Length-weight Relationships of Fishes from Tributaries of the Volta River, Ghana: Part II and Conclusion

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Abstract

Slopes and intercepts of length-weight relationships obtained for 37 populations from the rivers Oti, Pru and Black Volta were compared using a one way analysis of covariance with fixed effects. Although no significant differences were obtained from this analysis, an ANOVA comparing the magnitudes of mean condition factors (W* 100/ SL^3) found 9 out of 37 populations significantly different at the 0.05 level. A two-way nested ANOVA using all populations combined, however, did not yield any significant differences between the three rivers. Thus, pooling the data to obtain the results presented in Part I (see Entsua-Mensah et al. Naga 1995) is justified here.

Introduction

In Part I of this study, data from the rivers Oti, Pru and Black Volta were pooled to obtain length-weight relationships without testing for possible differences in population samples. When data are sparse or insufficient for regression analysis, such practice is probably the best possible way of obtaining some results. However, underlying differences which could lead to important observations or which could account for low correlations are masked.

Testing for differences of regression coefficients or of differences in the magnitudes of means are necessary steps before pooling data coming from different samples. Statistical packages such as STATISTICA or SAS make such tests easier to handle and avoid tedious computations of the descriptive parameters needed in order to obtain F or t statistics. This paper presents a series of steps which could generally be implemented when data such as that presented in Entsua-Mensah et al. (1995) are available for testing.

Materials and Methods

Of the 45 fish species analyzed in Entsua-Mensah et al. (1995), only 37 were used here. The main criteria for inclusion are (i) a minimum sample number of 10 per river; a minimum required in ANOVA (see StatSoft 1994), and (ii) a minimum comparison between two rivers. The null hypothesis, i.e., that the slope of the length-weight relationships (logW=log a + b * log SL) of all three rivers do not differ significantly, is tested using analysis of covariance (ANCOVA, see Sokal and Rohlf 1995) with log W as dependent variable, log SL as covariate and river as the fixed effects grouping variable. All samples from the 37 populations of fish species were processed through the commercial software STATISCA.

In order to ascertain the homogeneity of the populations among these three rivers. comparisons were performed using the condition factor (cf = W * 100 / SL^3) of fish which relates values of W and SL. The test design used here is of a one-way analysis of variance (ANOVA) using the effect of "river" as a grouping variable. The same criteria mentioned above were used in choosing the populations used in this analysis.

Results and Discussion

The data used in ANOVA analysis are summarized in Table 1. The slopes of the length-weight relationships for all 37 populations of fish species among the three rivers are of the same magnitude.

However, nine out of the 37 populations have cf values differing significantly from the mean at the 0.05 level (i.e., *Bagrus docmak*, *Chrysichthys auratus*, *Synodontis filamentosus*, *S. occelifer*, *S. vellifer*, *Raiamas senegalensis*, *Brycinus leuciscus*, *B. nurse* and *Marcusenius cyprinoides*). Further testing showed that four (*C. auratus*, *S. vellifer*, *B. leuciscus* and *B. nurse*) of these nine significant ANOVAs differ significantly (at 0.05 level) for the Levene's test of homogeneity of variances. This would call for a rejection of the ANOVA results and thus a conclusion that for these four populations, the means of cf are different in magnitude. However, it should be noted that the F-statistic in ANOVA provides a robust test of differences notably in cases when n>10 and where the means across groups do not correlate with the standard deviations across groups.

Moreover, the rivers studied here were sites of the Onchocerciasis Control Program of the World Health Organization (WHO) which took effect in 1974 (WHO INTERNET Gopher). The WHO sprayed selected sites in the Volta Basin to reduce the impact of the river blindness disease by controlling the blackfly vector *Simulium damnosum* complex (Order Diptera, Family Simuliidae; see Entsua-Mensah et al. 1995). Benthic insect larvae, including those belonging to the Order Diptera, provide a major food source for demersal species like catfishes, characins and elephant fishes; species which turned out to have significantly different cf means. If these larvae were eradicated from rivers as a direct effect of the insecticide spray, then it is possible for fish populations,

Table 1. **Summary of data from three Ghanaian rivers used in the ANCOVA and ANOVA test for difference in stages of linear regressions.**

Family	Species	River	n	b	se	r	Log SL Means	Log W Means
Polypteridae								
	Polypterus endlicheri	Oti	24	2.70	0.12	0.93	5.05	3.27
		Pru	58				4.98	3.23
		Volta*	7					
Bagridae								
	Bagrus bayad	Oti	24	2.92	0.08	0.98	3.92	2.76
		Pru	28				4.53	2.98
		Volta*	26				3.98	2.80
	Bagrus dogmac	Oti	39	2.90	0.09	0.97	4.43	2.87
		Pru	33				4.37	2.89
		Volta*						
	Chrysicthys auratus	Oti	67	3.05	0.09	0.92	3.54	2.50
		Pru	58				2.94	2.38
		Volta	62				3.30	2.42
	Chrysicthys nigrogiditatus	Oti	54	2.95	0.06	0.95	3.64	2.48
		Pru	151				3.53	2.48
		Volta	70				3.06	2.33
Mochokidae								
	Synodontis filamentosus	Oti	57	2.87	0.07	0.97	3.69	2.52
		Pru	12				3.34	2.47
		Volta	23				3.23	2.42
	Synodontis gambiensis	Oti	110	3.12	0.04	0.98	3.31	2.37
		Pru	150				3.38	2.40
		Volta	39				3.19	2.33
	Synodontis occelifer	Oti	108	2.90	0.05	0.95	3.17	2.31
		Pru	110				3.60	2.49
		Volta	65				2.74	2.19
	Synodontis sorex	Oti	42	2.92	0.08	0.98	3.99	2.57
		Pru	15				4.67	2.81
		Volta*	5					
	Synodontis vellifer	Oti	73	3.01	0.04	0.98	3.22	2.31
		Pru	112				3.15	2.26
		Volta	39				2.89	2.19
Cyprinidae								
	Barbus macrops	Oti	95	2.26	0.08	0.87	1.94	1.91
		Pru	137				2.04	1.95
		Volta	16				2.26	2.04
	Labeo coubie	Oti	95	3.08	0.08	0.96	3.76	2.49
		Pru*	8					
		Volta	24				3.66	2.47
	Labeo parvus	Oti	48	3.22	0.04	0.98	3.01	2.28
		Pru	150				3.88	2.55
		Volta*						
	Labeo senegalensis	Oti	123	3.07	0.03	0.99	3.79	2.55
		Pru*	6					
		Volta	143				3.62	2.51
	Raimas senegalensis	Oti	23	3.16	0.10	0.97	3.11	2.42
		Pru	18				3.59	2.58
		Volta	36				2.60	2.29
Characidae								
	Alestes baremose	Oti	27	3.24	0.05	0.99	1.40	1.11
		Pru*	3				1.42	1.11
		Volta	64					
	Brycinus leuciscus	Oti	199	2.70	0.05	0.91	1.98	1.91
		Pru	192				2.25	2.02
		Volta	105				2.13	1.96
	Brycinus macrolepidotus	Oti	105	2.94	0.03	0.98	3.50	2.52
		Pru	154				3.22	2.41
		Volta	25				3.46	2.51
	Brycinus nurse	Oti	198	2.93	0.03	0.98	2.95	2.28
		Pru	194				3.60	2.49
		Volta	79				3.24	2.36
	Hydrocynius forskli	Oti	51	3.04	0.07	0.98	3.92	2.77
		Pru*						
		Volta	43				3.75	2.70
Mormyridae								
	Hippopotamyrus pictus	Oti	72	2.91	0.04	0.98	2.91	2.45
		Pru	189				3.19	2.55
		Volta	10				2.97	2.44
	Marcusenius cyprinoides	Oti	10	2.93	0.11	0.98	2.76	2.42
		Pru*	160				3.08	2.51
		Volta	12				3.04	2.48
	Petrocephalus simus-simus	Oti	100	2.84	0.06	0.96	1.99	2.00
		Pru	101				2.04	2.03
		Volta	19				2.10	2.02
	Pollimyrus isidori	Oti	58	1.71	0.09	0.89	1.71	1.86
		Pru*						
		Volta	42				1.68	1.87
Schilbeidae								
	Eutropius niloticus	Oti	197	3.01	0.04	0.96	2.73	2.45
		Pru	120				2.93	2.54
		Volta	115				2.58	2.41
	Physailia pellucida	Oti	34	2.61	0.13	0.92	1.65	2.13
		Pru	22				2.01	2.16
		Volta	23				1.60	2.10

cont'd.

	Schilbe mystus	Oti	149	3.15	0.04	0.98	2.72	2.41
		Pru	131				2.95	2.48
		Volta	41				3.04	2.49
	Siluranodon auritus	Oti	47	2.82	0.13	0.90	2.19	2.28
		Pru	61				2.19	2.32
		Volta	18				2.24	2.27
Cichlidae								
	Chromidotilapia guentheri	Oti*						
		Pru	47	3.09	0.09	0.98	2.80	2.03
		Volta	13				2.29	1.88
	Hemichromis fasciatus	Oti	22	3.19	0.05	0.99	3.27	2.26
		Pru	55				3.39	2.27
		Volta	19				3.15	2.23
	Tilapia zilli	Oti*						
		Pru	10	3.19	0.07	0.99	3.27	2.16
		Volta	26				2.73	1.98
Anabantidae								
	Ctenopoma kingslaye	Oti	13	3.02	0.07	0.98	2.98	2.08
		Pru	55				3.00	2.09
		Volta	13				3.03	2.07
	Lates niloticus	Oti	47	2.78	0.20	0.90	3.62	2.51
		Pru*						
		Volta	11				3.97	2.60
Clariidae								
	Clarias anguillaris	Oti	80	2.91	0.09	0.94	4.48	3.02
		Pru	17				4.21	2.93
		Volta	31				4.68	3.08
Clupeidae	*Cynothrisa mento*	Oti	160	1.82	0.10	0.73	2.08	2.19
		Pru*						
		Volta	97				2.17	2.19
Distichodontidae								
	Distichodus rostratus	Oti	195	3.09	0.02	1.00	3.99	2.62
		Pru	105				4.61	2.82
		Volta*						

Note: se - standard error; *r* - correlation coefficient; b - slope
* Samples not included in the analyses

Table 2. Results of the two way ANOVA on condition factors of the pooled data sets for 14 populations of fish species (*Barbus macrops, Brycinus leuciscus, B. macrolepidotus, B. nurse, Eutropitus niloticus, Hippopotamyrus pictus, Marcusenius senegalensis, Petrocephalus simus simus, Parailia pellucida, Schilbe mystus, Siluranodon auritus, Synodontis filamentosus, S. gambiensis, S. vellifer*) sampled from the rivers Oti, Pru and Black Volta, Ghana.

Main effect: RIVER	Sum of squares	df	Mean square	F	p-level
Effect	10.70	28	0.382 1	4.917	0.000
Error	303.7	3 908	0.077 72		

cantly different cf means. If these larvae were eradicated from rivers as a direct effect of the insecticide spray, then it is possible for fish populations, i.e., fish condition factors, to be affected. Given this information, the ANOVA results presented above can not be readily rejected.

A further step was thus required to establish homogeneity of the relationship between length and weight in all of the three river communities. A complete univariate ANOVA with two grouping variables (river and species) was performed for values of cf for those species with representative samples from all three rivers. The two way ANOVA test design yielded a non significant F-statistic (see Table 2) after exclusion of outliers detected in the plot of means vs. standard deviations. These results justify an acceptance of the null hypothesis and thus, the pooling of samples as done in Entsua-Mensah et al. (1995).

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