

From the Department of Bacteriology, Royal Veterinary College,  
Stockholm.

## HAEMOLYTIC ESCHERICHIA COLI SEROTYPES ISOLATED FROM PIGS, CATTLE, DOGS, AND CATS<sup>1)</sup>

By  
*Ingmar Månsson*

It has long been recognised that *Escherichia coli*, although part of the normal intestinal flora, can also cause infections in human beings and animals. For many years there were no means of accurately typing the various strains isolated. This difficulty naturally hindered study of the significance of these organisms for the infectious diseases with which they were associated. Extensive investigations, particularly by *Kauffmann* and his associates, have now clarified many of the serological properties of *E. coli*. Strains isolated from diseased and normal organs can now be identified and many conclusions of practical value reached.

*Kauffmann & Knipschildt*, for example, found that cultures from pathological material were more often O-inagglutinable than those obtained from normal faeces. *Vahlne* (1945) could demonstrate that 78 per cent of the *E. coli* strains isolated from inflamed appendices of human beings belonged to O-groups 1 to 25 and that the corresponding proportion for strains from faeces was 42 per cent. The tendency for pathogenic strains of *E. coli* to have several serological properties in common was also demonstrated by *Ewertssen's* (1946) results; most cultures obtained from pathological material belonged to certain O-groups and at the same time they were often O-inagglutinable. *Wramby* (1948) made similar observations on *E. coli* strains recovered from calves and *Fey* (1954) found that 50 per cent of the *E. coli* strains isolated from bovine mastitis belonged to a few O-groups. *Sjöstedt* (1946) confirmed an earlier observation that *E. coli* of

---

<sup>1)</sup> This work has been supported by a grant from Statens medicinska forskningsråd.

O-groups 2, 4, and 6 are often haemolytic. There is now an extensive literature dealing with *E. coli* serotypes; the interested reader is referred to the monographs by *Kauffmann* (1954) and by *Edwards & Ewing* (1955) among others.

Haemolytic strains of *E. coli* isolated from pigs have been intensively studied during recent years. *Schofield & Davis* (1955) noticed an abundant growth of haemolytic *E. coli* in the faeces of pigs with "oedema disease" and *Gregory* (1955) made a similar observation. These first reports were rapidly followed by many others. *Gitter* (1957) reported that haemolytic *E. coli* could be isolated from pigs with diseases other than "oedema disease". More precise identification of these strains was clearly necessary. It was soon noticed (*Sojka et al.*, 1957) that only certain serotypes of haemolytic *E. coli* were associated with "oedema disease". *Ewing et al.* (1958) observed that 30 of 38 strains isolated from pigs with "oedema disease" belonged to one of two serotypes, O 138:K 81(B):(H 14) or O 139:K 82(B):H 1. The O-antigens 138 and 139 and the K-antigens 81(B) and 82(B) were new additions to the antigen pattern of *E. coli*. *Quinchon et al.* (1958) in France isolated three serotypes from "oedema disease" but since the same strains could also be demonstrated in healthy pigs they suggested that additional but unknown factors had a part in the production of "oedema disease". In a report from Holland, *Terpstra* (1958) mentioned that haemolytic *E. coli* could be isolated from pigs with gastroenteritis as well as from animals with "oedema disease" and that the serotypes corresponded with those described by *Sojka et al.* (1957). *Campbell* (1959) studied the occurrence of haemolytic *E. coli* in the faeces of healthy pigs and isolated 127 strains from the 293 pigs examined (43 per cent). Of these strains 55 belonged to the O-groups which have been associated with "oedema disease", i. e. 46 of his strains belonged to the O-group 138 (O 138) and nine to the O-group 141 (O 141). O 139 strains were not recovered from his material.

*Sojka et al.* (1960) typed 2321 strains, of which 1542 were haemolytic, recovered from pigs with "oedema disease" or with gastroenteritis. With the use of four sera 52 per cent of the strains could be O-grouped — 22 per cent as O 139, 11.3 per cent as O 141, 10.2 per cent as O 138, and 8.5 per cent as O 8. In spite of using an additional 40 sera, 31 per cent of the strains were not typable. Most of these untypable strains were non-haemolytic. Strains isolated from animals with "oedema disease" or gastroenteritis were not uniformly distributed among the four major O-groups. Of the 411 strains isolated from "oedema disease" 82 per cent could be typed with three sera — 38.9 per cent as O 139, 30.2 per cent as O 141, and 12.9 per cent as O 138. Most of these strains (92 per cent) were haemolytic. Many of the strains isolated from pigs with gastroenteritis were also haemolytic (406 of 549, 74 per cent) and 58.5 per cent represented three O-groups — O 141 (28.8 per cent), O 8 (17.7 per cent), and O 138 (12 per cent). Haemolytic *E. coli* could also be demonstrated in the faeces of clinically healthy pigs but only in relatively low numbers.

*Richards & Frazer* (1961) studied 33 haemolytic *E. coli* strains isolated from pigs 8—12 weeks old which had died of enteritis. The following serotypes were found: O 138:K 81(B) 26 strains, O 139:K 82(B) 2 strains, O 141ab:K 81(B) 2 strains. Three strains were untypable with the sera used. They could always demonstrate the haemolytic *E. coli* strains in the intestinal contents as well as in all but 9 per cent of the mesenteric lymph nodes and 45 per cent of the spleens cultivated. From their results they concluded that the pigs died of enteritis with terminal bacteraemia rather than in a true septicaemia.

According to *Saunders et al.* (1960) among others "oedema disease" and gastroenteritis are most prevalent among pigs eight to twelve weeks old. The intestines and mesenteric lymph nodes of pigs with "oedema disease" generally yield strains belonging to O-group 139 while in the isolates from pigs with gastroenteritis, strains belonging to O-group 141 dominate. *Saunders et al.* also described a disease of very young piglets which could be regularly associated with certain *E. coli* serotypes, particularly O 8 and O 141. The strains from the young piglets were less often haemolytic than the corresponding serotypes isolated from older pigs. A particular serotype, then, could be either haemolytic or non-haemolytic and "the production of haemolysis varies with the conditions of incubation, particularly carbon dioxide potential".

For further details and additional references on the occurrence of haemolytic *E. coli* in connection with "oedema disease" the reader is referred to publications by *Timoney* (1949, 1950, 1956, 1957), *Gitter & Lloyd* (1957), *Hess & Suter* (1954), *Roberts & Vallely* (1959), *Davis et al.* (1961).

In a preliminary report (*Månsson*, 1959) it was mentioned that an abundant growth of haemolytic *E. coli* (particularly serotypes O 138:K 81(B) and O 141:K 85(B)) could be obtained from the intestinal contents and various organs of pigs with acute haemorrhagic enteritis and that "oedema disease" had not been observed on the farms from which the animals originated. The present paper gives a more detailed description of these observations. The paper also includes information on the serotypes of haemolytic *E. coli* which have been encountered in material obtained from cattle, dogs, and cats as well as pigs. The haemolytic and serological properties of these strains will be described here and their biochemical properties in a subsequent paper.

## MATERIAL AND METHODS

The 272 haemolytic *E. coli* strains examined were isolated from 178 animals of various species, 108 pigs, 17 cattle, 45 dogs,

and 8 cats. Material from many of these animals (66 pigs, 17 cattle, 18 dogs, and 6 cats) was obtained after autopsy in the Dept. of Pathology at the Royal Veterinary College, Stockholm. Only one strain from a particular animal is included in this investigation except in the case of animals dying of septicaemia; at the most two strains have been included from these animals even although isolations were made from several organs. The pigs originated from more than 50 farms and each of the cattle represents a different herd. The additional strains from the dogs and cats were isolated from clinical material. Regional laboratories contributed 42 strains isolated from 28 pigs. And finally, 14 strains were obtained from the faeces of 14 clinically healthy pigs on farms where deaths had occurred and the pathological and bacteriological findings suggested that haemolytic *E. coli* was involved in the production of disease.

*Pathologic-anatomical findings.*

The pathological changes observed at autopsy have varied. Most of the *pigs* showed signs of enteritis with septicaemia—acute enteritis, often haemorrhagic, acute splenitis, and generalised acute lymphadenitis. Limited local and aetiologically independent lesions such as pneumonic foci in the lungs were noted in a few of the pigs. The age of the animals ranged from 4 to 10 weeks. The course was usually very rapid; animals often died without the owners noticing any clinical signs. A few animals vomited some hours before death, a few were anorexic and depressed. Deaths occurred sporadically; on most farms one or two pigs died but the others, even littermates, usually remained free from signs of disease. Only one pig, submitted from southern Sweden, had signs of “oedema disease”. The other pigs in the autopsy material originated from the Stockholm district where “oedema disease” has not been observed clinically (*Lannek*, 1961). The pig strains isolated at other laboratories in the country originated from pigs of much the same age and with a clinical history and autopsy findings similar to those for the autopsy material at the Royal Veterinary College.

Of the 17 *bovine* strains, 10 were isolated from calves less than 3 weeks old and for which the autopsy diagnosis was septicaemia. The other strains were obtained from mastitis and septicaemia (2 strains), chronic mastitis (1 strain), and acute enteritis (4 strains).

The haemolytic *E. coli* strains from *dogs* originated from animals with enteritis with septicaemia (2), post-operative peritonitis with septicaemia (1), and the rest from animals with enteritis, cystitis, bronchopneumonia, endometritis, or otitis externa.

The *cat* strains originated from animals with gastroenteritis, with or without septicaemia.

#### *Bacteriological technique.*

##### *Haemolytic test.*

The primary isolations were made on horse-blood agar. Colonies which showed haemolysis on these plates were also tested for haemolysis in peptone-saline solution containing horse erythrocytes which had been washed 3 times. To each 5 ml. medium in a tube was added 1 ml. erythrocytes. These tubes were inoculated with one needle point from a 20-hours agar culture, incubated overnight at 37°C and read ocularly.

##### *Serological methods.*

For serological study, immune serum was prepared in rabbits for ten *E. coli* strains isolated from animals which had not been in contact; 8 pigs, a calf, and a dog. The methods described by *Kauffmann* (1954) were used for the serological studies. Agglutinations were carried out in tubes, except for the K-agglutinations which were made on slides. Each serum was used separately. Through cross-agglutination and cross-absorption 5 O-antigens, 3 K-antigens, and 3 H-antigens could be demonstrated. These were referred to the International Escherichia Centre in Copenhagen for classification (Table 1). O-agglutination of homologous strains usually gave a distinct reaction in dilutions of 1:2560 and a less distinct reaction in dilutions of 1:5120.

It is apparent from Table 1 that these ten strains could be divided into five serologically identical groups — nos. 1, 2, and 9 (no. 1 was non-motile), nos. 3 and 4, nos. 5 and 10, and nos. 7 and 8, while no. 6 was the only representative of its type. All 272 strains covered by this report were then agglutinated with the O-sera 2, 6, 138, 139, and 141. K- and H-agglutinations were then carried out within the O-groups.

Table 1. Source of haemolytic *E. coli* serotypes.

Serial no.	Strain no.	Species	Autopsy diagnosis	Antigen		
				O	K	H
1	960/1957	Pig	Enteritis with septicaemia	138	81 B	non-motile
2	3439/1955	Pig	Enteritis with septicaemia	138	81 B	14
3	2012/1956	Dog	Pneumonia	6	— <sup>1)</sup>	1
4	2382/1957	Pig	Pneumonia	6	— <sup>1)</sup>	1
5	149/1957	Pig	Haemorrhagic enteritis with septicaemia	141	85 B	4
6	311/1957	Pig	Haemorrhagic enteritis with septicaemia	139	82 B	1
7	354/1957	Pig	Haemorrhagic enteritis with septicaemia	2	— <sup>1)</sup>	1
8	491/1957	Calf	Septicaemia	2	— <sup>1)</sup>	1
9	34/1958	Pig	Enteritis with septicaemia	138	81 B	14
10	316/1958	Pig	Enteritis with septicaemia	141	85 B	4

<sup>1)</sup> K-antigen not determined.

## RESULTS

Of these 272 strains, 209 or 76.8 per cent could be grouped with the five O-sera used (Table 2). The following distribution was obtained (cf. Table 3 a).

O-group 2	14	strains
O-group 6	24	„
O-group 138	79	„
O-group 139	6	„
O-group 141	86	„

Of the 14 strains in *O-group 2*, seven were isolated from seven dogs for which the diagnoses were endometritis, pneumonia, cystitis, hepatitis, or enteritis. Two strains originated from a cow with septic endometritis, and the remaining 5 from 5 pigs with enteritis.

Twelve of the 24 strains in *O-group 6* were isolated from 12 dogs with pneumonia, cystitis, or enteritis. Four strains were isolated from 4 cows, 2 with mastitis and 2 with enteritis. Two

Table 2. Isolations of haemolytic *E. coli* strains belonging to O-groups 2, 6, 138, 139, and 141.

Species	No. of O-grouped strains (2, 6, 138, 139 and 141)	No. of animals from which isolations were made	No. of strains not agglutinating with the 5 O-sera used	Per cent O-grouped strains	Relative no. of animals from which O-grouped strains were isolated	No. of animals from which non-typable strains were isolated
Pigs	163	99	16	91.1	91.7	9
Cattle (incl. calves)	18	12	10	64.3	70.6	5
Dogs	25	25	28	47.2	55.6	20
Cats	3	3	9	25	37.5	5
Total	209	139	63			39

strains were recovered from 2 cats with enteritis and the other 6 strains from 6 pigs with pneumonia or enteritis.

*O-group 138* includes 79 strains of which 71 were isolated from 39 pigs. Thirty-two of these pigs had enteritis, usually an haemorrhagic type with septicaemia. Seven of the pig strains were isolated from the faeces of living animals. The other 8 strains in this O-group were isolated from 5 calves with enteritis.

As for the 6 strains in *O-group 139*, 4 were isolated from 3 pigs with acute enteritis with septicaemia and 2 strains from a calf with the same diagnosis.

Of the 86 strains in *O-group 141*, 77 were isolated from 46 pigs. Thirty-nine of these animals had acute enteritis, often with septicaemia. Seven strains were recovered from the faeces of 7 pigs. Six strains originated from 6 dogs with pyometra, enteritis, pneumonia, or cystitis. The other 2 strains were isolated from 2 calves with enteritis or enteritis with septicaemia.

Table 3 a. Distribution of the 209 O-grouped strains (Table 2) according to O-group and host animal.

Species	O-group 2		O-group 6		O-group 138		O-group 139		O-group 141	
	No. of strains	%	No. of strains	%	No. of strains	%	No. of strains	%	No. of strains	%
Pigs	5	3.1	6	3.7	71	43.6	4	2.4	77	47.2
Cattle	2	11.1	4	22.2	8	44.4	2	11.1	2	11.1
Dogs	7	28	12	48	—	—	—	—	6	24
Cats	—	—	2	67	—	—	—	—	1	33
Total	14	6.7	24	11.5	79	37.8	6	2.9	86	41.1

Two strains have been included from some of the animals with septicaemia. For this reason Table 3 a does not indicate the number of animals from which the particular strains were isolated. This information is given in Table 3 b.

Table 3 b. Number of animals from which the strains listed in Table 3 a were isolated.

Species	O-group 2		O-group 6		O-group 138		O-group 139		O-group 141	
	No.	%	No.	%	No.	%	No.	%	No.	%
Pigs	5	5.1	6	6.1	39	39.3	3	3.1	46	46.4
Cattle	1	8.3	4	33.3	5	41.7	1	8.3	1	8.3
Dogs	7	28	12	48	—	—	—	—	6	24
Cats	—	—	2	67	—	—	—	—	1	33
Total	13	9.4	24	17.3	44	31.7	4	2.9	54	38.8

O 138 and O 141 were the most common types isolated from *pigs* and O 139 the least common (Tables 3 a, 3 b). Strains belonging to the O-groups 6 and 2 were also encountered in this species. The most common O-types seen in *cattle*, mature animals as well as calves, were 138 and 6, while strains belonging to the O-groups 2, 139, and 141 were also represented in the material. The strains isolated from *dogs* belonged to the O-groups 6, 2, and 141. Two *cat* strains were grouped as O 6 and one as O 141.

The K-antigen in the O-groups 2 and 6 has not been identified. Most of O 2 strains had the H-antigen 1; one strain had an H-antigen 6. O-group 6 also contained strains with an H-antigen 1 as well as with H-antigen 7, 10, and 31. (These additional serological studies were carried out at the International Escherichia Centre in Copenhagen). The strains in O-group 138 had identical O-, K-, and H-antigens. Most of these strains (73 of 79, 92 per cent), however, were non-motile in semi-solid media. Motile strains had H-antigen 14 and all had K-antigen 81 to give the serological formula O 138:K 81(B):(H 14).

The O 139 strains were also serologically identical and had the formula O 139:K 82 (B):H 1.

The O 141 strains were numerically the largest group. Most of the strains were motile (78 of 86, 91 per cent) and had H-antigen 4. Their K-antigen 85 was present as K 85ab(B) or K 85ac(B). Of 30 strains 12 were ab- and 18 were ac-strains (Ørskov, 1961).

Most of the strains (204 of 272) produced haemolysis in peptone-saline solution with added horse erythrocytes. This



haemolysis was usually quite strong and resulted in diffuse staining of the medium. For a few strains, however, haemolysis was fairly weak and could be seen only adjacent to the erythrocyte layer. Only 5 of the 209 strains which were serotyped (about 2 per cent) were non-haemolytic. Two of these strains were grouped as O 6, 2 as O 141, and 2 as O 138.

Abundant growth, often as pure culture, was obtained from the primary material. The tissues (liver, spleen, body lymph nodes) and intestinal contents from the animals with septicaemia gave very luxurious growth and in practically every instance pure culture of haemolytic *E. coli*. Colonies derived from different tissues were serologically identical apart from the very few exceptions (about 2 per cent) in which 2 serotypes were represented. When several animals from a particular farm were available for examination different serotypes were recovered in about 10 per cent of the instances.

The strains examined have formed mucoid colonies and this property was especially evident for O-group 138.

#### DISCUSSION

The use of 5 O-sera (2, 6, 138, 139, and 141) enabled the typing of 209 of 272 strains or 76.8 per cent. The serotype O 141: K 85(B):(H 4) was most common in pigs and included 46 per cent of the strains isolated from this species. A few strains belonging to the O-groups 2, 6, and 139 were also encountered. Only 6 strains of the group O 139 were recovered. These results confirm the observation that only relatively few serotypes are represented among the haemolytic *E. coli* strains which are associated with gastroenteritis in pigs (*Sojka et al.* (1960) among others). The distribution among the various O-groups found in the present material is remarkable in some respects. *Sojka et al.* (1960), for example, found that 28.8 per cent of the haemolytic *E. coli* strains isolated from pigs with various forms of gastroenteritis belonged to O-group 141 and 17.7 per cent of O-group 8 while O-group 138 represented only 12 per cent of their material. O 8 strains have not been demonstrated in the present material. Since so many of the pig strains (163 of 179 or about 91 per cent) were typable, this difference cannot depend upon O 8 serum not being used but instead reflects a real difference in the distribution of O-groups in the materials examined. Serotype O 138:K 81(B):(H 14) was identified much more often in the present material

than in that of *Sojka et al.* (1960) (Tables 2, 3). *Richards & Frazer* (1961) found that 33 of 36 haemolytic *E. coli* strains isolated from pigs with enteritis belonged to serotype O 138:K 81(B). It is apparent that different serotypes dominate in different materials studied.

Serotype O 139:K 82(B):H 1, often isolated from pigs with "oedema disease", was demonstrated in only 3 pigs, none with signs of this disease. The serotypes encountered most often in the pigs of this material have, with one exception, been isolated from diseases other than "oedema disease". This is remarkable since the same serotypes, together with O 139:K 81(B):(H 14), "account for 82 per cent of oedema disease strains" in the material studied by *Sojka et al.* (1960). These serotypes have, in fact, been demonstrated for several years in animals from a particular farm on which no signs of "oedema disease" have been observed (*Månsson*, 1962). Serotype O 138:K 81(B):(H 14) has also been recovered from 5 cattle and O 139 and O 141 strains have also been isolated from this species, in all instances in association with pathological changes. O 141 strains have also been isolated from dogs and cats but in these species were associated only with local inflammatory changes. There does not seem to be any great degree of host specificity for these strains, an observation of epizootological importance. Strains of O-groups 2 and 6 dominated in the dog and cat material and were mainly associated with local inflammatory changes (endometritis, cystitis, pneumonia etc.). Since only 28 of 37 strains from dogs and cats were typable, other serotypes seem to be fairly common in these species. It can be seen from the present results that strains of the O-group 2 can be isolated from pigs, cattle, and dogs. Seven of 45 strains from dogs belonged to this O-group, an indication that strains of this type are not infrequent in this species. O 2 strains have been recorded in Japanese pigs (*Ito*, 1960).

The material studied here included several animals, particularly pigs, with an autopsy diagnosis of septicaemia and from which an abundant growth of haemolytic *E. coli* was obtained in cultures from the intestinal contents and several internal organs. *Richards & Frazer* found true septicaemia to be unusual in pigs infected with haemolytic *E. coli*, particularly serotype O 138:K 81(B). The observations made on the material described in this paper do not confirm this opinion.

Of the 209 strains typed, 5 or about 2 per cent were non-haemolytic. Among the 63 strains which could not be typed 8 or about 13 per cent were non-haemolytic. Most of the strains were 3 to 5 years old and their haemolytic properties have been rechecked several times. This property thus remained fairly stable when tested in peptone-saline solution with added horse erythrocytes. Similar observations have been recorded by *Rees* (1959) and *Sojka et al.* (1960) among others. The proportion of non-haemolytic strains was greater among the strains which could not be typed with the sera used. From this it appears that the haemolytic properties of various haemolytic *E. coli* serotypes can vary and that strains of O-groups 138 and 141 are relatively stable in this respect. Non-haemolytic strains can also belong to these serotypes; *Rees* (1959), for example, has studied non-haemolytic O 141 strains. Even if the haemolytic property cannot be directly associated with the pathogenicity of a strain, this property is of great help in their primary recognition. *Saunders et al.* remarked that *E. coli* was more haemolytic when isolated from older pigs and that the occurrence of haemolysis varies with conditions of incubation, particularly carbon dioxide potential. Fifteen of the strains studied here were checked in this respect by culturing them on agar plates with horse blood added and in peptone-saline tubes with added horse erythrocytes. Incubation was carried out aerobically and in carbon dioxide and hydrogen atmospheres. There were no differences between the tubes after 20 hours. The plates incubated in a CO<sub>2</sub> atmosphere were difficult to evaluate because of the brownish colour induced in the blood. Haemolysis was distinct after incubation in a hydrogen atmosphere. Because of the effects of a CO<sub>2</sub> atmosphere on the erythrocytes, it seems unsuitable to test the haemolytic property under such conditions.

#### REFERENCES

- Campbell, S. G.*: Studies on strains of haemolytic *Escherichia coli* isolated from normal swine after weaning. *Vet. Rec.* 1959, 71, 909.
- Davis, J. W., Allen, R. G. and Suribert, R. M.*: Studies on hemolytic *Escherichia coli* associated with edema disease of swine. I. Separation and properties of a toxin of hemolytic *Escherichia coli*. *Amer. J. vet. Res.* 1961, 22, 736.
- Edwards, P. R. and Ewing, W. H.*: Identification of Enterobacteriaceae. Minneapolis, 1955.

- Erskine, R. G., Sojka, W. J. and Lloyd, M. K.*: The experimental reproduction of a syndrome indistinguishable from oedema disease. *Vet. Rec.* 1957, 69, 301.
- Ewertzen, H. W.*: Dyreexperimentelle Undersøgelser over Colibaciller-nes Pathogenitet og Effekten af Coliserum. Copenhagen, 1946.
- Ewing, W. H., Tatum, H. W. and Davis, B. R.*: *Escherichia coli* serotypes associated with edema disease of swine. *Cornell Vet.* 1958, 48, 201.
- Fey, H.*: Serologische, biochemische und biologische Untersuchungen an Stämmen aus boviner Colimastitis. Zürich, 1954.
- Gitter, M.*: Haemolytic *Bact. coli* in the "bowel oedema" syndrome. Part. I — An attempted investigation into the pathogenicity of the organism for experimental animals. *Brit. vet. J.* 1957, 113, 168.
- Gitter, M. and Lloyd, M. K.*: Haemolytic *Bact. coli* in the "bowel oedema" syndrome. Part. II — Transmission and protection experiments. *Brit. vet. J.* 1957, 113, 212.
- Gregory, D. W.*: Role of beta hemolytic coliform organisms in edema disease of swine. *Vet. Med.* 1955, 50, 609.
- Gregory, D. W.*: Edema disease /*E coli* toxemia/ of swine. *Vet. Med.* 1958, 53, 77.
- Gregory, D. W.*: Experimental edema disease /hemolytic *Escherichia coli* toxemia/ in pigs and in mice. *Amer. J. vet. Res.* 1960, 21, 88.
- Hess, E. und Suter, P.*: Die Ödemkrankheit des Schweines. *Schweiz. Arch. Tierheilk.* 1958, 100, 653.
- Ito, A.*: Studies on hemolytic *Escherichia coli* strains isolated from edema disease of swine in Japan. *Jap. J. vet. Res.* 1960, 8, 215.
- Kauffmann, F.*: *Enterobacteriaceae*. Copenhagen. 1954.
- Lannek, N.*: 1961. Personal communication.
- Månsson, I.*: Septic enteritis caused by haemolytic coliform bacteria. Preliminary report. XVI:th International Vet. Congr. Madrid, 1959, p. 529.
- Månsson, I.*: Haemolytic *E. coli* in diseased and healthy animals on a particular premises. *Acta vet. scand.* 1962. In press.
- Ørskov, F.*: 1961. Personal communication.
- Quinchon, A., Henry, M. and Mme Henry, G.*: Le syndrome entéro-toxique colibacillaire du porcelet. *Réc. Méd. Vét.* 1958, 134, 437.
- Rees, T. A.*: Studies on *Escherichia coli* of animal origin. 3. *E. coli* serotypes from pigs. *J. comp. Path.* 1959, 69, 334.
- Richards, W. P. C. and Frazer, C. M.*: Coliform enteritis of weaned pigs. A description of the disease and its association with hemolytic *Escherichia coli*. *Cornell Vet.* 1961, 51, 245.
- Roberts, H. E. and Vallely, T. F.*: An investigation into the relationship of haemolytic *Escherichia coli* to disease in pigs. *Vet. Rec.* 1959, 71, 846.
- Saunders, C. N., Stevens, A. J., Spence, J. B. and Sojka, W. J.*: *Escherichia coli* infection in piglets. *Res. vet. Sci.* 1960, 1, 28.

- Schofield, F. W. and Davis, D.*: Oedema disease /enterotoxemia/ in swine. II. Experiments conducted in a susceptible herd. *Canad. J. comp. Med.* 1955, 19, 242.
- Sjöstedt, S.*: Pathogenicity of certain serological types of *B. coli*. *Lund*, 1946.
- Sojka, W. J., Erskine, R. G. and Lloyd, M. K.*: Hemolytic *Escherichia coli* and "oedema disease" of pigs. *Vet. Rec.* 1957, 69, 293.
- Sojka, W. J., Lloyd, W. J. and Sweeny, E. J.*: *Escherichia coli* serotypes associated with certain pig diseases. *Res. vet. Sci.* 1960, 1, 17.
- Terpstra, J. I.*: Haemolytische colibakterien als oorzaak van ziekte bij het varken. *Tijdschr. Diergenesk.* 1958, 83, 1078.
- Timoney, J. F.*: Experimental production of oedema disease of swine. *Vet. Rec.* 1949, 61, 710.
- Timoney, J. F.*: Oedema disease in swine. *Ibid.* 1950, 62, 748.
- Timoney, J. F.*: Oedema disease of swine. *Ibid.* 1956, 68, 849.
- Timoney, J. F.*: Oedema disease in swine. *Ibid.* 1957, 69, 1160.
- Vahlne, G.*: Serological typing of the Colon Bacteria. *Acta path. microbiol. scand. Suppl.* LXII, 1945.
- Wramby, G.*: Investigations into the antigenic structure of *Bact. coli* isolated from calves. *Acta path. et microbiol. scand. Suppl.* LXXVI, 1948.

#### SUMMARY

Of 272 haemolytic strains of *E. coli* studied, 209 or 76.8 per cent belonged to 5 O-groups — 14 to O 2, 24 to O 6, 79 to O 138, 6 to O 139, and 86 to O 141. The strains were isolated from pigs, cattle, dogs, and cats. The distribution of the various serotypes among isolates from the different species is shown in Tables 3 a and 3 b.

The serotypes O 141:K 85(B):(H 1) and O 138:K 81(B):(H 14) were the most common types recovered from pigs, usually in association with acute enteritis — often haemorrhagic — and septicaemia in animals 4 to 10 weeks of age. Serotype O 141:K 85(B):(H 1) was also isolated from dogs and cats. Strains belonging to O-groups 2 and 6 were recovered from pigs, cattle, and dogs, usually in association with local inflammatory lesions (cystitis, pneumonia, enteritis etc.).

Serotype O 138:K 81(B):(H 14) was also isolated from cattle. Serotype O 139:K 82(B):H 1 was isolated from pigs and cattle. The haemolytic properties of the strains are discussed. With one exception no examples of "oedema disease" were seen.

#### ZUSAMMENFASSUNG

*Hämolytische Escherichia Coli Serotypen isoliert von Schweinen, Rindern, Hunden und Katzen.*

209 von 272 hämolytischen *E. Coli* Stämmen (76,8 %) gehörten zu 5 verschiedenen O-Gruppen, nämlich O-Gruppe 2 14St. O-Gruppe 6 24St. O-Gruppe 138 79St. O-Gruppe 139 6 St. und O-Gruppe 141 86St.

Die Stämme wurden von Schweinen, Rindern, Hunden und Katzen isoliert. Die Verteilung der verschiedenen Serotypen innerhalb der verschiedenen Tierarten geht aus den Tabellen 3 a und 3 b hervor.

Die Serotypen O 141:K 85(B):(H 1) und O 138:K 81(B):(H 14) kamen gewöhnlich bei Schweinen vor und wurden in der Regel im Zusammenhang mit akuten Enteriten isoliert — meistens hämorrhagische — mit Sepsis bei Schweinen im Alter von 4—10 Wochen. Serotyp O 141:K 85(B):(H 1) kam auch bei Hunden und Katzen vor. Stämme die zur O-Gruppe 2 und 6 gehörten kamen bei Schweinen, Rindern und Hunden vor, meistens im Zusammenhang mit lokalen Infektionen (Cystiten, Pneumonien, Enteriten etc.). O 138:K 81(B):(H 14) wurde auch von Rindern isoliert. O 139:K 82(B):(H 1) wurde von Schweinen und Rindern isoliert. Die hämolysierenden Fähigkeiten der Stämme wird diskutiert. Die Oedem-Krankheit ist mit einer Ausnahme nicht beobachtet worden.

#### SAMMANFATTNING

##### *Serologisk undersökning av hämolyserande Escherichia coli, som isolerats från svin, nöt, hund och katt.*

209 av 272 häm. E. coli stammar (76,8 %) tillhörde 5 O-grupper, nämligen O-grupp 2 14 st, O-grupp 6 24 st, O-grupp 138 79 st, O-grupp 136 6 st och O-grupp 141 86 st. Stammarna var isolerade från svin, nöt, hundar och katter. De olika serotypernas fördelning inom de olika djurslagen framgår av Tabell 3 a och 3 b.

Serotyperna O 141:K 85(B):(H 1) och O 138:K 81(B):(H 14) var vanligast förekommande hos grisar och hade som regel isolerats i samband med akuta enteriter — ofta hämorrhagiska — med sepsis hos grisar i åldern 4—10 veckor. Serotypen O 141:K 85(B):(H 1) förekom också hos hund och katt. O 2 och O 6 stammar förekom hos svin, nöt, hund oftast i samband med lokala infektioner (cystit, pneumoni, enterit etc.). O 138:K 81(B):(H 14) isolerades även från nöt. O 139:K 82(B):H 1 isolerades från svin och nöt. Hämolysförmågan hos stammarna diskuteras. Oedema disease har med ett undantag ej iakttagits.

(Received Febr. 15. 1962).