljavanje, Vransko jezero, Hrvatska, dužinsko-maseni odnos, indeks uhranjenosti, indeks visokoleđnosti

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