

## Some meristic characteristics of hybrids between *Acipenser naccarii* and *Acipenser baerii*.

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### Summary

The aim of this study was to describe meristic characters of hybrid *Acipenser naccarii* x *A. baerii*, to be used as the basis for characterizing hybrid specimens in a complementary manner to as described for *A. naccarii* by Hernando et al. (1999). Thirty 2+ and 3+ year class individuals from the Region of Lombardy (Italy) were analysed for eight morphological variables (Soljan 1975; Holcick et al. 1989), and weight. Three indices, viz the relative position of barbels (CA), the ratio of snout width to length (FB) (Garrido-Ramos et al. 1997), and the Soljan index (Hernando et al. 1999), were used to characterize hybrids.

A descriptive analyses of variables, simple and multiple regression analysis, and principal components relationships, were calculated. The relationships between TI and the indices was described using a stepwise multiple regression analysis:  $TI = 33.32 - 0.26 CA + 10.49 FB + 74.45 SOLJ$  ( $F = 1.96$ ;  $Df = 3$ ).

### Introduction

The first generation of hybrids between *Acipenser naccarii* and *Acipenser baerii* was obtained in 1993 at the Azienda Agricola VIP (Orzinuovi, Brescia, Italy), and named "AL". These hybrids are now being used at several aquaculture facilities, and adapt well to intensive culture conditions. Because nothing is known about their meristics and morphometrics, a preliminary study on different age groups and both sexes was performed using 14 variables. The data bank developed will be of use to both scientists and practitioners for comparative studies of growth and sexual development.

### Materials and methods

Thirty 2+ and 3+ year class individuals from the Azienda Agricola VIP (Orzinuovi, Brescia, Lombardy, Italy) were analysed. Eight variables were measured (Fig. 1): total length (TI, in cm); standard length (SI, in cm); weight (W, in g); distance from snout to the base of the barbels (s-b, in mm); width of the snout at the barbels (lab, in mm); distance from the base of the barbels to the cartilaginous arch of mouth (b-mc, in mm); distance from the tip of snout to the cartilaginous arch of mouth (s-mc, in mm); length of the head (lh, in mm); anal scute series (AS); dorsal scute series (DS); left and right lateral scute series (LLS and RLS, respectively); left and right ventral scute series (LVS and RVS, respectively), and internal width of mouth (IWM, in mm).

In accordance with the nomenclature used by Soljan (1975) and Holcick et al. (1989), indices were defined in order to determine the relative position of the barbels ( $CA = b-mc - s-b$ ), the ratio of the length to the width of the snout ( $FB = s-mc : lab$ ) (Garrido-Ramos et al. 1997) and the ratio of mouth width to length of the snout, referred to as the Soljan index ( $SOLJ = s-mc : IWM$ ) (Hernando et

al. 1999).

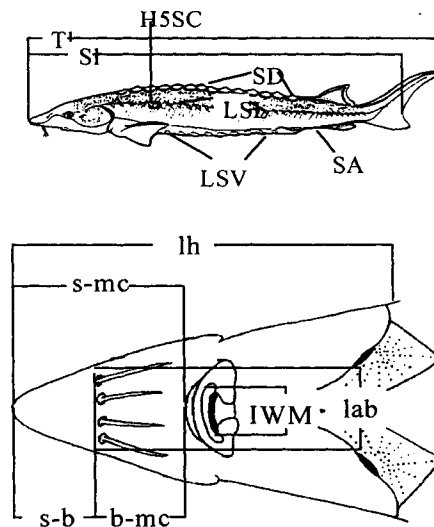


Fig 1.- Body and head morphometric characters on a schematic representation of an *Acipenser naccarii*, modified after Holcick et al (1989), used in this study. TI (Total length in cm), SI (standard length in cm), W (weight in grs.), s-b (distance from snout to the base of the barbels in mm), lab (width of the snout at the height of the barbels in mm), b-mc (distance from the base of the barbels to the cartilaginous arch of mouth in mm) s-mc (distance from the tip of snout to the cartilaginous arch of mouth in mm), lh (length of the head in mm), scute series: anal (AS), dorsal (DS), lateral (left LLS and right RLS), ventral (left LVS and right RVS) and IWM (internal width of mouth in mm)

Statistical analyses were carried out using STATGRAPHICS™ performing Multiple Comparisons, Simple Regression and Stewise Multiple Regression Analysis, and BMDP™ (Principal Components Analyses).

### Results and Discussion

A descriptive analysis of the variables was conducted by calculating averages, standard deviations and ranges. Once differences among variables had been demonstrated by multiple comparison to be due only to growth ( $Df: 31$ ;  $F = 1382.05$ ;  $p = 0$ ), a Principal Components Analysis (PCA) was performed to determine the trend of the variations in the morphometric variables. Of the total accumulated variance, 71.48 % was absorbed by analysis of its three components, distinguishing two wide groups (Fig 2A) (Table 1). The first one (LENGTHS) consists of all the morphometric variables related to the length of the individuals: TI, SI, AGE, lab, IWM, b- mc, s-mc, and s-b.

Thereby, the second one is composed of all the variables not related to the length. That is, the three indices and all the scutes series (INDICES & SCUTES). However, the second group is not homogeneous, being composed of two subgroups. The first is a subgroup made up of the scutes series and the second one of the CA and the SOLJ index, being separated by FB. This analysis shows the relationship between TI and the age of the exemplars, although independence of the index from the TI is also demonstrated.

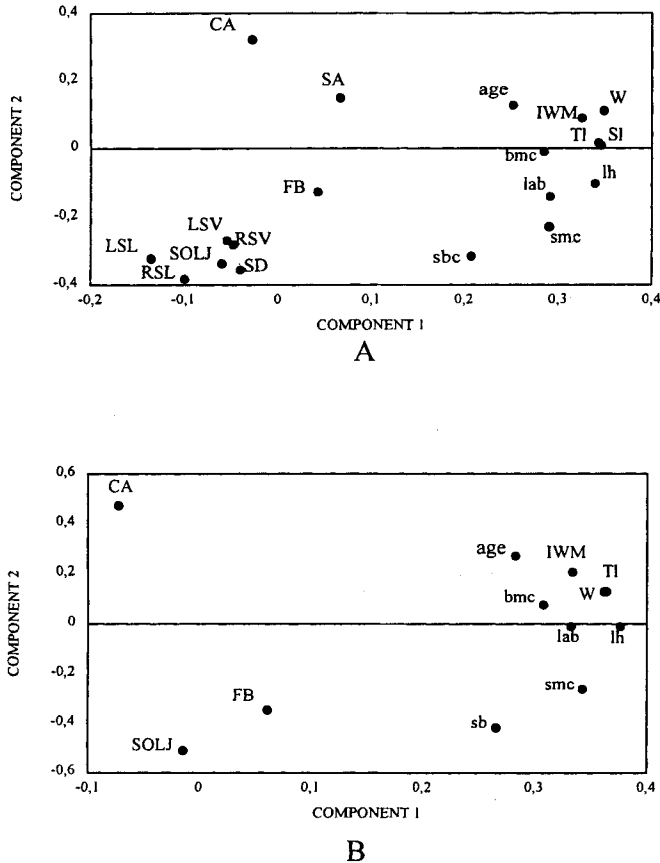


Fig. 2. A.- Plot weight of principal components of all variables. The first component is "LENGTHS" and second is "INDEX AND SCUTES". B.- Plot weight of principal components of variables without scutes series. The first component is "LENGTHS" and second is "INDEX". For identification of other Abbreviations see caption of Figure 1. 2.- Factor 1

In order to clarify the second group, a new PCA without the scute series was performed, to exclude its effect on the variance. In this case, 78.5 % of the variance was explained by the two components, showing two independent groups where, on the one hand, the new CA and SOLJ are closer and FB is more isolated, and on the other, the rest of the variables are grouped together with TI. (Fig 2B) (Table 2).

A model to explain the relationship between TI (dependent variable) and the indices (independent variables) was described using a stepwise multiple regression analysis giving the following polynomial:  $TI = 33.32 - 0.26 CA + 10.49 FB + 74.45 SOLJ$  ( $F = 1.96$ ;  $Df = 3$ ) showing that the fit was not significant. Thus, the indices are independent of TI.

Also, if the indices are compared against each other, they prove to be independent of each other (Table 3). Once the relationship between the variables and TI is described with PCA, linear models

are calculated using the TI as an independent variable and the rest as dependent (Table 4).

Table 1. Factor loadings (pattern) extracted by Principal Components Analysis (PCA) using all variables

Variable	LENGTH (Component 1)	INDEX & SCUTES (Component 2)
Age	0.2524	0.1253
AS	0.0676	0.1484
b-mc	0.2854	-0.0121
CA	-0.0266	0.3211
DS	-0.0392	-0.3578
FB	0.0436	-0.1291
IWM	0.3255	0.0874
lab	0.2919	-0.1424
hl	0.3395	-0.1056
LVS	-0.0534	-0.2710
LLS	-0.1340	-0.3242
RLS	-0.0982	-0.3846
RVS	-0.0465	-0.2839
s-b	0.2083	-0.3170
SI	0.3462	0.0065
s-mc	0.2908	-0.2291
SOLJ	-0.0586	-0.3389
TI	0.3490	0.1096
W	0.3434	0.0143

TI, Total length; SI, standard length; W, weight; s-b, distance from snout to the base of the barbels; lab, width of the snout at the height of the barbels; b-mc, distance from the base of the barbels to the cartilaginous arch of mouth; s-mc, distance from the tip of snout to the cartilaginous arch of mouth; hl, length of the head. Scute series: anal, AS; dorsal, DS; left, LLS; lateral right, RLS; ventral left, LVS; ventral right, RVS; IWM, internal width of mouth; CA = b-mc - s-b; FB = s-mc : lab; SOLJ = s-mc : IWM

Table 2. Factor loadings (pattern) extracted by Principal Components Analysis (PCA) using variables without scute series

Variable	LENGTHS (Component 1)	INDICES (Component 2)
Age	0.2831	0.2677
b-mc	0.3081	0.0747
CA	-0.0719	0.4726
FB	0.0612	-0.3462
IWM	0.3338	0.2044
lab	0.3323	-0.0122
hl	0.3766	-0.0129
s-b	0.2662	-0.4174
s-mc	0.3427	-0.2632
SOLJ	-0.0134	-0.5118
TI	0.3644	0.1263
W	0.3620	0.1264

TI, Total length; SI, standard length; W, weight; s-b, distance from snout to the base of the barbels; lab, width of the snout at the height of the barbels; b-mc, distance from the base of the barbels to the cartilaginous arch of mouth; s-mc, distance from the tip of snout to the cartilaginous arch of mouth; hl, length of the head; IWM, internal width of mouth; CA = b-mc - s-b; FB = s-mc : lab; SOLJ = s-mc : IWM

To compare TI to the weight, both variables were log transformed (base 10). The main relationships between the analysed morphometric variables, plus their dependence and relationship with TI, and the independence of the three calculated indices, was

demonstrated analysing all the data and considering the data by ages. Length in each year class (TI 2+ and TI 3+) was compared to the index at its respective ages (2+) or (3+). Table 5 shows that FB is the most stable index, with values between 1.25 and 1.81, whereas CA varied between -1.7 and 0.9 and SOLJ between 1.63 and 2.35.

Table 3.-  
Simple linear regression analysis between indices where a: Intercept; b: slope; r: correlation coefficient and p: level of significance

	a	b	r	p
Dependent variable CA				
Independent variables				
FB	21.03	-18.16	-0.402	0.0001
SOLJ	-34.82	55.7	0.492	0.0001
Dependent variable FB				
Independent variable SOLJ	1.97	-0.87	-0.346	0.0067

CA = b-mc - s-b; FB = s-mc : lab; SOLJ = s-mc : IWM; b-mc, distance from the base of the barbels to the cartilaginous arch of mouth; s-mc, distance from the tip of snout to the cartilaginous arch of mouth; s-b, distance from snout to the base of the barbels; lab, width of the snout at the height of the barbels; IWM, internal width of mouth

Table 4.-  
Simple linear regression analysis between TI and the remaining variables, where a: Intercept; b: slope; r: correlation coefficient and p: level of significance

Independent variable TI	a	b	r	p
Dependent variable				
log W	6.245	3.169	0.922	0
age	-0.907	0.038	0.754	0
b-mc	10.833	0.227	0.696	0
lab	17.476	0.393	0.743	0
hl	36.513	1.423	0.869	0
IWM	8.444	0.353	0.844	0
Sl	-2.807	0.829	0.987	0
s-b	18.02	0.263	0.459	0,0002
s-mc	30.42	0.52	0.683	0

TI, Total length; Sl, standard length; W, weight; s-b, distance from snout to the base of the barbels; lab, width of the snout at the height of the barbels; b-mc, distance from the base of the barbels to the cartilaginous arch of mouth; s-mc, distance from the tip of snout to the cartilaginous arch of mouth; hl, length of the head; IWM, internal width of mouth

Table 5-  
Simple linear regression analysis between TI (2+ and 3+) as independent variable and the CA, FB and SOLJ indices (dependent variables), where a: Intercept; b: slope; r: correlation coefficient and p: level of significance

Independent variable	Dependent variable.	a	b	r	p
TI (2+)	CA	13.98	-0.25	-0.29	0.119
	FB	1.05	0.005	0.27	0.1492
	SOLJ	0.607	-0.0007	-0.174	0.359
TI (3+)	CA	5.88	-0.11	-0.146	0.439
	FB	1.38	0.001	0.081	0.669
	SOLJ	0.6	-0.0007	-0.101	0.594

TI, Total length; CA = b-mc - s-b; FB = s-mc : lab; SOLJ = s-mc : IWM, where b-mc = distance from the base of the barbels to the cartilaginous arch of mouth; s-b = distance from snout to the base of the barbels; s-mc = distance from the tip of snout to the cartilaginous arch of mouth; lab = width of the snout at the height of the barbels; IWM = internal width of mouth

## References

- Garrido-Ramos, M.A.; Soriguer, M.C.; de la Herranz, R.; Jamilena, M.; Ruiz Rejon, C.; Domezain, A.; Hernando, J.A.; Ruiz Rejon, M., 1997: Morphometric and genetic analysis as proof for the existence of two sturgeon species in the Guadalquivir River. *Marine Biology* 129: 33 - 39
- Hernando J.A.; Arlati, G.; Domezain, A.; Soriguer, M.C.; Poliakova, L.A.; Domezain, J.; Vallespin, C.; Bravo, R., 1999: Morphometric study of *Acipenser naccarii* Bonaparte, 1836, in fish farm individuals. *J. Appl. Ichthyol.* **This issue.**
- Holcik, J.; Banarescu, P.; Evans., D.E., 1989: *A general introduction to fishes.* In: *The freshwater fishes of Europe* Vol 1/II.. Ed. J. Holcik, J. Aula-Verlag, Wiesbaden. pp. 18 - 147.
- Soljan, T., 1975: *I pesci dell'Adriatico.* Mondadori. Verona. 522 pp