

## Some Morpho-physiological Data on Skeletons of *Lacerta agilis* and *Lacerta viridis*

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The wealth of morphological and physiological data based on a large material consisting either of one or several related species enabled us an evaluation of developmental stages, similarities, changes in bodily proportions and variability in terms of mobility, feeding, reproduction and adaptation to environmental conditions, the climate etc.

When preparing skeletons of *Lacerta agilis* and *L. viridis* for school demonstrations at the cooperative "Dipra", records were made of their biometric data. Large material treated provided information on both the mode in which fat reserves were deposited for hibernation, and on the effectiveness of the individual maceration methods. We measured the condylobasal length of the skull, mandible length, premaxillo-jugal length, medial length of the crista calcarea, jugal and parietal width of the skull, length of presacral spine, length of the bones of zeugo- and stylopodia /radius, tibia, humerus, femur/, and those of the tail, the incidence of the regenerated tail portion after autotomy, and the number of ribs born on the individual sections of the spine. Some of the skull measurements and those of the presacral spine were treated allometrically for the purpose of distinguishing functionally important proportional differences in the size of the skeletons of closely related, but differently sized lizard species, as an example of poikilothermic animals which continue to grow throughout their lifetime, the growth rates of which, however, are greatly retarded in senile specimens. The allometric lines  $y = b \cdot x^a$  were calculated separately for each of both the respective sex and species. The obtained coefficient of regression /a/, organ coefficient /b/ and correlation coefficient /r/ determine both intra- and interspecific as well as sexual differences which are indicated by the slope and the mutual position of the lines. For a description of the measuring methods, tabulated values for 96 males and 82 females of *Lacerta agilis*, and 42 males and 40 females of *L. viridis*, statistical characteristics of allometric equations, figures and references see Porkert and Grosseová /1984, tab. 2, figs 1-6/, and Porkert /1964/.

Most osteometric data on the skeletal material mounted during 1959-1978, are not evaluated statistically in the present paper except of those concerning a variability in the number of presacral vertebrae and ribs /Tabs 1, 2/.

### RESULTS

We have summarized our experience and results as follows:

/1/ For the mounting of lizard skeletons, the most satisfactory method is a biological maceration /putrefaction/ in water which has to be interrupted at the right moment by adding  $\text{NH}_4\text{OH}$  /up to 5-10% of the resulting concentration/. The other chemical and biological /Dermestidae, etc./ methods commonly used for preparation of unmounted skeletons seem to be wholly unsuitable for mounting skeletons, in that the connective tissue

are either irregularly or excessively disturbed.

Table 1. Variability in the number of presacral vertebrae. The cervical vertebrae are not included. In some cases /indicated by two numerals/, ribs are born on vertebrae asymmetrically. In such cases the first numeral indicates which vertebra bears the most posterior free rib in dextral view, the second numeral indicates the same in sinistral view. Different numbers of presacral vertebrae as well as occurrence of mentioned anomalies may suggest that the length of spine is not yet stabilized in these lacertids.

number of vertebrae	<i>Lacerta agilis</i>				<i>Lacerta viridis</i>			
	males		females		males		females	
	n	%	n	%	n	%	n	%
24	34	3.13	-	-	-	-	-	-
24/25	5	0.46	-	-	-	-	-	-
25/24	5	0.46	-	-	-	-	-	-
25	632	58.09	14	2.17	18	90.0	-	-
25/26	19	1.75	3	0.47	1	5.0	-	-
26/25	13	1.19	3	0.47	-	-	-	-
26	371	34.10	313	48.53	1	5.0	22	84.6
26/27	2	0.18	15	2.33	-	-	-	-
27/26	2	0.18	16	2.48	-	-	-	-
27	4	0.37	272	42.17	-	-	4	15.4
27/28	-	-	4	0.62	-	-	-	-
28	-	-	5	0.76	-	-	-	-
29	1	0.09	-	-	-	-	-	-
	1088	100	645	100	20	100	26	100
Mean number of vertebrae	25.34		26.44		25.08		26.15	

/2/ Reserve fat for hibernation is deposited either in a fat-body on the ventrocranial part of the pelvis or in the muscles of the tail vertebrae that are capable of autotomy /Porkert, 1974/. The red colour of the muscles of the proximal tail vertebrae in which transverse processes are developed, is similar to that of all other skeletal muscles. A number of the above vertebrae range from 4 to 6 depending on a variation in the number of the praesacral ones /cf. Tab. 1/. In *L. agilis* the weight of the fat-body /n = 7/ varies from 0.12% of body weight in females or 0.15% in males after hibernation /June 18/ to 4.46% in females or 3.8% in males before hibernation /female - September 22, male - August 29/. The amount of fat /dry weight/ in the tail muscles capable of autotomy varies from 17.2% /♀/ or 19.0% /♂/ to 88.4% /♀/ or 82.6% /♂/. Normally, the female has more reserve fat than the male. There seems to be a relationship between the consumption of the remnants of reserve fat in the tail muscles in spring and the preparation for reproduction /assessed from the state of the gonads - size of testes, egg development, and from secondary sexual characters, e.g. femoral pores of the male; Porkert, 1974 and unpublished data/. Having obtained knowledge of the sites in which fat reserves are deposited for hibernation /tail muscles and fat-body on the pelvis/, but not knowing whether the fat lost by tail autotomy is compensated by its increase in the fat-body, an increased incidence of individuals with a regenerated tail might be ascribed to a consider-

able weakening of the viability of the population during and after hibernation /autotomy due to capture by predators or by man in recreation areas/.

Table 2. Relationship between the number of ribs and number of vertebrae /in %/ in *Lacerta agilis*.

number of vertebrae	males				females			
	24	25	26	29	25	26	27	28
number of specimens	8	234	148	1	7	90	114	5
number of ribs								
costae lumbales								
5	75	18.80	4.73	-	28.57	7.78	2.63	-
6	25	78.63	79.05	-	57.14	84.44	60.53	20
7	-	2.56	16.22	100	14.29	6.67	36.84	80
costae thoracales fluctuantes								
6	-	-	-	-	14.29	-	0.88	-
7	12.50	11.11	5.41	-	-	-	-	-
8	87.50	72.22	33.78	-	42.86	18.89	2.63	-
9	-	16.67	60.14	-	42.86	70.00	50.88	20
10	-	-	0.68	100	-	10.00	44.74	60
11	-	-	-	-	-	1.11	0.88	20
costae thoracales vertebrae								
4	-	1.28	-	-	-	1.11	2.63	-
5	100	80.77	77.03	100	100	84.44	76.32	80
6	-	17.95	21.63	-	-	14.44	20.18	20
7	-	-	1.35	-	-	-	0.88	-

/3/ Both sexual and interspecific differences are shown by the length of the presacral spine /Fig. 1/. Sexual differences are indicated partly by a larger number of presacral vertebrae /Tab. 1/, partly by their increased length mainly in the areas of the lumbar and the free thoracic ribs. The necessity of adapting the size of the abdominal cavity in *Lacerta agilis*, the smaller of the two species, for an identical number of relatively larger eggs than those of *L. viridis* shows itself in both a relatively and absolutely longer presacral spine of the female when compared with that of the male. The difference increases with growth /more eggs in an older female - diverging allometric lines of the male and female specimens of *L. agilis*/. This divergence is minimal in *L. viridis*, the larger of the two species, where an enlargement of the abdominal cavity requires only a functional transposition of the female line when plotted against that of the male. An interspecific difference in growth strategies is indicated by the steepness of transposition lines connecting the average values for males and females /almost isometric for *L. viridis*/. An allometric evaluation of relationships between the presacral length of the spine and the condylobasal length of the skull /Fig. 1/ is a reversal of that shown in an earlier paper /Porkert and Grosseová, 1984, tab. 2, fig. 2/. Both sexual and interspecific differences in the ratio PS : CB are of taxonomic significance and, therefore, important diagnostic characters when determining both the species and sexes. An understanding of the considerable variation in the number of ribs /Tab. 2/ and presacral vertebrae /Tab. 1/ observed in our greatly unhomogeneous material, may be obtained from a comparison of the known part of our material from central Bohemia /Prague and Milovice/ with that from S Moravia /Mikulov/, however, a certain genetic link seems to exist in the number of presacral vertebrae.

/4/ Of limited use as a criterion for a determination of sex and species /for males only/ is the ratio parietal width : condylobasal length /PAR : CB/, while the ratio jugal width : condylobasal length /JUG : CB/ is a reliable criterion for species determination in two specimens of *L. viridis* and *L. agilis* of the same size; the latter has jugal width greater.

/5/ Proportional differences in mandibular and premaxillo-jugal length to condylobasal length /MD and PJ : CB/ of the skull are of no taxonomic importance, as they are related to growth.

#### REFERENCES

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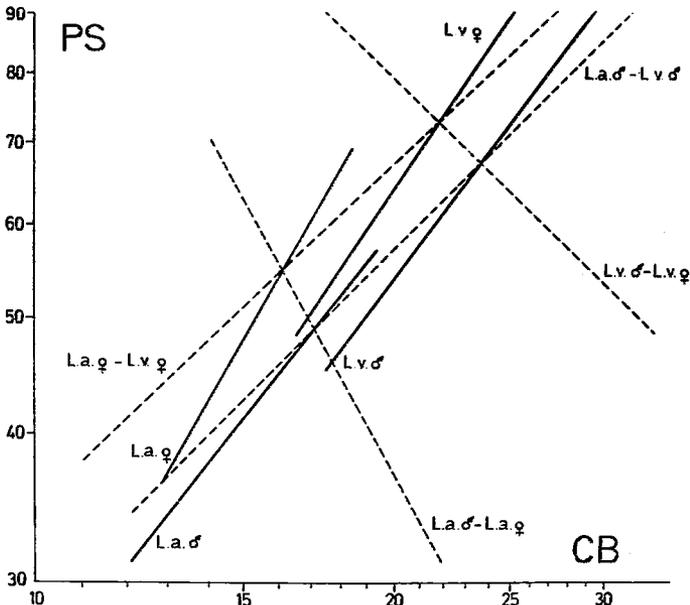


Fig. 1: Relations of the presacral part of the vertebral column /PS/ to the condylo-basal length of the skull /CB/ in the net of bi-logarithmic coordinates. Full lines - allometric straight lines; broken lines - transpositional straight lines /i.e. lines connecting average values/. L. a. - *Lacerta agilis*, L. v. - *Lacerta viridis*.