personal communication). The situation improved somewhat with repeated washing of the cells after trypsinization. The addition of trypsin inhibitor is envisaged for future use. The advantage of the trypsinized culture is a more complete dissociation of the neurons, resulting in more neurons and a clearer background in the microscopic field.

The use of isolated neurons in vitro in the study of the nervous system has a wide range of possibilities. The effect of changes in the composition of the growth medium, and of varying physical conditions can be studied by this method of culture. This article describes the baseline and control experiments for such studies.

We wish to thank Professor B. J. Meyer, Professor C. R. Jansen and Professor O. W. Prozesky for useful discussions and for the use of facilities; Mr N. Hugo for his technical assistance with the microscopy; Mr W. Joubert for his help with the preparation of the photographs; and Miss Geyer of the Virology Department, Onderstepoort, for technical assistance in the preparation of the culture mediums.

REFERENCES

Identification of Tapeworms*

E. M. PROCTOR, M.Sc., Amoebiasis Research Unit†, Durban

SUMMARY

As auto-infection from Taenia solium may give rise to cysticercosis in man, it is important to differentiate between the pork tapeworm and Taenia saginata, the beef tapeworm. Scolices are seldom found and identification based on the number of uterine branches in the terminal gravid segments may be misleading. Details of the differences in mature segments are given.


For some reason a patient with tapeworm infection is a constant source of amusement to his colleagues. The patient's own objection to the parasite is mainly aesthetic, as the symptoms are seldom severe.

It is not generally realized that a tapeworm grows some 5 - 7 cm per day and is thus a competitor for food. The theft of that much food would cause consternation in the kitchen, but is apparently acceptable when it occurs in the gut.

There is one aspect of tapeworm infection which is often disregarded, possibly because its significance is not fully appreciated. The larval form of Taenia saginata—Cysticercus bovis—is confined to the bovine, while that of Taenia solium—Cysticercus cellulosae—though normally harboured by the pig, may also invade the tissues of its definitive host—man. The expulsion of the eggs of Taenia solium is thus dangerous, not only to the patient himself, but also to those around him. It is therefore essential to distinguish between the two types of infection, not only for prognosis, but also as a general health precaution.

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Cysticercosis in man is far more prevalent in South Africa than is generally known. It contributes in considerable degree to the incidence of the nervous mani-
festations and adult-onset epilepsy so common in the Bantu. In pigs, Verster gives the over-all mean incidence for the whole country as 1.5%. This figure is not a true reflection of the epidemiological situation as it takes into account only the larger centres where there is adequate control. In areas such as the Transkei, where pigs are allowed to range, the prevalence is much higher. Heinz and MacNab state 'Umtata is reported to have more than 10% of the pigs infected.'

The recorded incidence of the adult form, *Taenia solium*, in man has in the past been incompatible with the high prevalence of its larval forms, *Cysticercus cellulosae*, in pigs, or for that matter in man. One possible explanation of this anomaly was a failure to differentiate between *T. saginata* and *T. solium*. Such identification has commonly been based on a single feature: the number of branches of the uterus in gravid segments. As will be seen (Table I), there is even divergence of opinion as to the number of uterine branches in the two species.

### TABLE I. NUMBER OF LATERAL BRANCHES OF THE UTERUS RECORDED BY VARIOUS AUTHORS

<table>
<thead>
<tr>
<th>Author</th>
<th><em>T. saginata</em></th>
<th><em>T. solium</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Leuckart</td>
<td>20 - 30</td>
<td>7 - 9</td>
</tr>
<tr>
<td>Küchenmeister</td>
<td></td>
<td>9, 11, 13, 15 - 20</td>
</tr>
<tr>
<td>Du Noyer and Baer</td>
<td>18 - 23</td>
<td>7 - 10</td>
</tr>
<tr>
<td>La Page</td>
<td>15 - 35</td>
<td>7 - 12</td>
</tr>
<tr>
<td>Verster</td>
<td>14 - 32</td>
<td>7 - 16</td>
</tr>
</tbody>
</table>

In an attempt to elucidate this aspect of the 'solium anomaly', a large number of specimens were examined with the object of evaluating possible criteria on which identification could be based. Apart from the distinctive scolex, the most highly organized portion of the worm is the 'mature' proglottid, containing fully developed male and female genitalia.

**MATERIALS AND METHODS**

The specimens examined were obtained from autopsies carried out at King Edward VIII Hospital, Durban, and from a survey in the rural area of the Transkei. The latter specimens were obtained from patients after the use of nloaosamide.

Portions of the strobila having mature segments were immersed in warm fixative (5% glycerine in 70% alcohol) and gently massaged to ensure relaxation of the proglottid. The material may be stored in the fixative. After washing for some hours in de-ionized water, the specimens were transferred to matured Mayer's acid haemalum for 24 - 48 hours. After differentiation in acidulated 70% alcohol to a pale pink colour, the specimens were 'blued' in repeated changes of tap-water, a process which can be accelerated by the addition of lithium carbonate.

The material was dehydrated in alcohol, commencing with 50% and finishing with two changes of absolute alcohol. It was essential to flatten and straighten the segments between two slides held together with rubber bands. The material was cleared in beechwood creosote with microscopical control, and finally mounted in Canada balsam.

Mature segments from 150 specimens were examined for the following features:

**Scolex:** When available the scolex was examined for the presence or absence of an armed rostellum as shown in Figs. 1 and 2.

![Scolex of the armed *Taenia*](image)

**Accessory lobe:** This lobe, when present, is on the poral side and situated between the genital ducts and the uterus, as shown in Fig. 3. By contrast, Fig. 4 shows a proglottid with 2 lobes and no accessory lobe.

**Vaginal sphincter muscle:** When this muscular structure is present, it surrounds the vagina and according to Verster is 40 - 50 μm in diameter and is situated 90 - 170 μm from the opening of the genital atrium. It is shown in Figs. 5 and 6.

**Confluence of the testes:** The testes, as illustrated in Fig. 7, extend from the anterior to the posterior margin of the proglottid and are confluent posterior to the vitallarium. On the other hand, Fig. 4 shows a segment in which the testes, though they extend to the posterior margin, are not confluent posterior to the vitallarium.

**Cirrus pouch:** This organ enlarges with the maturity of the segments. Figs. 7 and 8 show how it may extend to the longitudinal excretory vessels but not into the medulla. By contrast, Figs. 9 and 10 illustrate a proglottid in which it does not extend to the excretory vessels.

**RESULTS**

The findings of the various criteria of the 150 specimens examined are shown in Table II.
TABLE II. DIFFERENTIAL DIAGNOSTIC FEATURES

<table>
<thead>
<tr>
<th>Specimens With Vaginal Sphincter</th>
<th>Specimens Without Vaginal Sphincter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taenia saginata</td>
<td>Taenia solium</td>
</tr>
<tr>
<td>1. The presence of an armed rostellum.</td>
<td>1. Absence of an armed rostellum.</td>
</tr>
<tr>
<td>2. Two lobes and an accessory lobe of the ovary.</td>
<td>2. Two lobes of the ovary.</td>
</tr>
<tr>
<td>3. Vaginal sphincter muscle absent.</td>
<td>3. Vaginal sphincter muscle present.</td>
</tr>
<tr>
<td>4. Testes are confluent posterior to the vitellarium.</td>
<td>4. Testes not confluent posterior to the vitellarium.</td>
</tr>
<tr>
<td>5. Cirrus pouch extends to the longitudinal excretory vessels.</td>
<td>5. Cirrus pouch does not extend to longitudinal excretory vessels.</td>
</tr>
</tbody>
</table>

Specimens With Vaginal Sphincter

In the 131 specimens with a vaginal sphincter muscle, the accessory lobe of the ovary was absent in all. The testes in every specimen extended to the posterior margin but were not confluent posterior to the vitellarium. In 128 specimens the cirrus pouch did not extend to the excretory vessels. In the remaining 3 specimens its position was not clearly seen, due to distortion of the outer edge of the segment. The scolex was available in 101 of these specimens, and all showed the small, unarmed rostellum characteristic of *Taenia saginata*.

Specimens Without Vaginal Sphincter

An accessory lobe was seen in 19 specimens, and in all these the testes were confluent posterior to the vitellarium. The extension of the cirrus pouch to the longitudinal excretory vessels could only be observed in 17. Careful

![Fig. 2. Scolex of the unarmed Taenia.](image)

![Fig. 3. Mature segment of the armed Taenia.](image)

![Fig. 4. Mature segment of the unarmed Taenia.](image)

![Fig. 5. Vaginal sphincter muscle of the unarmed Taenia.](image)
study of these specimens did not reveal a vaginal sphincter muscle. Nine of these specimens had the armed scolex of *Taenia solium*.

![Fig. 6. The vaginal sphincter muscle in relation to the genital atrium.](image)

![Fig. 7. Cirrus pouch extends from the genital atrium to the longitudinal excretory vessels.](image)

![Fig. 8. Cirrus pouch of the armed Taenia.](image)

![Fig. 9. Cirrus pouch extends to midway between the longitudinal excretory vessels and genital atrium.](image)

![Fig. 10. Cirrus pouch of the unarmed Taenia.](image)
Table III summarizes the criteria on which differentiation of the species can be made.

The presence or absence of an armed rostellarum is the most easily assessed feature. When the scolex is not available, the number of lobes of the ovary and the presence or absence of the vaginal sphincter muscle are the most reliable criteria for differentiation. The position of the testes and the cirrus pouch may be considered as reliable confirmatory criteria.

**DISCUSSION**

Early studies have discovered what has come to be known as the 'solium anomaly'. The discrepancy between the incidence of the adult form of *Taenia solium* and that of its larval form, *Cysticercus cellulosae*, in pigs and in man, has been recorded by a number of workers. Several factors may be responsible for this disproportion, one of which is possible misidentification of the adult in routine laboratories.

Identification is commonly based on a single morphological feature: the number of branches of the gravid uterus. This feature is not only somewhat subjective, but there is an overlap in the number of branches in the two species. Added to this is the fact that gravid segments are not always available. If the scolex is present, species differentiation is easy, providing it is borne in mind that the delicate hooklets may have been lost. It is thus apparent that other criteria on which species differentiation can be based, are essential.

The presence of a third lobe of the ovary in a mature segment is diagnostic of *Taenia solium*, while that of a vaginal sphincter muscle is characteristic of *Taenia saginata*. In the former the cirrus pouch extends to the longitudinal excretory vessels and the testes are confluent posterior to the vitellarium.

It is apparent that from a clinical point of view the tapeworms and their larvae are of considerable importance in South Africa. It is felt that routine laboratories should conduct more critical morphological studies on all tape-worm material received. This would naturally involve fixation and elaborate staining techniques. It is vital that differentiation be made between *Taenia saginata* and *Taenia solium*, in view of the danger of cysticercosis in man.

**REFERENCES**