MORPHOLOGICAL AND HISTOLOGICAL STUDIES ON THE VULVAR CONFIGURATIONS IN HAEMONCHUS CONTORTUS (RUD., 1803)

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Abstract. The females of three phenotypes of Haemonchus contortus, though being similar in the body length and egg volume, differ significantly in the position of vulva. The differences in the comparative measurements of various types distinguished by Roberts within each phenotype are non-significant. Histological studies revealed that in all these phenotypes the body wall in the vulval region consists of three layers.

The females of Haemonchus contortus (Rud., 1803), the common blood-sucking parasite of sheep, goats and other ruminants, consist of three phenotypes (Plate I, Figs. 1—3): linguiform, knobbed and smooth (Das and Whitlock 1960). In these three phenotypes, 14 morphological variants have been figured in alphabetical order from A to N (Roberts et al. 1954). Crofton and Whitlock (1969), LeJambre and Whitlock (1968), McKenna (1971) and Sood and Kaur (1976) have studied the seasonal changes in the different morphs. Daskalov (1969 a, b, 1971, 1972 a, b, and 1975) has provided genetic and biologic insight into different phenotypes.

Only little work has been done on the relationship of body measurements of the three phenotypes and various Roberts types of H. contortus. The only work done on this aspect is by LeJambre et al. (1970) and Padmavathi et al. (1971). No work has been done on the histological details of the vulvar region of three phenotypes. The purpose of this paper is to give an account of the measurements of the phenotypes and their morphological variants together with the histological details of the vulvar region of the three phenotypes in H. contortus.

MATERIAL AND METHODS

The adult female worms were collected from the naturally infested goats (Capra hircus) procured from the local slaughter houses at Ludhiana. The mature female specimens cleared and mounted in lactophenol were identified and classified into three groups: linguiform, knobbed and smooth (Das and Whitlock 1960) and subsequently identified for the Roberts types (Roberts et al. 1954).

For histological studies, a little body part with vulvar region was fixed in Bouin’s fluid separately for each phenotype. The paraffin sections were cut at 7 µm and stained with Mallory’s triple stain.

RESULTS

The comparative measurements (body length, distance of the vulva from the hind end and the egg-volume) of the 13 Roberts types recorded during the present studies are given in Table 1. The table shows that the various types in each group and of all the three groups somewhat differ from each other in their main body length, position of the vulva and the egg-volume. These differences are, however, statistically non-signi-
significant when the F test is appiled. This shows that Roberts types A, B, C and I of the group linguiform, the types D, E, J, K, L, M, N of the group knobbed and the types F and G of the group smooth differ from one another with respect to the above measurements non-significantly. It may be concluded, therefore, that the different Roberts types of each group cannot be differentiated from each other merely on the basis of the body length, position of the vulva or the egg-volume.

Table 1. Measurements* of 13 Roberts types of adult females of *H. contortus* (Rud., 1803)

<table>
<thead>
<tr>
<th>Roberts type females (total)</th>
<th>Body length range (mean)</th>
<th>Distance of the vulva from hind end range (mean)</th>
<th>Egg-volume** range (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(10)A</td>
<td>17.68—28.17 (22.60)</td>
<td>3.40—5.62 (4.19)</td>
<td>.0000176—.000108 (0.000487)</td>
</tr>
<tr>
<td>(10)B</td>
<td>14.00—24.63 (19.39)</td>
<td>2.68—4.74 (3.69)</td>
<td>.0000212—.0000717 (0.0003608)</td>
</tr>
<tr>
<td>(10)C</td>
<td>17.22—23.55 (21.43)</td>
<td>3.22—4.55 (4.04)</td>
<td>.0000212—.0000636 (0.000465)</td>
</tr>
<tr>
<td>(10)D</td>
<td>16.63—24.07 (20.37)</td>
<td>2.55—4.50 (3.55)</td>
<td>.0000212—.0000717 (0.000387)</td>
</tr>
<tr>
<td>(10)E</td>
<td>15.22—25.11 (19.81)</td>
<td>2.55—4.75 (3.44)</td>
<td>.0000212—.0000717 (0.000465)</td>
</tr>
<tr>
<td>(10)F</td>
<td>18.22—24.84 (21.47)</td>
<td>3.70—4.72 (4.15)</td>
<td>.0000242—.0000717 (0.000443)</td>
</tr>
<tr>
<td>(10)G</td>
<td>13.77—24.01 (18.78)</td>
<td>2.31—4.41 (3.43)</td>
<td>.0000212—.0000717 (0.000443)</td>
</tr>
<tr>
<td>(10)H</td>
<td>12.72—27.76 (20.42)</td>
<td>1.60—4.92 (3.64)</td>
<td>.0000212—.0000795 (0.000427)</td>
</tr>
<tr>
<td>(5)L</td>
<td>14.82—28.87 (20.75)</td>
<td>2.29—4.87 (3.83)</td>
<td>.0000212—.0000717 (0.000465)</td>
</tr>
<tr>
<td>(5)M</td>
<td>15.45—23.27 (19.76)</td>
<td>2.40—4.54 (3.62)</td>
<td>.0000212—.0000717 (0.000465)</td>
</tr>
<tr>
<td>(5)N</td>
<td>14.34—20.31 (17.74)</td>
<td>2.40—4.26 (3.27)</td>
<td>.0000212—.0000717 (0.000530)</td>
</tr>
<tr>
<td>(10)I</td>
<td>14.96—33.16 (22.19)</td>
<td>2.47—6.52 (4.47)</td>
<td>.0000212—.0000849 (0.000475)</td>
</tr>
<tr>
<td>(10)G</td>
<td>16.80—26.20 (20.47)</td>
<td>3.67—4.04 (4.18)</td>
<td>.0000212—.0000849 (0.000475)</td>
</tr>
</tbody>
</table>

* in mm

**The eggs of *H. contortus* being prolate spheroids, the volume can be calculated by the formula:

\[
\frac{\pi \times \text{length} \times (\text{breadth})^2}{6}
\]

(LéJambre et al. 1970)

The values of the relative measurements combined and averaged for one phenotype are given in Table 2. The differences in the body length and the egg-volume of the three phenotypes are again found to be statistically non-significant. But the three phenotypes: linguiform, knobbed and smooth, differ significantly at 5 % level of significance from each other with respect to the position of the vulva. The distance of the vulva from the hind end is in the order: smooth > knobbed > linguiform.
The histological details of the vulval region of the three phenotypes (Plate II, Figs. 1—4) have shown that in all the three phenotypes, the body wall of the vulval region has the usual three layers, the cuticle, hypodermis and the muscle layer. In all the three phenotypes, these three layers are equally well-developed both anterior and posterior to the vulval region. In the linguiform females, the flap is formed by the cuticle which is differentiated into two regions, the outer colourless "thinner" and the inner brownish, sclerolized "thicker" region. A small proplasmic core lies in the centre of a thicker region (Fig. 1). The extra cuticular swellings in the linguiform females are formed only by the cuticle which bulges outwards (Fig. 2). These formations have been attributed to the advanced age of the worm and it has been emphasized that no taxonomic importance should be attached to such additional cuticular formations found near or over the linguiform flap of *H. contortus* (Daskalov 1972). In the knobbed females, the cuticle of the body wall gets much thickened in the region of the knob. The other two layers, the hypodermis and the muscle layer also enter in the formation of the "knob". However, the main part is constituted by the thickened cuticle (Fig. 3). No such modifications occur in the layers of the body wall in the vulval region of smooth type females (Fig. 4).

**DISCUSSION**

According to Padmavathi et al. (1971) the body length of the two types, linguiform and knobbed is similar to each other and the position of the vulva from the tail end and the egg-size of the two types are somewhat different. But these differences have not been statistically analysed. In their case, the distance of vulva from the hind end is more in linguiform than that in the knobbed females. But in the present case, it is in the reverse order.

LeJambre et al. (1970) while studying the egg-size in relation to polymorphism in *H. contortus* have found significant differences in the egg-volume of the three phenotypes. They observed the egg-size of the three phenotypes in the order of linguiform > smooth > knobbed. But in the present investigations, the differences in the egg-volume of the three phenotypes are found to be non-significant and the egg-size falls in the order; smooth > knobbed > linguiform. The significance of differences in three phenotypes of *H. contortus* (LeJambre et al. 1970) and their nonsignificance (present study) may be attributed to the differences in the experimental approach. Such differences in the egg-size have been related to the time/temperature required for hatching (Crofton...
The hatching time of *H. contortus* eggs has been shown to be different in different geographical regions (Crofton and Glazier 1965). Differences in hatch time among the morph types of *H. contortus* could well help to explain the geographical changes in the fitness of morph types (LeJambre et al. 1970).

Present studies reveal that the various female variants and the three main phenotypes of *H. contortus* are similar in their body lengths. Minor differences may be neglected and accounted for worm age and sampling as the differences are statistically non-significant. But the three phenotypes significantly differ from each other with respect to the position of vulva. The position of the vulva is of significant value in the speciation of the nematodes. However, the problem, whether the morphologically distinct subspecies of *H. contortus* are physiologically and bionomically different from each other is yet unsettled. By studying protein fractions of different morphological types of *H. contortus*, Daskalov et al. (1972) have found no evidence for differentiating morphological types into subspecies, as no differences occur between protein fractions of different types.

**MОРФОЛОГИЧЕСКОЕ И ГИСТОЛОГИЧЕСКОЕ ИЗУЧЕНИЕ ФОРМЫ ВУЛЬВЫ У HAEMONCHUS CONTORTUS (RUD., 1803)**

М. Ј. Суд и Ч. Кавр

**Резюме.** Самии трех фенотипов Haemonchus contortus, хотя похожие по длине тела и объе мы ниц, значительно отличаются друг от друга расположением нульвы. Различия в сравнительных размерах различных типов отличаемых Робертсом у каждого фенотипа незначительны. Гистологическими методами было обнаружено, что стенка тела в области нульвы всех этих фенотипов состоит из трех слоев.

**REFERENCES**


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The latest volume of the series Osnovy nematologii (Principles of nematology) is devoted to the family Protostrongylidae Leiper, 1926, which is important both from the biological and economical views. The first part of the monograph deals with the position of the family Protostrongylidae in the system of nematodes. Adopting the classification by Lane, 1917, the author includes the family Protostrongylidae in the superfamily Metastrongyloidea Lane, 1917. Comprehensive and detailed morphological and anatomical characteristics of members of the family Protostrongylidae, including their known larval stages, are given in the introductory part of the book. Then follows a description of all representatives of the family with detailed morphological characteristics, data on the biology, pathology, diagnostics, control and epizootiology. A brief note commenting taxonomic problems is attached to the description of some species.

The family Protostrongylidae Leiper, 1926 is divided into five subfamilies:


b) Muellerinae Skrjabin, 1933 with the genera *Muellerius* Cameron, 1927 and *Cystocaulus* Schulz, Orlow et Kutass, 1933.


d) Neostrongylinae Boev et Schulz, 1950 with the genera *Neastrongylus* Gebauer, 1932 and *Orthostrongylus* Daugherty et Cole, 1946.


The book is completed by a comprehensive list of references, list of hosts and their parasites of the family Protostrongylidae and list of genera and species of the family Protostrongylidae.

Prof. S. N. Boev compiled in this volume the results of his many years’ experience. It is therefore a high scientific level, written in a comprehensible manner and its division and descriptions of species enable the reader a quick orientation. For its intelligibility and matter-of-factness this work is of value to the specialists in helminthology and represents an essential cool for the students, veterinarians, zootechnicians and other readers, for example those concerned with hunting. The book is also a significant contribution to zoogeographical studies, because of the data on geographical distribution of the representatives of the family Protostrongylidae.

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and Dr. V. Baruš, D.Sc.

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Figs. 1—3. Photographs of the vulvar region of three phenotypes of *H. contortus*. Fig. 1. Linguiform. Fig. 2. Knobbed. Fig. 3. Smooth. (1×70; 2—3×100).
Figs. 1—4. Histology of vulval region of three phenotypes of *H. contortus* females. Fig. 1. Transversal section through linguiform female showing linguiform vulval flap (LVF). Fig. 2. Transversal section through linguiform female showing linguiform vulval flap (LVF) on one side and the cuticular process (CP) on the other side. Fig. 3. Transversal section through knobbed female showing knobbed vulval process (KVP). Fig. 4. Transversal section through vulval region of smooth female. Figs. 1—4 × 100.