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Comparative morphometric analysis of injured and uninjured newly metamorphosed smooth newts (*Triturus vulgaris*)

Szilárd NEMES[1]

[1]Studiegången 19-105
416 81 Gothenburg, Sweden
nemessz@gmail.com

Mutilations and malformations in amphibians have attracted the increasing attention of herpetologists since the discovery of an unusually high percentage of malformed newly metamorphosed frogs in Minnesota, USA. Many recent studies on post metamorphic amphibians report the occurrence of different kind of malformations and/or discuss the causes that lead to the appearance of malformations and mutilations (Loeffler et al., 2001, Meteyer 2000, Meteyer et al., 2000, Szekely & Nemes 2003). In September 1997, I collected a sample of newly metamorphosed smooth newts near Cluj-Napoca city, that showed a relatively large percentage of injuries (missing legs, toes and injured tails) caused by invertebrate predators (Nemes, 2002). The present note analyses the morphological differences between injured and uninjured newts. My presumption is that injured newts should have smaller size as the energy expenditure of wound recovery may reduce the resources allocated to growth, thus slowing it down.

To test the above mentioned null hypothesis, five body and head related variables were measured: Lvs; Snout vent length; Lcd; Tail length; D: Axilla – groin length; Lc: Head length; Lct: Head width. Raw data were summarised by descriptive statistics. The size of the five morphological characters was tested by one-way ANOVA on log 10 transformed data; Kolmogorov-Smirnov test was run to compare the distributions of the two samples (injured vs. uninjured); Equality of variances was tested by the F-test (Underwood, 1997). Power calculations were made according to Cohen (1988) using S-Plus 6.2 statistical software.

Contrary to the anticipations, none of the measurements but tail length, showed significant differences between injured and uninjured newts regarding average, distribution and variance (Table 1). The length of injured tails was significantly shorter and, as it was expected, the two datasets had different distribution patterns.

Table 1. Results of null hypothesis significance testing on mean, goodness of fit and variance between uninjured and injured newly metamorphosed *Triturus vulgaris.*

Variables	Mean		Goodness of fit		Variance	
	F	*p*	*D*	*p*	*F*	*p*
Lvs	0.14	0.71	0.65	0.78	0.72	0.48
Lc	0.53	0.46	1.16	0.13	0.81	0.62
Ltc	1.46	0.23	1.01	0.26	0.48	0.15
Lcd	127	<0.0001	2.22	<0.001	4.37	0.06
D	0.32	0.57	0.55	0.91	1.13	0.97

As injuries usually affect the tails at different points, there should different size of tail section be missing, but the measured injured newts showed lower variance regarding the tail length than uninjured ones (Table 2). True, the difference is not significant at 95% confidence level.

Table 2. Descriptive statistics on morphometric characteristics of uninjured and injured newly metamorphosed *Triturus vulgaris* (SD-Standard Deviation; CV – Coefficient of variance, L 95%CI and U 95%CI lower and upper 95% Confidence interval).

	Uninjured (n=42)						
Variables	Mean	SD	CV	L 95%CI	U 95%CI	Skewness	Kurtosis
Lvs	17.76	1.84	10.34	17.23	18.28	0.54	-0.58
Lc	5.46	0.62	11.37	5.28	5.64	-0.03	0.46
Ltc	3.80	0.38	10.13	3.69	3.91	0.90	0.51
Lcd	17.27	3.03	17.54	16.16	18.03	-0.81	0.87
D	8.77	1.57	17.96	8.31	9.22	0.51	-0.70
	Injured (n=7)						
Variables	Mean	SD	CV	L 95%CI	U 95%CI	Skewness	Kurtosis
Lvs	18.01	2.15	11.95	16.02	20.00	0.09	0.37
Lc	5.63	0.69	12.21	4.99	6.26	-1.13	0.36
Ltc	3.97	0.55	13.85	3.46	4.48	0.21	-0.53
Lcd	10.37	1.49	14.38	8.99	11.75	0.12	-2.16
D	8.44	1.48	17.53	7.07	9.81	0.14	-1.68

One could explain the lack of genuine differences among newts with the small sample size. To achieve a statistical power of 0.8 at effect size d=0.18 - as the case of snout vent length in a balanced design - one should have 456 specimens measured in each group. Collecting a sample with more than 900 specimens is highly unrealistic. Compared to this, the effect size for tail length is 1.95, which only requires a sample of 12 specimens, 6 in each group. The confidence intervals support the results of null hypothesis tests (see Table 2, and Snijders, 2001; Colegrave & Ruxton 2003 for discussion on this topic).

The most plausible explanation of lack of differences might be the short period of time between the predation encounter that caused the injury and the time the newts were collected. Metamorphosed smooth newts emerge from the end of June to the beginning of October (Kordges & Thiesmeier 2000). Wound recovery might affect the newts' life in a longer period than one or two months. Even if no size related differences have been recorded, it is conceivable that wound recovery requests a substantial amount of resources. This may reduce the quantity of stored energy, which may have major influence on surviving during winter hibernation. Even if injured newts survive during winter, their post emergence traits will probably be inferior to the uninjured ones'.

At the moment, there is no scientific paper I know of which deals with the long term effects of malformations on newts (and other amphibians). Future studies on survival should be carried out on both uninjured and injured newts. Besides this, comparative morphometric studies may help to elucidate the effect of malformations and mutilations on metamorphosed amphibians.

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