The rumen ciliates of greater kudu *Tragelaphus strepsiceros* (Pallas) from South Africa and Zimbabwe with a description of one new species

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Eighteen species of the family Ophryoscolecidae, representing three genera, and three species of the family Isotrichidae representing two genera, were found in the rumina of kudu from the Republic of South Africa and Zimbabwe. One new ophryoscolecid *Entodinium carinatum* is described. Certain aspects of the taxonomy of *Diplodinium archon, Entodinium longinucleatum* and *Entodinium dilobum* are discussed.
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Agtien spesies van die familie Ophryoscolecidae, verteenwoordigend van drie genera, en drie spesies van die familie Isotrichidae, verteenwoordigend van twee genera, is in die rumina van koedoes afkomstig vanaf die Republiek van Suid-Afrika en Zimbabwe gevind. Een nuwe spesie *Entodinium carinatum* behorende tot die Ophryoscolecidae word beskryf. Aspekte met betrekking tot die taksonomie van *Diplodinium archon, Entodinium longinucleatum* en *Entodinium dilobum* word bespreek.
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Despite extensive research on the rumen ciliates of African ruminants the greater kudu *Tragelaphus strepsiceros* has received little attention. For example, van der Wath & Myburgh (1941) mention only the following ciliates in kudu from South Africa: *Diplodinium neglectum, Epidinium ecaudatum* and *Entodinium simplex*. In contrast the related *Tragelaphus scriptus* (bushbuck) has received more attention (Buisson 1924; Dogiel 1927; Noirot-Timothée 1956; Latteur 1966, 1968). The present report gives an account of the rumen ciliates of kudu from different regions of the Republic of South Africa and Zimbabwe.

Materials and Methods

A total number of 22 rumen fluid samples were obtained from kudu from the following localities:

Lower Sabi River Valley, Zimbabwe — two samples,
Soutpansberg district, Transvaal — eight samples,
Thabazimbi district, Transvaal — three samples,
Loskopdam Nature Reserve, Transvaal — six samples,
Grahamstown district, Cape Province — three samples.

Sampling of rumen fluid was based on the methods of Lubinsky (1963). As soon as possible after the kudu was killed an incision of approximately 25 cm in length was made in the rumen wall. The rumen contents were then poured into a bucket or left in the rumen, in both instances being thoroughly mixed. In order to obtain 20 ml of fluid free from solid material, small quantities of the rumen contents were squeezed by hand or filtered through cheese cloth. This fluid was poured into a vessel containing 20 ml of 10% formalin.

Slides for microscopical examination were prepared by using the ordinary smear technique as described by Mahoney (1973). In order to obtain representative subsamples from the sample containers the preserved rumen fluid was thoroughly mixed and a few drops were quickly placed on a microscope slide together with a drop of glycerine. This mixture was smeared to approximate the size of a 22 × 40 mm cover slip. The function of the glycerine is to prevent the desiccation of the preparation. After this a cover slip was placed on the preparation and sealed and fixed to the microscope slide with a mounting medium.

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Such unstained preparations remain in a good condition for several months and all organelles are clearly recognizable. Furthermore, the deformation of ciliates often encountered when using staining agents is prevented. Ten such preparations were made for each individual sample. Where it was necessary to study the structure of skeletal plates, chlorzinc iodine was used as a staining agent (Dogiel 1927).

Identification of the species of the family Ophryoscolecidae was accomplished with the aid of Dogiel (1925, 1927, 1932) Buisson (1924) and Kofoid & MacLennan (1930, 1932). The emendments of Noirot-Timothée (1960) as far as the subgenera of the genus *Diplodinium* are concerned were accepted. For the classification of the family Isotrichidae the system used by Becker & Talbot (1927) was followed.

Taxonomic problems concerning the family Ophryoscolecidae were encountered in only a few species. Consequently the ciliates found in kudu are, with a few exceptions, only listed in tabular form. Description of the morphology of the Ophryoscolecidae follows Lubinsky (1958).

Results

Eighteen species of the Ophryoscolecidae and three species of the Isotrichidae were found in the rumina of kudu (Table 1).

The following are comments on the problems encountered in the Ophryoscolecidae:

Genus *Diplodinium* Schuberg, 1888 emend. Noirot-Timothée, 1960

Diplodinium (Diplodinium) archon Latteur, 1966

Synonym: *Eodinium bispinosum* Kleynhans & van Hoven, 1976.

The synonym of this species originated from the work of Kleynhans & van Hoven (1976) who, at the time of their research, were unaware of the description of Latteur (1966). Furthermore in the allocation of this species to the genus *Eodinium* they followed the system proposed by Kofoid & MacLennan (1932).

The presence of only one contractile vacuole in this species is in contrast with other *Diplodinium* species in which two or more contractile vacuoles are found (Dogiel 1927). This species can, nevertheless, be placed under the subgenus *Diplodinium* because of the absence of skeletal plates. Latteur (1966) did not specify the subgenus to which this species belongs.

Diplodinium archon was previously identified from bushbuck in Zaire (Latteur 1966) and *Giraffa camelopardalis* (giraffe) in South Africa (Kleynhans & van Hoven 1976).

Genus *Entodinium* Stein, 1858

Entodinium longinucleatum Dogiel, 1925.

Kleynhans & van Hoven (1976) found specimens of *Entodinium longinucleatum* with what appeared to be a contractile vacuole in the lower side and posterior part of the body. Such specimens were not observed in this study and it is unlikely that a contractile vacuole can occur in this area because its position is relatively constant in *Entodinium* species (Kofoid & MacLennan 1930). It is most probable that this structure was an artifact formed during the staining process.

Table 1 The rumen ciliates of kudu from different localities

Species	Locality				
	Lower Sabi River	Soutpansberg	Thabazimbi	Loskopdam Nature Reserve	Grahamstown
Family Ophryoscolecidae					
Epidinium africanum	–	–	–	+	–
E. ecaudatum	–	–	–	+	–
Diplodinium costatum	+	+	+	+	+
D. archon	–	–	+	+	+
D. neglectum	+	+	+	+	+
D. triloricatum	–	+	+	+	–
Entodinium exiguum	–	+	–	+	+
E. longinucleatum	+	+	+	+	+
E. triacum	+	+	+	+	–
E. quadricuspis	+	+	+	+	+
E. bicornutum	+	–	–	–	–
E. rectangulatum	–	–	–	–	+
E. furca	–	–	+	+	+
E. dilobum	–	–	+	+	+
E. anteronucleatum	–	–	+	+	–
E. simplex	–	+	+	+	–
E. dubardi	–	+	+	+	+
E. carinatum sp. nov.	+	+	–	–	–
Family Isotrichidae					
Dasytricha ruminantium	+	+	+	+	+
Isotricha prostoma	–	–	–	+	–
I. intestinalis	+	–	+	+	+

– = absent; + = present

Entodinium dilobum Sládeček, 1946.

It is evident now that what Dogiel (1927) considered a form (*viz. dilobum*) of *Entodinium furca* was actually a morphological variety of quite a different species. Dogiel mentioned the presence of two pointed triangular lobes as distinctive. In his description of *Entodinium dilobum* Sládeček (1946) indicated the possession of similar but blunt lobes plus two flanges as diagnostic for this species. Furthermore, he mentioned that the *dilobum* form of *E. furca* usually occurred in the same hosts in which he encountered *E. dilobum* and obviously failed to see the relationship between the two forms.

Lubinsky (1958) observed intermediate forms between *E. dilobum* Sládeček, 1946 and the *dilobum* form of *E. furca* and concluded that these names actually refer to the same taxon which differ sufficiently from the other two forms of *E. furca* to be recognized as a separate species. According to him the specific name applied by Sládeček (*op. cit.*) is not valid because Sládeček still recognized and used the name *dilobum* to denote the existence of a certain form of *E. furca*. Lubinsky (*op. cit.*) held the view that any third name in a trinominal has the status of a

subspecific name and that a species name has to be rejected as a homonym when it has previously been used for some other species or subspecies of the same genus. Lubinsky proposed, therefore, that the fact that intermediate forms between *E. dilobum* as described by Sládeček (*op. cit.*) and the *dilobum* form of *E. furca* as described by Dogiel (*op. cit.*) are evidently present, the name *E. dilobum* must be used for this taxon but that Dogiel (1927) must be the author. I agree with him as far as the naming of the taxon is concerned but disagree on the point of authorship. Article 1 of the International Code of Zoological Nomenclature (adopted by the XV International Congress of Zoology, London, July, 1958; published by the International Trust for Zoological Nomenclature, 1964) states that any infrasubspecific forms as such are excluded in the rules and Article 10(b) that 'A name first established with infrasubspecific rank becomes available if the taxon in question is elevated to a rank of the species-group, and takes the date and authorship of its elevation'. Because Dogiel (*op. cit.*) clearly indicated that he did not refer to subspecies when he used the term 'forma' this name must be regarded as that of an infrasubspecific form (*vide* Art. 45d (iii) of the code referred to above). The name *dilobum* can therefore be used in the genus *Entodinium* as a specific or subspecific name. It will thus be correct to recognize Sládeček as the author of *E. dilobum*, although he did not realize that this species exhibited a relatively wide range of different morphological forms.

Lubinsky (1958) was uncertain as to the status of other forms of *E. furca*, that is, the *monolobum* and *angustatum* forms. Dogiel (1927) pointed to the fact that he did observe transitional stages between the *dilobum* and *monolobum* forms of *E. furca*. Because of this it is obvious that the *monolobum* form of *E. furca* is in actual fact a form of *E. dilobum*.

In the kudu only individuals with two pointed caudal lobes were observed. Flanges were completely absent. It is interesting to note that in *Damaliscus dorcas dorcas* (bontebok) all specimens have flanges (Kleynhans unpublished) and in giraffe flanges are absent (Kleynhans & van Hoven 1976).

Measurements for *E. dilobum* from kudu are comparable with those from giraffe (Kleynhans & van Hoven *op. cit.*). Individuals measured by Dogiel (*op. cit.*) and Lubinsky (*op. cit.*) are larger.

Entodinium carinatum sp. nov. (Figure 1A & B).

Diagnoses. Oesophagus funnel-shaped, elongated, terminating in the region of the posterior third of the macronucleus; sharp depression present on the right hand side of the body.

Description. Anterior end of the body truncate. Ovoid in shape with the sides smooth and convex. The left hand side of the body terminates in a prominent lobe and the right hand side in a smaller lobe. When viewed from the upper side it can be seen that the right hand side of the body forms a prominent depression which ranges from the adoral area to the anal region (Figure 1A). Macronucleus elongated, wedge-shaped and situated near the right hand side of the body. To the left and about in the middle region of the macronucleus lies the micronucleus.

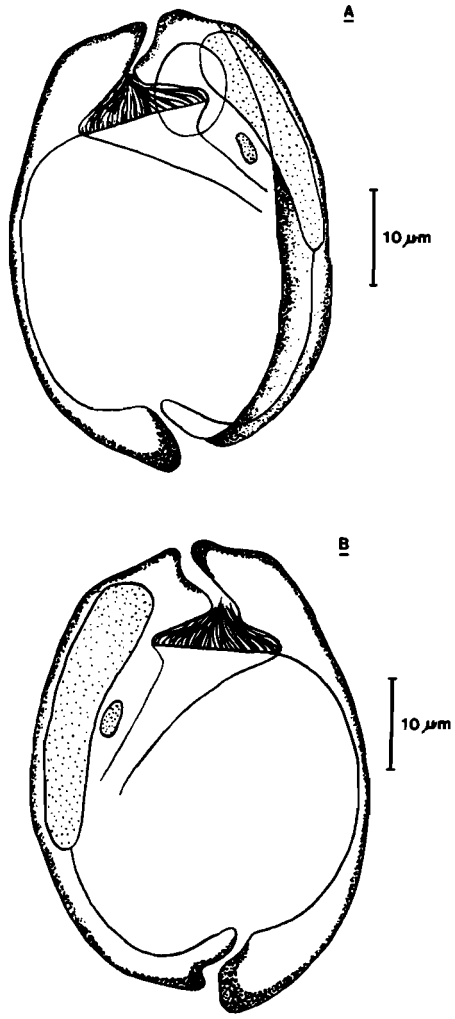

Figure 1 (A) *Entodinium carinatum* sp. nov. viewed from the upper side. (B) *Entodinium carinatum* sp. nov. viewed from the lower side.

Oesophagus long and funnel-shaped, directed towards the right and terminates in the region of the posterior third of the body. The contractile vacuole is situated in the upper side of the body and anterior and on the left side of the macronucleus. A large endoplasmic sac is present with the ectoplasm of moderate thickness except in the anal region where it is thicker to form the caudal lobes (Figure 1A & B).

Variations. No marked morphological variations were observed.

Dimensions. Measurements for 50 individuals are: body length 42,8(37,2 – 48,7) µm; body width 31,7(26,7 – 35,3) µm; macronucleus length 23,8(18,1 – 28,7) µm; body length to body width ratio 1,35(1,17 – 1,47) and body length to macronucleus length ratio 1,80(1,50 – 2,18).

Relationships. Owing to the presence of a depression on the right hand side of the body *E. carinatum* does not resemble any other species. The depression as encountered in this species is not similar to the flanges present in *Entodinium dilobum* and *Entodinium fyferi* van Hoven, 1975. A flange is a region of thickened ectoplasm devoid of any cuticular striations (Kofoid & MacLennan 1930). *Entodinium carinatum* resembles other spineless species of *Entodinium viz. E. anteronucleatum, E. dubardi* and *E. simplex* in having an ovoid shaped body.

This description is based on the rumen fluid of kudu from the Soutpansberg district of the Transvaal Province and the Lower Sabi River Valley in Zimbabwe.

Discussion

It is evident from Table 1 that the rumen ciliates of kudu from different areas differ with respect to the ciliates present. The only ciliates found in samples from all areas are *Diplodinium neglectum, D. costatum, Entodinium longinucleatum, E. quadricuspis* and *Dasytricha ruminantium*.

The kudu has eight ciliate species in common with bushbuck, namely: *Diplodinium archon, D. triloricatum, D. neglectum, Epidinium ecaudatum, Entodinium longinucleatum, E. triacum, E. bicornutum* and *E. dubardi* (Buisson 1924; Dogiel 1925, 1927, 1932; Noirot-Timothée 1956; Latteur 1966, 1968).

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