Growth of Five Spirlin (*Alburnoides bipunctatus*) Populations from the Croatian Rivers

Tomislav TREER
Dobrila HABEKOVIĆ
Ivica ANIČIĆ
Roman SAFNER
Marina PIRIA

SUMMARY

Age, growth and mortality were analysed for spirlin (riffle minnow), *Alburnoides bipunctatus* that was collected from the five rivers in Croatia. Growth in length was very similar at all locations, so the average growth curve for this species in Croatia can be expressed as:

$Lt = 15.2\ (1\text{-}e^{-0,28(t+0,93)})$

A comparative growth index for the first five years of spirlin life was the lowest in the middle Korana river (98.0%) and the best in the middle part of the Dobra river (103.1%). All these indices are very close. The phi-primes also varied a little, resulting in the following average: $\phi' = 4.24 \pm 0,11$.

Weight expressed positive allometric growth at four locations (b-value ranging from 3.10 to 3.56) and negative at only one ($b = 2,80$). At the same location the total instantaneous mortality rate was the highest ($z = 1.14$), while at other locations it ranged from 0.77 to 0.93. Spirlin is evidently subjected to great predation. Consequently, these results can help in comparing different water habitats.

KEY WORDS

spirlin, riffle minnow, *Alburnoides,* growth, von Bertalanffy, Croatia

Department of Fisheries, Beekeeping and Special Zoology
Faculty of Agriculture University of Zagreb
Svetošimunska cesta 25, 10000 Zagreb, Croatia
e-mail: treer@agr.hr

Received: March 16, 2000

Rast pet populacija dvoprugaste uklije (*Alburnoides bipunctatus*) iz hrvatskih rijeka

Tomislav TREER
Dobrila HABEKOVIĆ
Ivica ANIČIĆ
Roman SAFNER
Marina PIRIA

SAŽETAK

Starost, rast i mortaliteti analizirani su kod riblje vrste dvoprugaste uklije, *Alburnoides bipunctatus*, iz pet hrvatskih rijeka. Dužinski tempo rasta je vrlo sličan na svim lokacijama, tako da se prosječna krivulja rasta ove vrste u Hrvatskoj može izraziti sljedećom formulom:

$Lt = 15,2\ (1-e^{-0,28(t+0,93)})$

Usporedni indeks rasta u prvih pet godina života dvoprugastih uklija bio je najmanji u središnjem toku Korane (98,0%), a najbolji u središnjem toku Dobre (103,1%). Svi ovi indeksi su vrlo bliski. Performanca rasta također malo varira, dajući prosječnu vrijednost od $\phi' = 4,24 \pm 0,11$.

Masa pokazuje pozitivan alometrijski rast na četiri lokacije (vrijednost b varira između 3,10 i 3,56), a negativan na jednoj ($b = 2,80$). U istoj rijeci je i smrtnost najveća ($z = 1,14$), dok se na drugim lokacijama nalazi u rasponu između 0,77 i 0,93. Dvoprugaste uklije su očito podložne velikoj predaciji. Posljedično, ovi rezultati mogu pomoći u uspoređivanju različitih vodenih biotopa.

KLJUČNE RIJEČI

dvoprugasta uklija, *Alburnoides,* rast, von Bertalanffy, Hrvatska

Zavod za ribarstvo, pčelarstvo i specijalnu zoologiju
Agronomski fakultet Sveučilišta u Zagrebu
Svetošimunska 25, 10000 Zagreb, Hrvatska
e-mail: treer@agr.hr

Primljeno: 16. ožujka 2000.

INTRODUCTION

Spirlin (riffle minnow), *Alburnoides bipunctatus* is a fish species spread over the central part of the European continent from the Atlantic coast of France to the Caspian lake and more to the east (Ladiges and Vogt, 1979). It inhabits both - running and stagnant waters - eats mainly small planktonic and benthic organisms as well as the insects falling from the air (Vuković and Ivanović, 1971). Thus, the parameters of its growth can significantly reflect upon the conditions of niche of this species and can be used as a comparison to different habitats. In cases when sufficient amount of data is accumulated it is possible to quantify them and create standard growth curves, as it was done, for example, for chub (*Leuciscus cephalus*), bream (*Abramis brama*), roach (*Rutilus rutilus*), dace (*Leuciscus leuciscus*) and pike (*Esox lucius*) in the British Isles (Hickley and Dexter, 1979; Hickley and Sutton, 1984), for redear sunfish (*Lepomis microlophus*) in the United States (Pope et al., 1995) or for chub in Croatia (Treer et al., 1997).

The spirlin populations reflect the changes in habitats (Jurajda et al., 1996). Water constructions can critically endanger this species (Lusk, 1995). There are several papers dealing with the growth of spirlin. (Bastl et al., 1975; Johal, 1979, Papadopol and Cristofor, 1980; Šorić and Ilić, 1985). In his extended investigation of this species Skora (1972) concluded that no great differences were found in comparison with the results of the works of other authors. So we used the data of five spirlin populations in Croatia in order to compare them with those results.

MATERIALS AND METHODS

Data on spirlin growth were collected from five locations. The habitats cover north-western part of the country and belong to the Danube river system. These habitats are thoroughly described in the data sources. The locations are the Bednja river (Habeković et al., 1983), middle section of the Dobra river (Habeković et al., 1988a), the Sava river at the Croatian-Slovenian border (Habeković et al., 1979; Treer et al., 1994) and the middle and lower sections of the Korana river (Habeković et al., 1988b). The conditions in these rivers are shown in table 1.

In every data source the age was determined by the number of year rings formed on the scales and the total length was presented as the mean sizes in different age groups. Mean mass and the number of specimens from the same age groups were also taken into account.

The von Bertalanffy growth curves, phi-primes, length-mass relationship and the instantaneous mortality rates were calculated according to Sparre and Venema (1992).

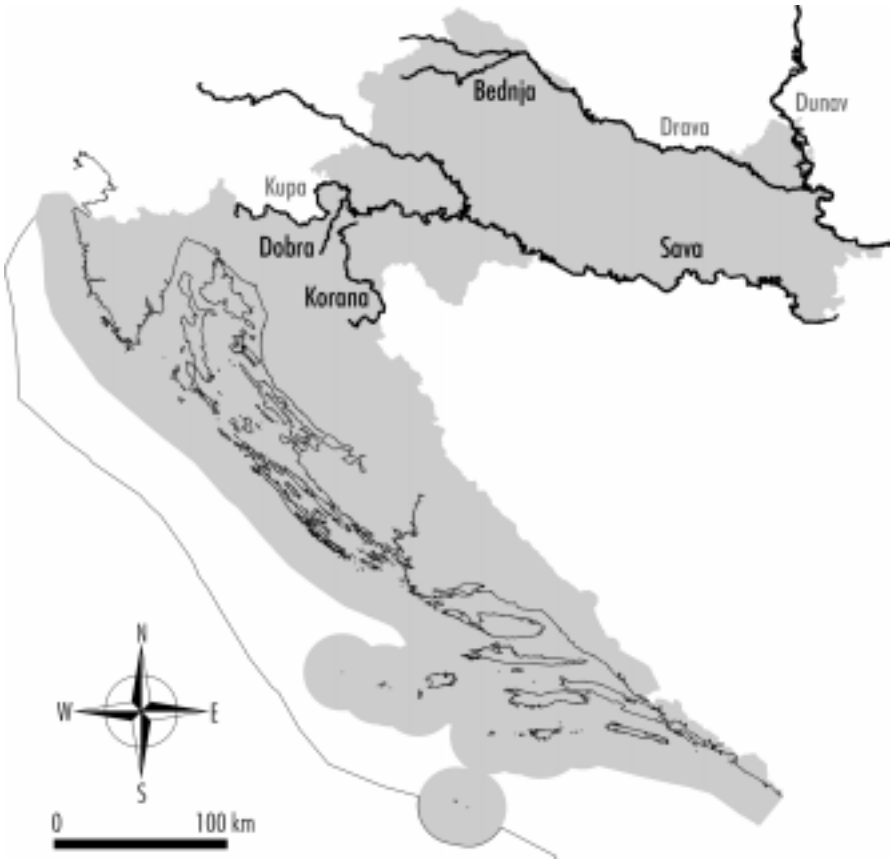

Figure 1. The locations of investigated rivers

Table 1. Some chemical and biological parameters from the investigated rivers: chemical oxygen demand (COD) in mg $KMnO_4 \cdot l^{-1}$, NH_4^+, NO_3^- and PO_4^{3-} in $mg \cdot l^{-1}$ and benthic invertebrates in $g \cdot m^{-2}$ (min-max)

	Dobra	Bednja	Korana middle	Korana lower	Sava at Slovenian border
COD	4,7-6,7	5,7-36,4	11,06	3,48-5,69	4,73-20,75
NH_4^+	0,06-0,07	0,12-1,47	0,14	0,06-0,43	0,01-2,18
NO_3^-	0,16-0,47	0,05-0,49	0,10	0,13-1,03	-
PO_4^{3-}	0,03-0,23	0,07-2,76	0,22	0,06-0,07	0,70-1,43
benthic invertebrates	5,10-16,09	3,34-45,56	0,65-8,11	1,80-14,41	2,58-38,89

The condition factor (CF) was calculated as: $CF = WL^{-3}10^2$, with weight (W) in grams and length (L) in centimetres. Mean condition factors for each population were estimated from the CF-values of the individual length classes.

Standard curve and growth indices were calculated according to Hickley and Dexter (1979).

The relationship between total length (TL) and standard length (SL) was calculated as TL = 1.239 SL (according to Johal, 1979).

RESULTS AND DISCUSSION

The investigated rivers, except in their position and climatic influence (Fig. 1), differ in their chemical and biological composition, as well (Table 1). The Sava and Bednja from the Pannonian valley have the biggest amount of organic matter shown through the highest COD values. They also have the highest values of NH_4^+ and PO_4^{3-}. That resulted in the biggest amounts of benthic invertebrates, too. The Dobra and lower Korana rivers, although flowing through the mountainous slopes still have significant quantities of benthic organisms, while the middle part of Korana river is the poorest in all investigated parameters.

The growth parameters of spirlin populations in Croatia are shown in table 2. The growth curves from five investigated habitats resulted in an average curve that can be expressed as:

$$Lt = 15.2\ (1\text{-}e^{-0.28(t+0.93)})$$

A comparative growth index, according to Hickley and Dexter (1979) for the first five years of spirlin life was the lowest in the middle Korana river (98.0%) and the upper Sava river (98.2%). The Bednja river expressed growth index of 100.9% and the lower part of the Korana river 101.1 %, which is almost the same as the standard one. Finally, the best growth was expressed in the middle part of the Dobra river (103.1%). All these indices are very close, so the curves are almost overlapping each other (Fig. 2). Therefore, their above mentioned average can be suggested as the standard growth curve of *A. bipunctatus* for Croatia, although as a result of only five populations. It can also be concluded

Table 2. Growth parameters for spirlin, *Alburnoides bipunctatus*, from five locations in Croatia: number of specimens (n), von Bertalanffy growth curve (L_∞, K, t_o), overall growth performance (ϕ'), length-weight relationship constants (a, b), condition factor (CF) and total instantaneous mortality rate (z)

	Dobra	Bednja	Korana middle	Korana lower	Sava
N	157	77	43	288	16
L_∞	20,5	15,5	15,1	17,7	11,5
K	0,16	0,33	0,28	0,19	0,59
t_o	-1,38	-0,42	-0,86	-1,47	-0,47
ϕ'	4,21	4,37	4,16	4,09	4,36
A	0,0059	0,0150	0,0088	0,0030	0,0044
B	3,2245	2,7970	3,1043	3,5567	3,4032
CF	0,97	0,97	1,11	1,01	1,06
Z	0,77	1,14	0,87	0,93	0,90

Table 3. Comparison of growth parameters for spirlin, *Alburnoides bipunctatus*, using total lengths, obtained from data from different rivers.

River	Asymptotic length in cm (L_8)	Curvature parameter (k)	Overall growth performance (ϕ')
Dunajec (Skora, 1972)	20,1	0,15	4,10
Turiec (Bastl et al., 1975)	15,6	0,28	4,22
Radimna (Papadopol & Cristofor, 1980)	14,4	0,30	4,13
Croatian average (this paper)	15,2	0,28	4,24

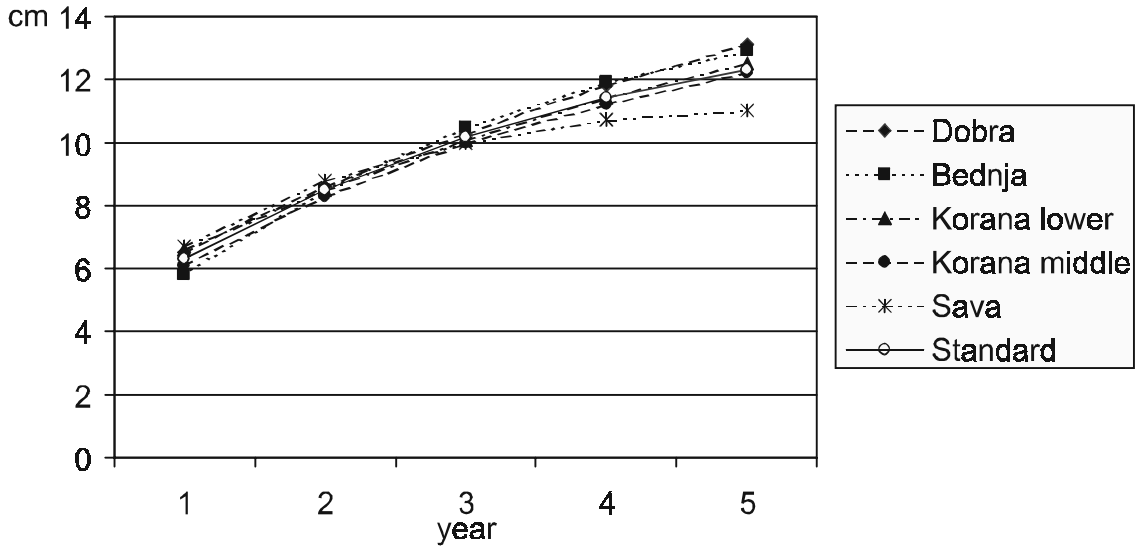

Figure 2. Von Bertalanffy's growth curves for spirlin in Croatian rivers

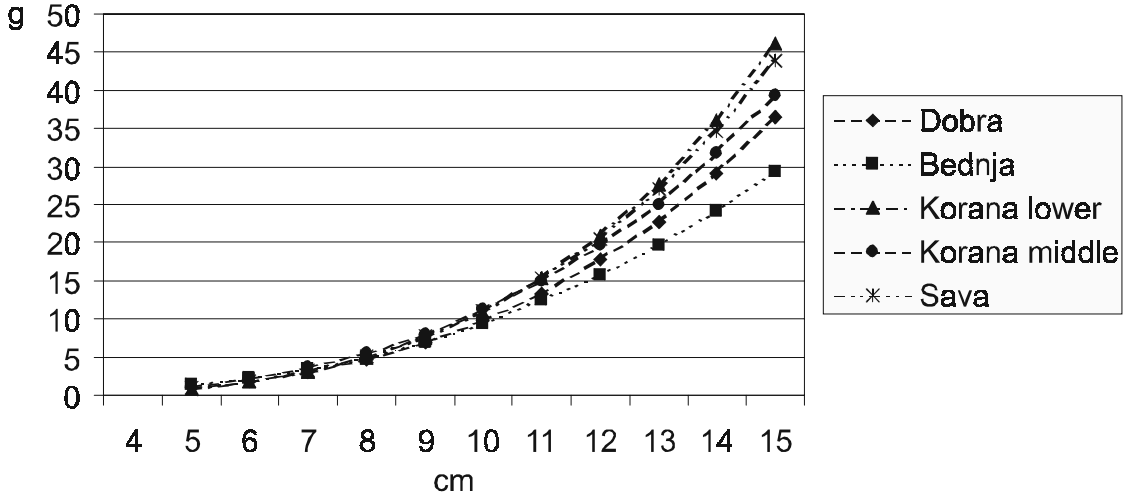

Figure 3. Length-weight relationships for the five spirlin populations in Croatian rivers.

that spirlin has very stabile growth in length in spite of the different habitats it inhabits, particularly during the first three years of their life. This confirms the conclusion of Skora (1972) that no great differences were found in comparison with the results of the works of other authors. Later on, growth differs more in different habitats.

The phi-prime of Croatian spirlin, *A. bipunctatus*, is $\phi' = 4{,}24 \pm 0{,}11$. This is almost identical (Table 3) as the phi-prime of spirlin from the river Turiec (Bastl et al., 1975) and very similar to those from the rivers Radimna (Papadopol and Cristofor, 1980) and Dunajec (Skora, 1972). These data confirm the reliability of spirlin growth curves, as the overall growth performance (ϕ') has minimum variance within the same species (Moreau et al., 1986). These values are also not very different from the phi-primes for the related genus *Alburnus*' species. According to the data of Točko (1975) it is calculated that for *A. albidus alborella* $\phi' = 4.59$ and according to Cakić (1982) for *A. alburnus* $\phi' = 4.52$. Other cyprinids have more different phi-primes, as roach (*Rutilus rutilus*), $\phi' = 5.23 \pm 0.03$ (Przybylski 1996), chub (*Leuciscus cephalus*), $\phi' = 5.69 \pm 0.14$ (Treer et al., 1997) and common carp (*Cyprinus carpio*) $\phi' = 6{,}88$ (Talaat & Olah 1986).

The parameters connected with the mass of fish, condition factor (CF) and b-value of length-weight relationship (Fig. 3) point out the spirlin population in the Bednja river. While other populations express positive allometric growth, this is the only one with the negative allometric growth (2.80). Total instantaneous mortality rate is also the highest in this river ($z = 1{,}14$). Supposedly the main reason for such a high mortality of spirlins in the Bednja river is predation. Dominant predators found in this river are pike (*Esox lucius*) and chub (Habeković et al., 1983). So high mortality rates are common for minnows in the waters of the Pannonian valley (Biro, 1990).

LITERATURE

Bastl I., Holčik J., Kirka A. (1975). Ichthyological investigation of the protected habitat of the Danubian *salmon (Hucho hucho* L.) on the river Turiec (Czechoslovakia) and suggestions for its management. Ac. Rer. Natur. Mus. Nat. Slov., Bratislava, 21: 191-224 (In Slovakian with English summary)

Biro P. (1990). Population structure, growth, P/B-ratio and egg-production of bleak (*Alburnus alburnus* L.) in lake Balaton. Aquacultura Hungarica, 6: 105-118

Cakić P. (1982). Growth of the bleaks (*Alburnus alburnus* L.) in the Velika Morava river. Ichthyologia, 15: 1-7

Habeković D., Debeljak Lj., Pažur K. (1988a). Kompleksno uređenje sliva Kupe. Knjiga 9.2 - Dobra. Fakultet poljoprivrednih znanosti, Zagreb, 140 pp

Habeković D., Debeljak Lj., Pažur K. (1988b). Kompleksno uređenje sliva Kupe. Knjiga 9.1 - Korana i Mrežnica. Fakultet poljoprivrednih znanosti, Zagreb, 175 pp

Habeković D., Homen Z., Fašaić K., Mavračić D., Popović J. (1979). Ekološko-floristično-faunistička istraživanja rijeke Save od Krškog do Podsuseda. B) Ihtiološka istraživanja. Fakultet poljoprivrednih znanosti, Zagreb, 67 pp

Habeković D., Mišetić S., Debeljak Lj., Marko S., Popović J., Fašaić K., Homen Z., Mavračić D. (1983). Ribarsko - gospodarska osnova područja zajednice SRD Varaždin. Fakultet poljoprivrednih znanosti, Zagreb, 216 pp

Hickley P., Dexter K. F. (1979). A Comparative Index for Quantifying Growth in Length of Fish. Fish. Mgmt., 10: 147-151

Hickley P., Sutton A. (1984). A Standard Growth Curve for Pike. Fish. Mgmt., 15: 29-30

Johal M. S. (1979). Notes on growth and systematics of *Alburnoides bipunctatus* (*Pisces, Cyprinidae*). Vest. čs. spol. zool., 43: 270-277

Jurajda P., Hohausova E., Prasek V., Dvorak M. (1996). Fishes of Polana Mountain Streams. Biologia, 51:173-178

Ladiges W., Vogt D. (1979). Die Su3wasserfische Europas. Paul Parey, Hamburg & Berlin, 299 pp

Lusk S., Halačka K., Luskova V. (1995). Influence of Small Hydroelectric Power Stations on Fish Communities in Streams. Živočišna Vyroba, 40:363-367

Moreau J., Bambino C., Pauly D. (1986). Indices of overall fish growth performance of 100 tilapia (*Cichlidae*) populations. In: Maclean J. L., Dizon L. B., Hosillos L. V. (ed): The first Asian fisheries forum. Asian Fisheries Society, Manila, pp 201-206

Papadopol M., Cristofor S. (1980). Recherches sur L'ecologie de deux populations de Spirlin, *Alburnoides b. bipunctatus* (Bloch), des eaux de la Roumanie (*Pisces, Cyprinidae*). Trov. Mus. Hist. nat. Grigore Antipa, 22: 483-493

Pope K. L., Brown M. L., Willis D. W. (1995). Proposed revision f the standard weight (Ws) equation for redear sunfish. Journal of Freshwater Ecology, 10:129-134

Przybylski M. (1996). Variation in fish growth characteristics along a river course. Hydrobiologia, 325: 39-46

Skora S. (1972). The cyprinid *Alburnus bipunctatus* Bloch from the basins of the rivers Upper San and Dunajec. Acta Hydrobiol., 14: 173-204

Sparre P., Venema S. C. (1992). Introduction to tropical fish stock assessment. FAO Risheries Technical Paper, 306/1 , 376 pp

Škorić V. M., Ilić K. R. (1985). Systematical and ecological characteristics of *Alburnoides bipunctatus* (Bloch) in some waters of Yugoslavia. Ichthyologia, 17: 47-58

Točko M. N. (1975). Growth of the bleak, *Alburnus albidus alborella* (Fillipi) from lake Globočica. Ichthyologia, 7: 79-84

Talaat K. M., Olah J. (1986). Fishery studies on *Cyprinus carpio* L. in Hungarian inland waters. Aquacultura Hungarica, 5:241-250

Treer T., Aničić I., Safner R., Habeković D. (1994). The biomass of the macroinvertebrates in periphyton of the river Sava. Ribarstvo, 52: 151-162

Treer T., Habeković D., Aničić I., Safner R., Kolak A. (1997). Standard growth curve for chub (Leuciscus cephalus L. 1758.) in Croatia. Ribarstvo, 55: 47-52

Vuković T., Ivanović B. (1971). Slatkovodne ribe Jugoslavije. Zemaljski muzej BIH, Sarajevo, 268 pp

---

acs65_22