SELENOMONAS RUMINANTIUM, A BLOOD PARASITE OF WHITE-TAILED DEER IN ILLINOIS

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ABSTRACT. — *Selenomonas ruminantium* was found in 27 (6%) of 445 blood smears from white-tailed deer *Odocoileus virginianus* in Illinois. No other protozoan or helminth parasites were seen in these smears. The taxonomic position of *Selenomonas* is still uncertain. It has been considered a flagellate protozoon or a bacterium. Electron micrographs of sections of the flagella will probably be necessary to decide its position.

In conjunction with a study of disease of wild, whitetailed deer (*Odocoileus virginianus*) being carried out in Illinois under the direction of Dr. Deam H. Ferris, an opportunity was provided to study their blood parasites.

MATERIALS AND METHODS

The deer were shot by hunters in the October hunting seasons of 1958 thru 1962. They were brought to check stations maintained by the Illinois State Department of Conservation. There they were weighed and blood samples were taken for serologic studies. Blood smears were made of some of them and brought to the laboratory in Urbana for later parasitologic examination. The smears were fixed in methyl alcohol and stained with Giemsa stain. Each slide was carefully examined under the oil immersion objective, using a Leitz Ortholux microscope equipped with apochromatic objectives.

RESULT

The only blood parasite recognized was *Selenomonas ruminantium* (Certes, 1889) von Prowazek, 1913. Details of its occurrence are given in Table 1. The organism was found in 27 (6%) of 445 blood smears. It was present in 13 (8.5%) of 153 blood smears from northern Illinois (the Savanna Ordnance Depot and the vicinity of Oregon, Illinois), and in 14 (4.7%) of 292 blood smears from southern Illinois (the region around the Dixon Springs Experiment Station of the Uni-

TABLE 1.—Prevalence of *Selenomonas Ruminantium* in the Blood of White-tailed Deer *Odocoileus Virginianus* in Illinois.

Locality and year	No. smears Examined	Positive smears Number	Positive smears Percent
Savanna Ordnance Depot			
1958	52	2	4
Oregon, Illinois			
1958	101	11	11
Dixon Springs Exper. Sta.			
1958	100	9	9
1959	76	4	5
1961	111	1	1
1962	5	0	0
Total	445	27	6

versity of Illinois). Its prevalence varied from 1 to 9% in different years around the Dixon Springs station. Because of this variation, the difference in prevalence between northern and southern Illinois is not considered significant.

Taxonomy and Discussion

Selenomonas ruminantium occurs commonly in the rumen of cattle, sheep and goats; it has also been found in various wild ruminants including the gazelle, giraffe and antelope (*Cephalophus maxwelli*) in Africa and the pronghorn antelope (*Antilocapra americana*), mule deer (*Odocoileus hemionus*) and elk (*Cervus nannodes*) in the United States (California) (Levine, 1961). According to Lessel (1957), it is the predominant organism found on microscopic examination of the rumen fluid.

S. ruminantium has been found in the blood of *C. maxwelli* in Africa by Kérandel (1909), of *A. americana* in California by Chattin, Herman and Kirby (1944), and of *O. hemionus* in California by Herman and Sayama (1951). Ours is the first report of its occurrence in *O. virginianus*.

S. ruminantium is crescent-shaped, 8 to 11 by 2 to 3 μ, with a tuft of flagella arising from the center of the concave side. The nucleus is in the center of the concave side.

Three species of *Selenomonas* are presently accepted. *S. ruminantium* occurs in the rumen of various ruminants. *S. palpitans* Simons, 1922 occurs in the cecum and upper part of the colon of the guinea pig. *S. sputigena* (Flügge, 1886) Boskamp, 1922 occurs in the mouth of man. The last species was accepted as the type species of the genus by the Judicial Commission of the International Microbiological Congress (1958), altho Jeynes (1956) had previously considered *S. ruminantium* to be the type species.

The taxonomic position of the genus *Selenomonas* is still uncertain. Wenyon (1926) and Levine (1961) considered it a flagellate protozoon and assigned it to the family Callimastigidae. Jeynes (1955, 1956) also considered it a flagellate, assigning it to the family Monadidae.

However, Bryant (1956), Lessel (1957), and Hobson and Mann (1961) considered it to be a bacterium belonging to the family Spirillaceae. MacDonald, Madlener and Socransky (1959) considered *S. sputigena* and *S. ruminantium* to be bacteria, assigning them to the genus *Spirillum*, but they considered *S. palpitans* to be a protozoon.

The reasons for this difference of opinion are grounded in the structure and cultivability of the organisms. Macdonald (1953) cultivated *S. sputigena* readily in thioglycollate broth and other media; Macdonald and Madlener (1957) studied it further, isolating it from the oral cavity of man in veal heart infusion-sodium lauryl sulfate-sheep serum medium.

Bryant (1956) first cultivated *S. ruminantium* from bovine rumen contents, using a variety of anaerobic media, including rumen fluid or yeast extract-trypticase media containing glucose. Bryant (1956) described the cultural characters of *S. ruminantium* from cattle. Some

strains are unable to utilize lactate, whereas others produce propionic and acetic acids from it; Bryant (1956) considered the latter a new variety, *S. ruminantium* var. *lactilyticas*.

Hobson and Mann (1961) considered *S. ruminantium* var. *lactilyticas* to be among the most important microorganisms of the glycerol-fermenting flora of the sheep rumen. They grew it anaerobically in a casein hydrolysate (Difco Casitone)-yeast extract medium containing ammonium sulfate and 1.0% glycerol; the glycerol was fermented to propionic acid. Later, Hobson, Mann and Smith (1963) found that Strain 6 of *S. ruminantium* from sheep differed from bovine *S. ruminantium* in not utilizing ammonia and in requiring amino acids for growth.

S. palpitans of the guinea pig has not been cultivated, and Macdonald, Madlener and Socransky (1959) reported that all their attempts to do so were unsuccessful.

The appearance of *S. ruminantium* in culture is different from its appearance in the rumen. The selenomonads from sheep studied by Hobson and Mann (1961) in culture were curved gram-negative rods with flagella in various locations, especially on the middle of the curved side. They gave outline sketches of 15 individuals, but none had the crescent shape characteristic of the species, and all were smaller than the forms present in the rumen. However, Hobson, Mann and Smith (1962) found that fluorescent antisera prepared against strains of the small *S. ruminantium* var. *lactilyticas* grown in vitro from sheep rumen contents appeared to react specifically with some of the large selenomonads that they saw in vivo in rumen contents; they concluded that the selenomonads isolated in culture were probably the same as those seen in the rumen.

Macdonald, Madlener and Socransky (1959) published three electron micrographs of *S. sputigena* shadowed with palladium and another one unshadowed, and said that *S. ruminantium* appeared similar. They stated that the flagella of these two species originated in a random fashion, singly or as tufts, from any point on the circumference of the body. However, their electron micrographs did not reveal the structure of the flagella. As mentioned above, they considered these two species to be bacteria, and *S. palpitans* to be a protozoon.

On the basis of the above studies, it is still uncertain whether *Selenomonas* is a protozoon or a bacterium. The fact that *S. ruminantium* will grow in bacterial culture media does not prove that it is a bacterium; trichomonads, for instance, will grow readily in thioglycollate broth and other bacterial media, and trypanosomes will grow readily in leptospire media. Electron micrographs of sections of the flagella prepared to establish their fine structure will probably be necessary to decide the taxonomic position of the genus.

There is still some uncertainty whether a parasite of the rumen and reticulum can also occur in the blood or whether it may have invaded the blood stream after death or may have been introduced into the smears as a contaminant at the time

they were prepared. The last possibility seems unlikely to have occurred in such a high percentage of cases, especially since care was taken to avoid such contamination. However, since all the smears examined in the present study were made after the animals had died, the second possibility cannot be ruled out. Positive smears from the peripheral blood of living animals would be required in order to do so. In discussing the possibility, however, Herman and Sayama (1951) considered it unlikely.

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