MORPHOMETRIC STUDY OF MALE REPRODUCTIVE ORGANS IN THE RODENT SPECIES
APODEMUS SYLVATICUS AND APODEMUS FLAVICOLLIS

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The morphometric analysis of the microscopic structure of the testes and epididymis in the rodent species Apodemus sylvaticus and Apodemus flavicollis is reported. In A. sylvaticus the epithelium forms 76.9%, interstitium 8.3% and lumen 14.8% of the seminiferous tubules. The tubular diameter is 142.5 µm. In the epididymis the relative volume of the epithelium represents 54.3%, stroma 13.2% and lumen 32.6%. The diameter of the epididymal duct is 125.9 µm and the epithelium height is 19.1 µm. A similar structure is reported in A. flavicollis, where the epithelium forms 67.6%, interstitium 7.8% and lumen 24.7% of the testicular seminiferous tubule. The tubular diameter is 140.2 µm. In the epididymis, the height of the epithelium is 19.1 µm and it forms 46.3%. Relative volume of stroma is 14.8% and lumen 38.9%. The epididymal tubular diameter is 151.8 µm.

Key words: Apodemus sylvaticus, Apodemus flavicollis, testis, epididymis, morphometry.

Reproductive organs are not unconditionally necessary for the individual life, but they have essential role in the reproduction and genesis of species. The great attention is given in relation to practice as well as to theoretical science (1, 9). Reproductive organs represent the most dynamic organs in the animal as well as in human body. Great attention to study the reproductive organs has been always reported (2, 3, 4, 5, 6, 10, 19). Morphological structure and physiological function of reproductive organs in many species are well studied and described. But there are still many empty spaces mostly in wild animals (17).
In 1998 - 2000, the community composition of small mammals was studied in reed stands in South - West Slovakia, where 1599 individuals of sixteen species were caught. *Sorex araneus*, *Clethrionomys glareolus* and *Apodemus sylvaticus* are the most dominant and constant. At individual sites, the diversity ranged from 1.22 to 1.67 and equitability from 0.53 to 0.62. The breeding season lasts on average 6.3 months in *A. sylvaticus* and their mean weight peak in spring and drop in winter. The average litter size is relatively small in *C. glareolus* (4.6) and *A. sylvaticus* (4.1), but relatively high in *S. araneus* (7.8). The average number of young per female of the all three species per year is 18. In general *A. sylvaticus* are significantly female dominated (10, 11).

The target of this study was to describe microscopic structure and to give exact morphometric values of the male reproductive organs (testes and epididymis) of selected species of the family Rodentia (*Apodemus sylvaticus* and *Apodemus flavicollis*).

**Material and Methods**

The male reproductive organs of species *Apodemus sylvaticus* (Linnaeus, 1758) and *Apodemus flavicollis* (Melchior, 1834) captured in 100 m long lines in forest and swamp ecosystems were analysed. The organs were obtained in the same year period (May) from 35 adult animals, which were sexually active and in very good body condition (*Apodemus flavicollis*: number of males: 20; average length 100 mm and average weight 38.4 g; *Apodemus sylvaticus*: number of males: 15; average length 97.7 mm, average weight 28.2 g).

The samples from the testes and epididymis were fixed in 10% formalin and embedded in paraffin blocks. Sections of 10 µm thick were stained with haematoxylin and eosin (20, 22, 23).

Quantitative and qualitative microscopic analysis was determined using microphotographs and morphological methods previously described (13, 16, 19). In the testis relative volume (%) of the epithelium, interstitium, lumen and diameter of seminiferous tubules (µm) were evaluated. In the epididymis (*cauda epididymis*) relative volume (%) of the epithelium, interstitium and lumen, tubular diameter (µm) and height of the epithelium (µm) were measured.

From all determined quantitative data basic statistical parameters and correlation relationships were calculated using PC programme SAS (18).

**Results and Discussion**

**Testes.** The testes of the studied species were covered with strong stroma (*tunica albuginea*), which consisted collagenous tissue. On the surface of the testes there was *tunica vaginalis propria*. Radial formed septa (*septali testes*) divided testes to lobes (*lobuli testes*) of pyramidal shape.

The fact that the testes were in reproductive process was demonstrated by the localization of the testes and their size. The testes were completely descent in the scrotum, their colour was milky - white and they were of typical ovoid formation. Average size of the testes in *Apodemus sylvaticus* was 13 x 8 mm and in *Apodemus flavicollis* 12.3 x 7.7 mm.
Microscopic analysis of the testes showed normally formed germinal epithelium, which contained all cellular stages of spermatogenesis. Tubules have ovoid form and no alterations in their wall were found. The space between the tubules was filled with interstitial tissue, where various size blood vessels and capillaries were observed.

The relative volume of the germinal epithelium was 76.9 ± 4.9% in Apodemus sylvaticus and 67.6 ± 9.9% in Apodemus flavicollis. Higher relative volume of lumen was in Apodemus flavicollis (24.7 ± 8.2%) in comparison with Apodemus sylvaticus (14.8 ± 6.0%). The diameter of seminiferous tubules was in both studies species very similar (Table 1).

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<th>Apodemus sylvaticus</th>
<th>Apodemus flavicollis</th>
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<tr>
<td>Epithelium (%)</td>
<td>76.9 ± 4.9%</td>
<td>67.6 ± 9.9%</td>
</tr>
<tr>
<td>Interstitium (%)</td>
<td>8.3 ± 1.6%</td>
<td>7.8 ± 4.3%</td>
</tr>
<tr>
<td>Lumen (%)</td>
<td>14.8 ± 6.0%</td>
<td>24.7 ± 8.2%</td>
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<tr>
<td>Diameter of tubules (µm)</td>
<td>142.5 ± 30.5 µm</td>
<td>140.2 ± 37.3 µm</td>
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</table>

Our results correspond with our previous observations. Germinal epithelium constituted 77.6%, interstitium 12.3% and lumen 10.0% of rabbit testes (20). Relative volume of these structures in the testes of the fallow–deer was also studied (14). In this animal the germinal epithelium forms 76.2%, lumen 12.4% and interstitium 11.5%. In the testes of the fox germinal epithelium forms 52.7%, interstitium 11.3% and lumen 36.0% (13).

In Sprague Dawley rats germinal epithelium constitutes 82.4% (15) and in rams 70.5% (24). In rabbit lumen forms 11.1% of seminiferous tubule (20). During a year period relative volume of germinal epithelium in hare is 57.3 – 73.4% (13). The interstitium values range from 6.3 to 34.0% and lumen ones from 8.6 to 24.2% due to the season (month) and sexual activity. Similar results have been detected also by some other authors (2, 3). Our results are similar to those found in the sexually active period.

In the rabbit the diameter of tubules is 118.7 µm (20). These results are comparable with our morphometric values of tubular diameter – 142.5 µm and 140.2 µm. In the fallow–deer the diameter of tubules is 143.1 µm (14). The diameter of seminiferous tubules in the testes in stallion and boar is reported to be 200 – 240 µm and in bulls 180 – 320 µm. The average diameter of seminiferous tubules in male fox is 281.4 ± 30.5 µm (16). From this data it can be concluded that the diameter of seminiferous tubules is very similar in various mammalian species.

High negative correlation between relative volume of the germinal epithelium and tubular lumen (Apodemus sylvaticus – 0.904, Apodemus flavicollis – 0.978) was demonstrated. Between the tubular diameter and the relative volume of the germinal epithelium in Apodemus sylvaticus the relationship was very low (~ 0.048), but in Apodemus flavicollis high positive correlation existed (0.758). In both species between tubular diameter and interstitium high negative relationship was found (~ 0.830 and ~
0.677). Low positive relationship (0.258) in *Apodemus sylvaticus* between tubular diameter and its lumen was found. In *Apodemus flavicollis* this relationship was middle negative (−0.564).

**Epididymis.** Average size of the epididymis in *Apodemus sylvaticus* was 12 mm and in *Apodemus flavicollis* – 8.7 mm. Microscopic analysis showed tubules covered with tall cylindric epithelium. A mass of mature spermatozoa in the *cauda epididymis* was found. The space between tubules was thin and filled with interstitial tissue.

Morphometric data of relative volume of main structures of the epididymis, diameter of tubule, and height of epithelium are listed in Table 2.

<table>
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<th><strong>Apodemus flavicollis</strong></th>
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<tr>
<td></td>
<td>x ±s v %</td>
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</tr>
<tr>
<td>Epithelium (%)</td>
<td>54.3 ± 2.8 5.1</td>
<td>46.3 ± 14.2 30.7</td>
</tr>
<tr>
<td>Interstitium (%)</td>
<td>13.2 ± 12.7 96.6</td>
<td>17.8 ± 9.8 66.0</td>
</tr>
<tr>
<td>Lumen (%)</td>
<td>32.6 ± 15.5 47.5</td>
<td>38.9 ± 11.2 28.9</td>
</tr>
<tr>
<td>Tubular diameter (µm)</td>
<td>125.9 ± 41.1 32.6</td>
<td>151.8 ± 70.3 48.7</td>
</tr>
<tr>
<td>Height of epithelium (µm)</td>
<td>19.0 ± 5.6 27.3</td>
<td>19.1 ± 3.5 18.3</td>
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</table>

All the studied parameters are very similar in both species. The relative volume of the epithelium in *Apodemus sylvaticus* was 54.3 ± 2.8% and in *Apodemus flavicollis* 46.3 ± 14.2%. The relative volume of the interstitium was 13.2 ± 12.7% in *Apodemus sylvaticus* and 17.8 ± 9.8% in *Apodemus flavicollis*. The tubular diameter was higher in *Apodemus flavicollis* (151.8 ± 70.3 µm) than in *Apodemus sylvaticus* (125.9 ± 41.1 µm). The height of the epithelium was very similar in both species (19.0 ± 5.6 and 19.1 ± 3.5 µm, respectively).

In rabbits the relative volume of the epithelium was 30.3% and relative volume of the interstitium 17.5% (20). The volume of lumen in rabbit was 52.2% and in hare 37.1 – 62.5% (13). The diameter of the tubule in *Apodemus sylvaticus* was 125.9 µm and in *Apodemus flavicollis* 151.8 µm. There was a low positive correlation between the epithelium and lumen, which indicates a low increase in relative volume of lumen with increase in epithelium volume. On the other hand, an increase in epithelium volume caused a decrease in interstitium size.

In relation to month (season) it has been reported that in the hare the epithelium forms 10.9 – 24.3%, interstitium 23.1 – 48.3% and lumen 18.5 – 62.5%. High range of these values is in relation to the effect of season (2, 3, 13), and consequently to the level of sexual activity. In male fox in the *caput epididymis* the epithelium forms 48.7 ± 6.9%, interstitium 19.6 ± 6.2 and lumen 31.8 ± 10.0%. The diameter of the tubule in the *caput epididymis* is 287.1 ± 11.1 µm. In the *cauda epididymis* the epithelium forms 17.6 ± 4.2%, stroma 38.6 ± 15.8 and lumen 43.8 ± 15.6% of epididymal structure. The diameter of the tubule in the *cauda epididymis* is 352.3 ± 46.1 µm (13).

In *Apodemus flavicollis* high negative correlation between relative volume of the epithelium and lumen means that with a decrease in the epithelium volume the
lumen significantly increased (− 0.729). In middle negative relationship was the relative volume of the epithelium and stroma. The volume of lumen and stroma was in low negative correlation (− 0.091).

Between the diameter of the tubule of the epididymis and its epithelium only a low positive correlation was registered, what means that with the increase in epithelium volume the increase in diameter is low. The same relationship was between diameter of tubule and volume of stroma (0.197). Middle negative correlation (− 0.392) was found between the tubular diameter and relative volume of lumen.

The height of epididymal epithelium in *Apodemus sylvaticus* was 13.3 – 30.0 µm with the average value of 19.0 µm. In *Apodemus flavicollis* the range of 10.0 – 33.4 µm (19.1±3.5 µm) was found. In the fallow–deer the average height of epithelium in spring is 20.8 µm and in autumn 21.6µm (14).

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**References**


Dear Prof. Wilczyńska – Ciemiega,

We have corrected our manuscript No. 351 entitled: “MORPHOMETRIC STUDY OF MALE REPRODUCTIVE ORGANS IN THE RODENT SPECIES APODEMUS SYLVATICUS AND APODEMUS FLAVICOLLIS” written by P. MASSÁNYI, A. JANČOVA and V. UHRIN according to your comments.

With great respect and appreciation,

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